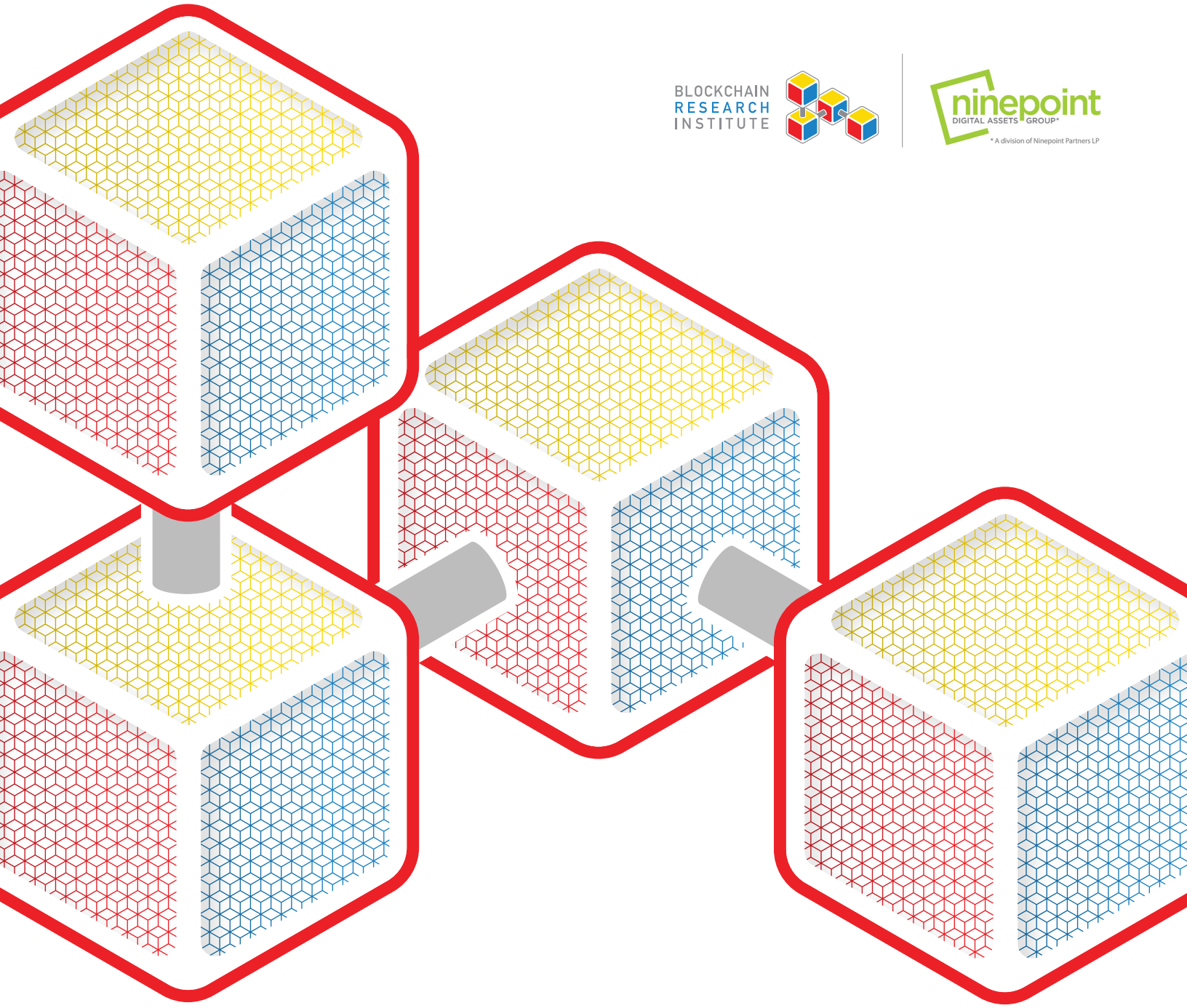


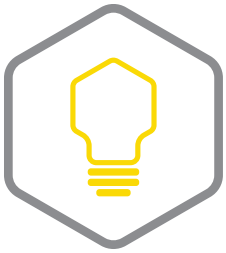
DIGITAL ASSET REVOLUTION

The Rise of DeFi and the Reinvention of Financial Services

Alex Tapscott
Blockchain Research Institute
Sponsored by Ninepoint Digital Assets Group

December 2021

A BLOCKCHAIN RESEARCH INSTITUTE BIG IDEA WHITE PAPER



Realizing the new promise of the digital economy

In 1994, Don Tapscott coined the phrase, "the digital economy," with his book of that title. It discussed how the Web and the Internet of information would bring important changes in business and society. Today the Internet of value creates profound new possibilities.

In 2017, Don and Alex Tapscott launched the Blockchain Research Institute to help realize the new promise of the digital economy. We research the strategic implications of blockchain technology and produce practical insights to contribute global blockchain knowledge and help our members navigate this revolution.

Our findings, conclusions, and recommendations are initially proprietary to our members and ultimately released to the public in support of our mission. To find out more, please visit www.blockchainresearchinstitute.org.

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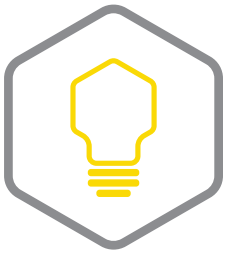


Foreword

I've been collaborating with Alex Tapscott on blockchain and digital assets since 2014. He was deeply entrenched in the financial services industry where he was, among oter things, handling the deal flow for investments in Bitcoin companies. He left his job to write *Blockchain Revolution* with me in 2015–2016, during which we spent considerable time thinking through the coming impact of what we called the "Internet of Value" on the industry.

Software instead of institutions can validate identity, confirm asset ownership, and clear and settle transactions.

The first chapter on industry transformations focused on financial services, the cardiovascular system of all economic activity, as Alex put it. To me, the topic was inscrutable: the industry's technology looked like a massive Rube Goldberg contraption, incredibly complex for doing simple tasks. I asked Alex whether he could explain—in straightforward terms—what banks and related firms might actually do with blockchain. He came back a couple of hours later with a model and language, that the industry really performs about eight (and now nine) functions. As with many taxonomies, I found his enormously helpful in understanding this new species of assets and enterprise.

We then dug into how blockchain might transform each of these functions. Once our book hit the market, Alex did a TEDx talk, "How Blockchain is Eating Wall Street," that has become one of the most watched TEDx talks on the topic.[1] The theory sounded a little improbable at the time, and some industry executives responded to Alex's ideas with coolness or even hostility.

Flash forward almost six years, and Alex's theory has become reality. His model of the industry has held up, and we can now see that the changes we projected would happen. Blockchain is not just disrupting these nine functions but revealing its potential to replace the role of banks and other institutions in each role.

These shared ledgers serve as common sources of the truth and a medium for trust. Software, not institutions, can validate identity and assets, and clear and settle transactions. They supplant the records of banks, governments, corporations, and the large technology companies that have become the most powerful intermediaries of the digital economy. Blockchains allow individuals to transact, coordinate and build value, and engage in a wide range of economic activities peer to peer. It is enabling individuals and entities to digitize virtually all their financial and other assets throughout the economy.

This is the meaning of the DeFi revolution: distributed ledger technologies are decentralizing and democratizing the capabilities of Wall Street. Anyone who reads this research will benefit in a couple of ways. First, Alex explains Web 3 and its role in this transformation. Second, he also builds upon his clear taxonomy of digital assets, long needed by everyone in this space, including investors and enterprise executives. Each asset type has different properties, functions, and behaviors.

Of course, I'm biased. Still, I've met no one who understands how this technology is changing the industry better than Alex. I'm delighted that he has taken time to gather strong evidence and present his findings. Disrupters and incumbents alike will find this research clear and focused with comprehensive framework for understanding the transformation underway.

DON TAPSCOTT
Co-founder and Executive Chairman
Blockchain Research Institute

Introduction

This upheaval is enabling new business models and organizational capabilities that will transform industries, organizations, and the nature of work.

Financial services, foundational to all industry and economic activity, is going through the greatest upheaval since the invention of double-entry bookkeeping in the Middle Ages. Every aspect of the industry is about to change, from how we move and store value to how we access credit, invest, trade, transact, and insure against risk. But this upheaval is about more than changes to existing industries like banking or insurance. It's about enabling new business models and organizational capabilities that will not only transform existing industries, but also redefine the architecture of the firm and other institutions, change profoundly how we interact online with companies and with each other, alter the fabric of daily life, reimagine the nature of work, and more.

The rise of digital assets and the future of financial services

At the root of this upheaval are blockchains, which allow us to create new asset classes, business models, and governance systems for the digital age. The industrial-age solution of companies and vast government bureaucracies coordinating human activity and the movement of value in the economy and in society is coming to an end. Blockchain enables new decentralized governance systems that are more inclusive, participatory, transparent, and trustworthy.

Blockchains are tamper-resistant ledgers of transactions distributed across a network maintained by many parties. These shared ledgers serve as common sources of the truth. In effect, they supplant the records of banks, governments, corporations, and the large

technology companies that intermediate much of the digital economy. Blockchains are the first digital medium for value, just as the Internet was the first digital medium for information.

In this brave new world, we can move, store, manage, organize, govern, create, fragment, and direct anything and everything of value to whatever end we desire peer to peer. Financial services are no longer centralized within an industry; they are decentralized across blockchain networks such as Bitcoin, Ethereum, Solana, Terra Luna, Avalanche, and Cosmos. *Decentralized finance* (DeFi) is shaking the windows and rattling the walls of Wall Street banks, government agencies, and global institutions. Call it the DeFi Revolution. Like many revolutions, it holds great promise and great peril. Critics malign its chaotic and seemingly uncoordinated growth as well as its potential to displace jobs and accuse it of undermining the monetary sovereignty of governments, exacerbating inequality, and warming the planet.

Financial services are no longer centralized within an industry; they are decentralized across blockchain networks such as Avalanche and Cosmos.

The revolution began in 2008 with the launch of the Bitcoin blockchain. Its creator Satoshi Nakamoto once quipped, "I'm better with code than words."[2] But his brilliant white paper, "Bitcoin: A Peer-to-Peer Electronic Cash System," introduced a radical new concept: cash for the Internet and a means of minting, moving, and storing value without intermediaries such as banks and governments.[3] What's more, bitcoin worked. It set the wheels in motion for changes we see happening now.

DeFi extends Satoshi's concept of peer-to-peer electronic cash to lending, trading, investing, managing risk, and more, all of which are built on top of distributed networks, not corporations. These innovations are possible, thanks to a breakthrough called a *smart contract,* an immutable self-executing *decentralized application* (dapp) settled on a blockchain such as Ethereum. Contracts are the foundation of every asset class, every corporation, and all economic activity. Yet, most of today's contracts are quite dumb. The changes wrought by dapps in general and smart contracts in particular will be cataclysmic. Every industry will feel DeFi's impact, because finance is the cardiovascular system of the global economy, the lifeline of all other industries.

DeFi will become the cardiovascular system of the global economy, the financial lifeline of all industries.

Web 3 and the new Internet of value

In *Blockchain Revolution,* we predicted that blockchains would usher in a new era of the Internet that we dubbed "the Internet of value," where individuals could transact, do business, and create value in a trustless and peer-to-peer way without the need for traditional intermediaries and gatekeepers. This was a radical idea and a big departure from the old ways of doing things. The first era of the Internet—the Internet of *information*—was more limited. In Web 1, the Internet was mainly a broadcast medium for publishing information, mostly text but also some images and video. In Web 2, the Internet evolved into a collaborative communication medium: a platform for mass organizing online (e.g., Wikipedia, GitHub), building communities (as on Reddit and Slack), engaging on social media

(e.g., TikTok, YouTube), and hosting web apps (e.g., Dropbox, Google Analytics) that have become critical to the fabric of daily life.[4]

With Web 2, we rely on intermediaries—not only banks, but also social media giants and digital conglomerates—to perform many essential functions, from moving and storing value to verifying identities and performing such basic business logic as record-keeping, contracting, and so forth, all to establish trust in online transactions. This reliance is problematic for several reasons. For one, such intermediaries are centralized, which makes them vulnerable to cyberattack and corruption. Financial intermediaries also add friction to transactions online, adding delays of days or weeks, charging fees as high as 20 percent for international money transfers, and engaging in other rent-seeking behavior.

During the Financial Crisis of 2008, managers of big banks took outsize risks to earn bonuses at the expense of clients, shareholders, and taxpayers.

Banks as well as social media companies and Internet service providers are gatekeepers that exclude many people. In banking, over a billion people lack access to financial services. These gatekeepers also capture all the data and much of the value created online—the largest companies in the world are digital conglomerates like Apple and social media companies like Facebook, which have built their empires in part or in whole on user data. But they don't protect our privacy—think of the breaches of Facebook, Nintendo, Twitter, Zoom, and even Whisper in 2020.[5] Those in control often misalign the incentives of management, shareholders, and deposit holders (known as *moral hazard*) so that managers act in the short term for their own sake at the expense of everyone else. We saw this misalignment in the actions of the big banks during the Financial Crisis of 2008, when managers took on outsize risks to earn handsome bonuses at the expense of clients, shareholders, and ultimately taxpayers.

Chris Dixon, general partner at the venture capital firm Andreessen Horowitz, captured the central limitation of Web 2: "Web 2 left out digital property rights. When you use a site (or app), it would only let you borrow or rent things. Imagine if in the real world you had to buy everything from scratch every time you went to a new place. That's Web 2."[6] Consider videogames, where every time we download a new game, we must buy that game's digital goods. We can't take them with us; and, if the game developer goes belly up or changes the code, then we may lose them forever. We rent our identities because every time we log onto a new service, we share personal information about ourselves. Our identities are not owned by us but by the digital conglomerates and other third parties who have access to it. They monetize it, reaping vast rewards, while we get bread crumbs.

Blockchain gives us a way to digitize and manage our property rights online peer to peer and port digital goods from platform to platform.

Blockchain gives us a way to digitize and manage our property rights online peer to peer. Digital bearer assets, commonly referred to as tokens, enable us to hold and port valuable digital goods from platform to platform online. These goods can be currencies, securities, and other financial assets as well as collectibles, intellectual property, identities, and the as-yet unimagined. Dixon explained how this new Internet of value, commonly referred to as Web 3, will reshape our global economy:

Like websites, tokens are digital primitives that can be generalized to represent almost anything—money, art, photo, music, text, code, game items, control, access, and whatever people dream up in the future. Users can now have a persistent inventory of objects in their wallet that they take from one app to another. If their objects increase in value, the user gets the upside. This is a big change from Web 2 where the upside was mostly captured by tech companies.[7]

"Users can now have a persistent inventory of objects in their wallet … . If their objects increase in value, they get the upside."

CHRIS DIXON
General Partner
Andreessen Horowitz

Web 3 will be built on top of blockchain networks. But just what networks exactly? At the bottom of Web 3 are the platforms like Ethereum and Solana that enable us to create, move and manage digital goods, and interact with them via decentralized applications. On top of these so-called "Layer 1" platforms can be additional blockchains that help to scale the Layer 1s so they're more useful. These "Layer 2" platforms like Polygon help to reduce the cost and increase the metabolism of protocols like Ethereum by moving some transactions off the main chain, where the network can become congested due to DeFi's surging popularity.

Connecting the various Layer 1s with each other (so we can move assets seamlessly between different platforms) are interoperability protocols such as Cosmos and Polkadot. Cosmos supports an "Internet of blockchains" known as IBC (the inter-blockchain communication protocol) that allows many other chains to connect with one another so that assets and applications can interoperate across different chains. More than $125 billion worth of assets are connected through IBC. Finally, on top of this stack are the decentralized applications in DeFi, NFTs, and beyond. We will discuss these different kinds of networks and corresponding cryptoassets and their impact on finance and more in this paper.

The Golden Nine: Essential functions of the financial industry

"DeFi [transforms] legacy financial products into trustless and transparent protocols that run without intermediaries."

SANDEEP NAILWAL
Co-founder and Chief Operations Officer
Polygon Technology

DeFi is already disrupting capital markets. In one year, the DeFi industry's market capitalization has ballooned 30 times to $150 billion.[8] The total value of user deposits (known in the industry as *total value locked* or TVL) has surged 100 times to nearly $200 billion.[9] What's driving this unprecedented growth?

Sandeep Nailwal, co-founder of multibillion-dollar blockchain protocol Polygon explained, "DeFi solves five key problems inherent in the current system of finance—centralized control, limited accessibility, inefficiency, lack of interoperability, and lack of transparency—by transforming legacy financial products into trustless and transparent protocols that run without intermediaries."[10] Here is a preview of how DeFi addresses these issues in each of the nine functions of the finance industry. See Figures 1 and 2 on pages 10 and 12.

1. **Storing value:** Individuals and institutions can use noncustodial wallets like MakerDAO to act as their own banks, and third-party custodians can hold crypto at scale for

institutions. For managing and protecting shared resources, Gnosis Safe has *multisignature* (multisig) capability, meaning that groups can program transactions to require more than one signature to execute them.[11] DAO treasuries are upending how organizations think of storing and allocating capital.

With multisig *capability, groups can require more than one signature to execute transactions.*

2. **Moving value:** BTC, MakerDAO's DAI, Terra Luna's UST, the Centre Consortium's USD Coin (USDC), Tether (USDT), and other stablecoins route around banks, PayPal's Venmo, Early Warning Services' Zelle, the Society for Worldwide Interbank Financial Telecommunications (SWIFT) network, and other interbank settlement systems.

3. **Lending value:** Pooled lending protocols such as Compound (COMP) and Aave (AAVE) augment savings accounts at banks and other financial intermediaries and have better yields to boot.

4. **Funding and investing:** Investment aggregators such as Yearn Finance (YFI) and Rarible (RARI) could ultimately disintermediate investment advisors, mutual funds, exchange traded funds, and roboadvisors.

5. **Exchanging value:** Decentralized exchanges such as Uniswap (UNI), SushiSwap (SUSHI), and QuickSwap (QUICK) are competing with centralized cryptocurrency exchanges for liquidity and dollar volumes and will be the model for all exchanges, including today's centralized stock exchanges such as the New York Stock Exchange (NYSE) and the Nasdaq marketplace.[12]

6. **Insuring value and managing risk:** On-chain insurance such as Nexus Mutual and derivatives platforms such as the SX Network (SX), Perpetual Protocol (PERP), and dYdX (DYDX) could supplement or replace insurance policies and over-the-counter derivatives.[13]

7. **Analyzing value:** On-chain data analysis such as DeFiLlama, DeFi Pulse, Open-orgs.info, and others produces a rich array of information on the movement, storage, and status of all digital assets. Messari and CoinGecko are the Bloomberg and Thomson Reuters of the new decentralized financial world.

Accessing open-source DeFi protocols requires no formal verification. Users can be pseudonymous or anonymous.

8. **Accounting for and auditing value:** Block explorers such as Etherscan and PolygonScan track asset movements in real time. Contract auditors such as Zeppelin and DeFi Score could augment or even replace the key work of the Big Four accounting firms Deloitte Touche Tohmatsu (Deloitte), Ernst & Young (EY), Klynveld Peat Marwick Goerdeler (KPMG), and PricewaterhouseCoopers (PwC).[14]

9. **Authenticating identity:** Accessing open-source DeFi protocols requires no formal verification. Pseudonymous or anonymous identities are common. Persistent, portable,

blockchain-based identities are becoming more common online.[15] As DeFi scales with institutions and as regulators tighten rules, there is a growing need for a reliable, immutable on-chain identity system.[16]

As DeFi scales with institutions and as regulators tighten rules, we need a reliable, immutable digital identity system. Protocols such as Shyft and SelfKey are addressing this need. The lines between traditional finance and DeFi will blur as DeFi adoption rates grow in usage and TVL. As Robert Leshner, founder of Compound Labs, a leading lending DeFi protocol, tweeted, "DeFi is not going to be called DeFi in the next five years. It's just going to be called finance. And all finance is going to run on blockchains; most assets will make their way onto a blockchain."[17] In this white paper, we describe how DeFi is disrupting every aspect of the industry.

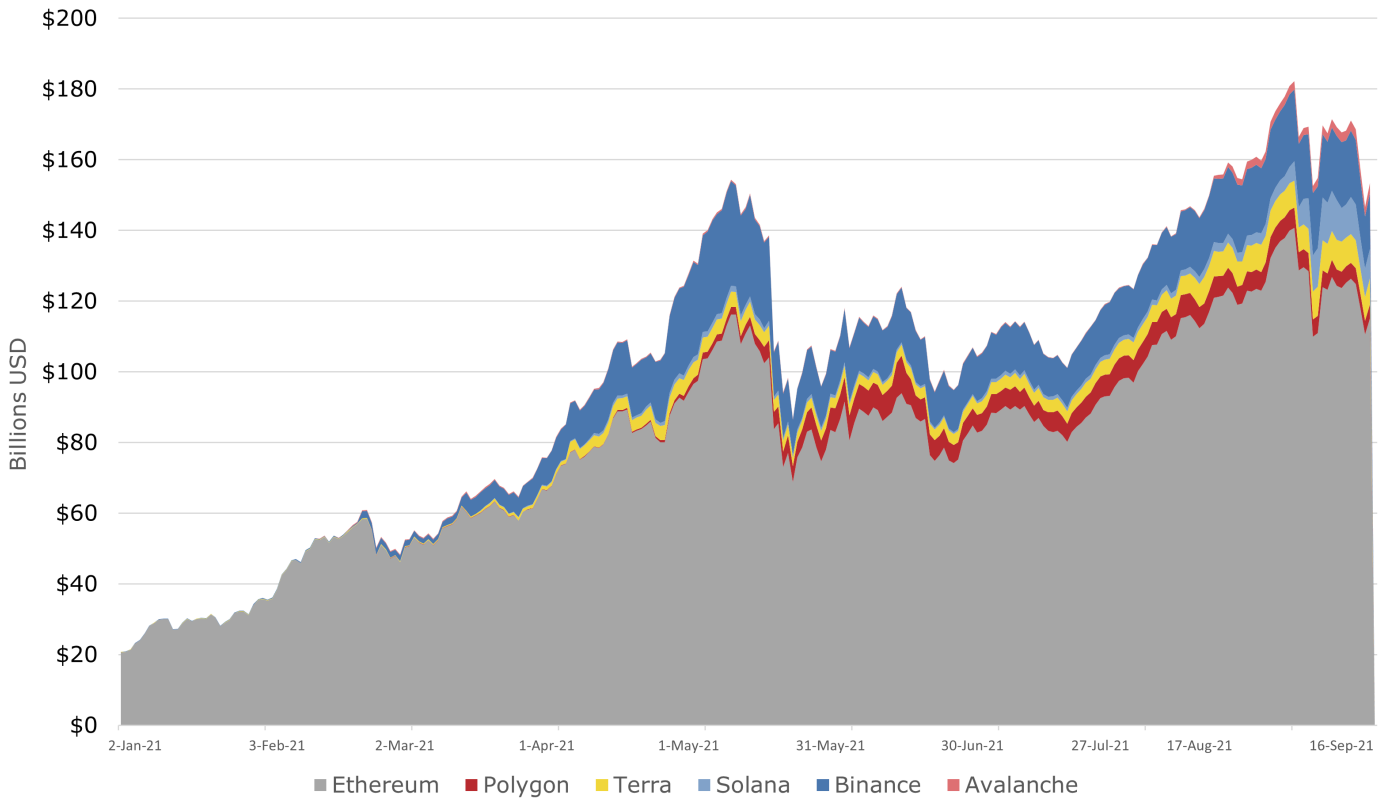
"In the next five years … all finance is going to run on blockchains; most assets will make their way onto a blockchain."

ROBERT LESHNER
Founder
Compound Labs

A taxonomy for digital assets

With DeFi, a new ecosystem of digital assets is emerging.[18] Our token taxonomy has grown to nine assets:

Figure 1: DeFi total value locked



Sources of data: DeFi Pulse, DeFiPulse.com*; and DeFi Llama,* DeFiLlama.com*, 30 Sept. 2021.*

Protocol tokens give holders governance over platform protocol decisions whereas governance tokens give holders rights in governing dapps and DAOs.

1. **Cryptocurrencies (aka digital money):** Bitcoin is the mother of all cryptocurrencies with a market capitalization of over $1 trillion and tens of millions of users. It functions like cash for the Internet and a final settlement layer for the crypto economy. It's digital gold for investors and a lifeline for many of the world's unbanked. Bitcoin is unrivaled in this role. Other cryptocurrencies such as Monera and Zcash tried to improve on bitcoin by enhancing privacy but remain minor players.

2. **Protocol tokens:** These are the native tokens of Layer 1 blockchains and are used to power transactions and secure these networks. Examples include ether, the native token of Ethereum; AVAX, the native token of Avalanche; and ATOM, the native token of Cosmos.

3. **Governance tokens:** Governance tokens such as Uniswap's UNI, Compound's COMP, and Aave's AAVE token give holders say in the governance of *decentralized autonomous organizations* (DAOs) and dapps. As dapps gain users and increase TVL, their governance tokens often appreciate. For example, the value of UNI has grown from $2 billion to a decentralized exchange over $15 billion in one year.[19] Protocol tokens also give holders governance rights but for convenience's sake we will not call them governance tokens.

4. **Non-fungible tokens (NFTs):** NFTs are unique digital assets; they provide a means to verify the scarcity, provenance, and ownership of these assets. They can also represent physical assets such as sports memorabilia and luxury goods. Fine art NFTs alone are worth more than $65 billion a year.[20]

5. **Exchange tokens:** Crypto-exchange tokens such as Binance Coin (BNB) and the FTX Token (FTT), valued at $110 billion and $7.6 billion respectively, are native to centralized exchanges like Binance and the FTX ecosystem.[21] Typically, these tokens are essential to the exchange's functionality and incentivize adoption, but they are more centrally managed and confer no governance rights. BNB serves a dual purpose as an exchange token and the native token of the Layer1 Binance Smart Chain, which is why it's so valuable.

Centralized *stablecoins are backed by deposits of cash and equivalents.* Decentralized *stablecoins are collateralized by cryptoassets held in smart contracts.*

6. **Securities tokens**: There are three kinds of securities tokens: digitally native securities such as DeFi investment funds, synthetic securities such as Mirrored Google (mGOOGL) and Mirrored Tesla (mTSLA), and securities tokens originated by traditional financial entities such as investment banks or asset managers.[22] They are transforming markets for stocks, bonds, and derivatives.

7. **Stablecoins:** Stablecoins are cryptoassets with stable value such as Tether (USDT) and TerraUSD (UST), with a total market value of $125 billion in early October.[23] They use different methods to stabilize their value. *Centralized*

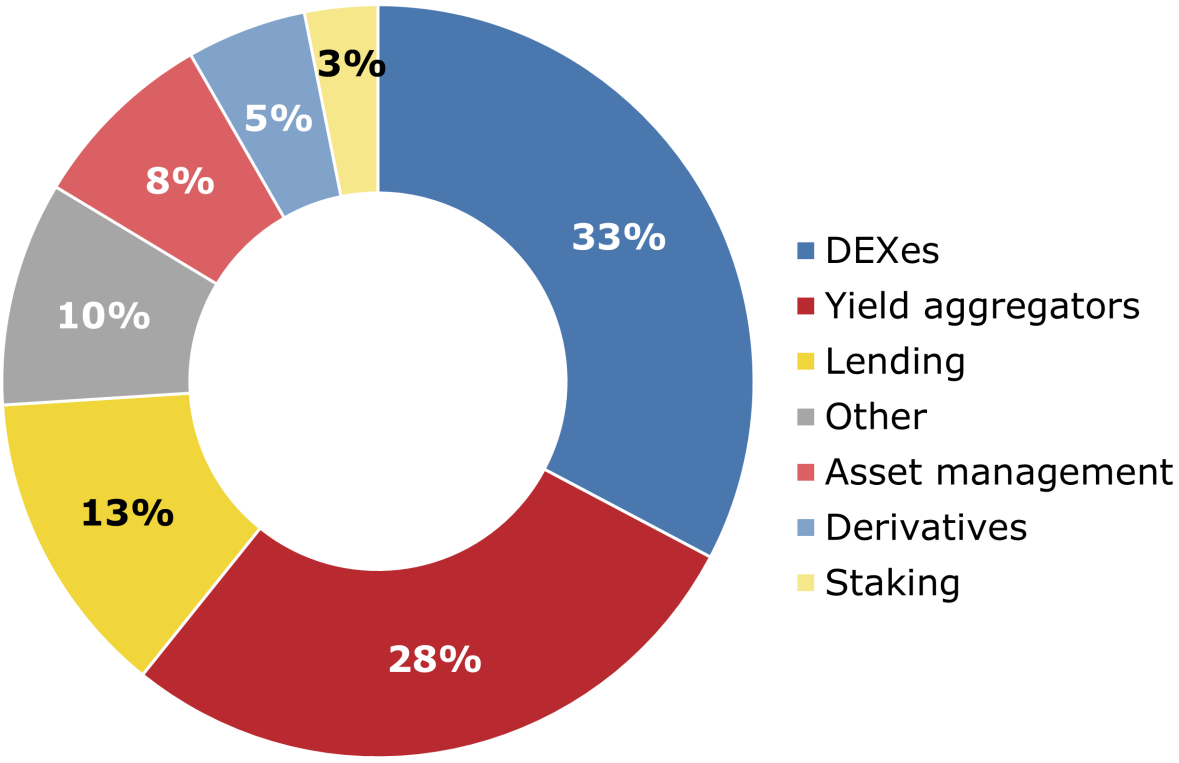
stablecoins are backed by deposits of cash and equivalents. *Decentralized* stablecoins are collateralized by cryptoassets held in smart contracts.

8. **Natural asset tokens:** These are digital assets backed by real-world commodities such as oil or gas, land, or carbon. For example, the blockchain-based ecology network Regen is connecting land stewards who protect and conserve ecosystems with buyers of offsets through the Regen registry, bringing transparency, liquidity, and verifiability to the carbon credit market.

9. **Central bank digital currencies: Central bank digital currencies (CBDCs)** are crypto versions of fiat currency such as China's digital renminbi and South Korea's digital won.[24] Advocates tout their potential to reduce friction, improve stability, and broaden financial access; opponents point to their potential use for mass surveillance and political oppression.

This taxonomy is not exhaustive or predictive of every use case for blockchain and digital assets. Unlike taxonomies in nature, it is also not completely mutually exclusive: one asset may fall in more than one category. However, any asset falls primarily into one of these

Figure 2: DeFi assets by sector



Sources of data: DeFi Pulse, DeFiPulse.com*; and DeFi Llama,* DeFiLlama.com*, 30 Sept. 2021.*

categories. Overall, we have attempted to organize this ecosystem of disparate assets into a coherent structure so that we can better understand and discuss what's happening.

DeFi is not fintech; it is our new global financial architecture.

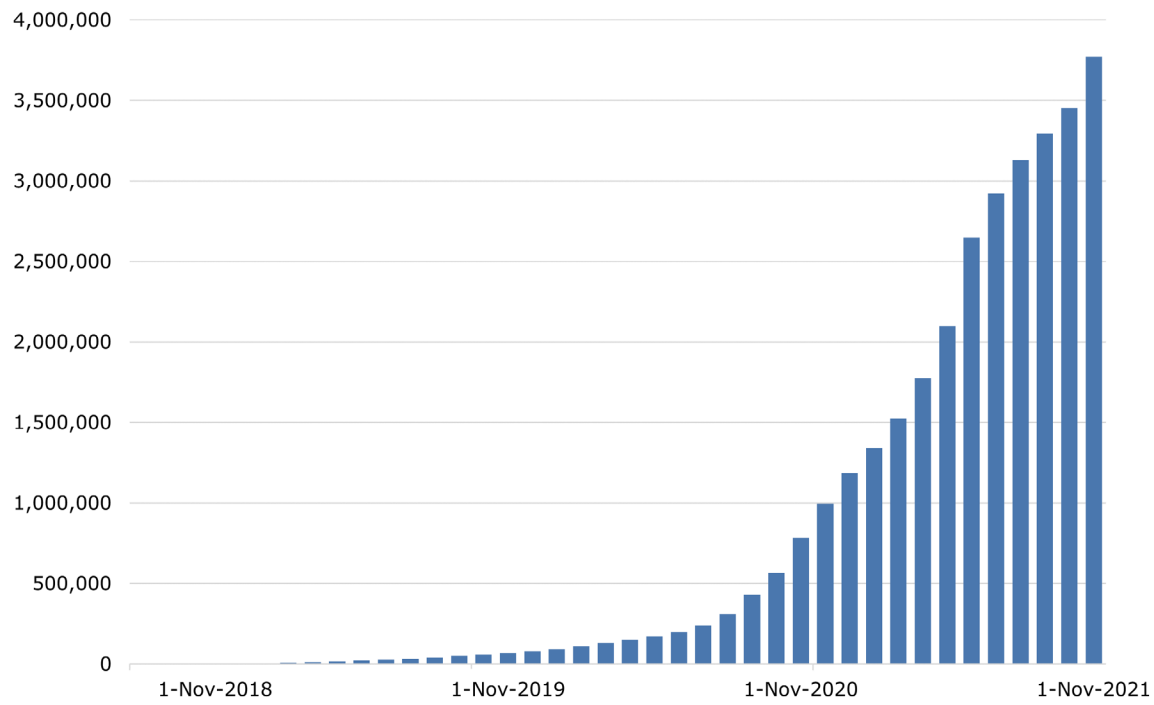
Decentralized finance is eating Wall Street

DeFi is not fintech. Fintech applications, although important, still require banks and other intermediaries to establish trust between parties, verify account balances, and perform the business logic—clearing, settling, contracting, and so forth—that makes the system work. In the end, most fintech innovation is digital wallpaper, a sleek user interface that conceals the Rube Goldberg contraption underneath. In this sense, DeFi is a new financial architecture.

DeFi: A new architecture for the financial system

The growth of DeFi has been blistering (Figure 3). In under two years, many of these DeFi protocols—they aren't traditional start-ups—are competing with or eclipsing many fintech darlings. For example, on many days, the volumes on the decentralized exchange Uniswap have exceeded those on Coinbase, a $60 billion NYSE-listed company.[25]

Figure 3: DeFi user growth over time



Source of data: @richardchen39, "Total DeFi Users over Time," Dune.xyz, used under the terms of Dune Analytics AS, as of 1 Nov. 2021.

The automated investment aggregator Yearn Finance (YFI, pronounced "Wi-Fi"), through which investors pool capital in a smart contract that invests on their behalf, hit $5 billion TVL within its first year.[26] By contrast, fintech company Wealthsimple took more than six years to reach the same value.[27] MakerDAO's stablecoin DAI (pegged to USD) does far more volume daily than Venmo.[28] In the second quarter of 2021, the Ethereum network settled $2.5 trillion in transactions, up 1,500 percent year over year, driven primarily by DeFi and stablecoins.[29]

"DeFi democratizes access to financial products. [People] no longer need the permission of banks or other gatekeepers to secure a better financial future."

PENG ZHONG
Chief Executive Officer
Tendermint Inc.

In today's financial markets, value accrues to large banks and hedge funds, in part, because they can offer economies of scale and greater liquidity.[30] In the DeFi ecosystem, value accrues to protocols, not to corporations. Protocols can deliver the economies of scale and efficiencies of the big banks, but in a way that anyone can access. As Ethan Buchman, co-founder of DeFi leader Cosmos, a $10 billion blockchain, said, "Decentralization of finance is really the democratization of finance. It's about eradicating barriers."[31] Peng Zhong, CEO of Tendermint, put it this way:

> *DeFi democratizes access to financial products that most people around the world are barred from accessing, providing a level playing field to everyday services as well as exciting investment opportunities that were previously only in the domain of the ultra-wealthy. … We want to empower people to control their own finances and understand that they no longer need the permission of banks or other gatekeepers to secure a better financial future.*[32]

The Golden Nine: How DeFi is reimagining Wall Street

Moving value

"Stablecoins continue to grow rapidly, with over $50 billion of stablecoins in circulation that power $200 billion in payment volume each month."

CUY SHEFFIELD
Vice President, Head of Crypto
Visa USA Inc.

Digital assets are transforming how we move value in three important ways. First, usage of bitcoin and cryptocurrency is skyrocketing in many parts of the world, making it easier for millions of users to store, send, and receive money. In a way, Bitcoin is the original decentralized finance protocol—a censorship-resistant, decentralized version of cash. Second, stablecoins designed to hold a stable value have exploded in value. Earlier in the year, Visa's head of crypto, Cuy Sheffield said, "Stablecoins continue to grow rapidly, with over $50 billion of stablecoins in circulation that power $200 billion in payment volume each month."[33] Today the figures are much higher. They have obvious and widespread applications across a range of industries. Finally, applications like Chai, which uses the Terra Luna blockchain, are disintermediating traditional payment processers by undercutting fees and settling payments in real time.[34]

Bitcoin

Today, bitcoin secures $1 trillion in value and serves millions of people. According to Chainalysis, "Global adoption [of cryptocurrencies] has grown by over 2,300 percent since Q3 2019

and over 881 percent in the last year."[35] The report's authors argued, "In emerging markets, many turn to cryptocurrency to preserve their savings in the face of currency devaluation, send and receive remittances, and carry out business transactions."[36]

The Lightning Network seeks to reduce Bitcoin's energy consumption, increase its transaction throughput, and lower fees for different payment applications.

In June 2021, El Salvador announced that it would formally adopt bitcoin as legal tender.[37] Politicians in Argentina, Brazil, Mexico, Panama, and Paraguay also expressed their public support for bitcoin.[38] Could Latin America become the first economic region to embrace bitcoin at the state level? Perhaps. In many South American countries, the US dollar plays an outsized role. Until recently, it was El Salvador's only official currency. US dollar remittance payments, largely from the United States, constituted more than 20 percent of El Salvador's gross domestic product (~$24.6 billion in 2020).[39] Furthermore, 70.4 percent of Salvadorans are unbanked.[40] So the Bitcoin blockchain could serve more residents and potentially reduce fees for the poorest. Of course, a new government could reverse the decision. Still, it could prove to be a watershed for the world.

Bitcoin is known for its high energy consumption, low transaction throughput, and high fees, which limits its utility for different payment applications. For example, today's average transaction fee is $3.328, which would be prohibitive for the 22 percent of Salvadorans living on $5.5 a day.[41] The Lightning Network, a Layer 2 protocol developed on top of the Bitcoin blockchain, seeks to overcome these implementation challenges. With Lightning, parties can open payment channels between them and conduct off-chain transactions, which are batched and settled on the main chain.[42] The Lightning Network has grown rapidly. In mid-March 2020, the total capacity of the network was only $4.79 million; a year later, it was $64.93 million.[43] Then in September 2021, Strike, the leading bitcoin wallet developed on Lightning, launched its *application programming interface* (API) for Twitter users in the United States and El Salvador.[44] By mid-October, Lightning's capacity stood at $177.6 million.[45]

"For the financially disenfranchised, stablecoins represent a novel onboarding tool to a new, open, and more inclusive financial system."

DO KWON
Co-founder and Chief Executive Officer
Terraform Labs

Stablecoins

Stablecoins hold the potential to transform legacy payments infrastructure such as SWIFT, the interbank network that handles global payments and more. They have also undeniably fueled the rise of DeFi. Stablecoins will almost certainly transform the payments industry by ushering in a new era of frictionless global real-time value settlement. They will lower barriers for individuals to access goods and services online and increase the metabolism of commerce. They will also help end the remittance rip-off, where annually people pay more than $60 billion in fees just to send money to family overseas. As Do Kwon of Terra Luna said, "For the financially disenfranchised, stablecoins represent a novel onboarding tool to a new, open, and more inclusive financial system."[46]

Blockchain-based payment applications

Finally, blockchains are enabling new applications that can compete outright with dedicated payment processing applications by reducing cost, friction, and time of settlement. For example, Terra's Chai App is a payment processor that is like PayPal or Alipay but can offer payment processing for a fraction of the cost by clearing transactions on its blockchain. Moreover, it can offer instant settlement compared to traditional payment processors that take days to settle. As of June 2021, Chai had more than 2.4 million users and processed more than 130,000 transactions per day.[47]

Storing value

In broad terms, there are several ways to store cryptoassets. Users can hold their own assets by keeping their own private keys in a software wallet like MetaMask, a hardware wallet like Trevor, or multisig wallet like Gnosis Safe. (See Figure 4 on wallet users, next page.)

In multisig wallets, accessing assets requires more than one person, sort of like safety deposit boxes that require two keys. Because multisig wallets are programmable, users can secure a multisig wallet any number of ways—for example, having five key holders and requiring at least three to move anything out of the wallet. Alternatively, users can rely on third parties to hold their private keys for them, such as the custodial services of cryptocurrency exchanges like Coinbase Custody or Gemini Custody, both regulated under New York State banking law.[48]

Users who hold their own private keys may do so in a hot or cold wallet. A *hot wallet* is a software wallet online, always connected to the Internet. For example, MetaMask is an Ethereum hot wallet created by ConsenSys. Users can access their MetaMask wallets via a browser extension or mobile app. It is an immensely popular gateway to the Ethereum ecosystem for its 10 million-plus monthly active users, especially the Philippines and Vietnam.[49]

Hot wallets are *noncustodial*: MetaMask holds no private keys yet is connected to the Internet. Similar wallets include Phantom (basically MetaMask for Solana), ImTOKEN, Trust Wallet, TokenPocket, Rainbow, and Coin98.[50] They have fewer users than MetaMask but are growing quickly. Phantom recently announced its weekly active users surpassed 500,000.[51]

A hot wallet *is a software wallet online, always connected to the Internet, whereas a* cold wallet *stores private keys offline.*

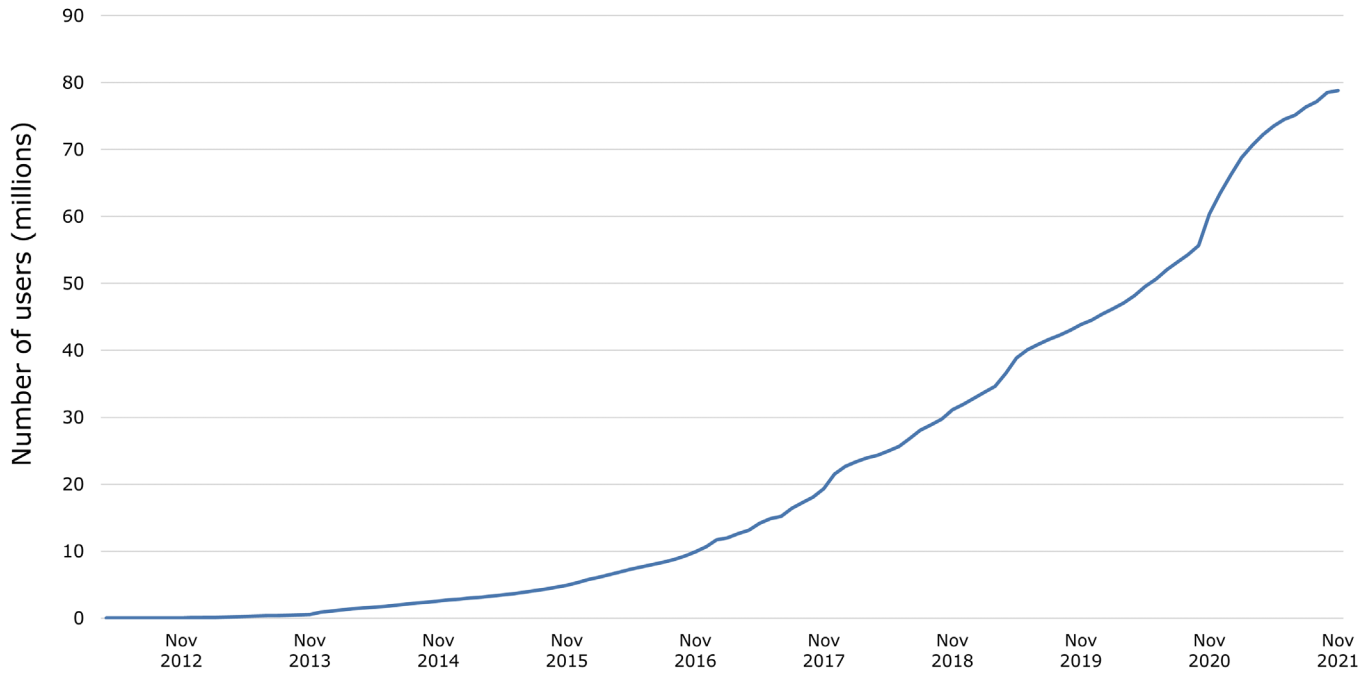
In contrast, a *cold wallet* is not connected to the Internet. For example, hardware wallets such as Trevor or Ledger store keys offline, offering the kind of security that hot wallets can't. Similarly, third-party custodians may also keep keys in hot or cold storage. For example, Gemini Trust Company stores almost all the coins in custody in cold storage.[52] However, the coins of anyone who trades on Gemini are, by necessity, online in a hot wallet.

Gnosis Safe is a platform for securely storing, exchanging, and managing digital assets. Today it secures $100 billion in value across

23,500 safes, with the top twenty-five holding $4 billion. Many asset-rich entities trust Gnosis as an institutional and high-net-worth product. Users also have the option to buy insurance from Nexus Mutual. Gnosis employs an innovative "bug bounty" system, where it rewards $1 million per bug found. So far, no one has uncovered any major bugs nor earned the million. Gnosis uses a variety of security protocols to secure assets, but the most well-understood is "multi-signature" verification. Rather than one single key residing with one individual, multi-signature requires that a certain minimum number of people approve before a transaction occurs. (For a comparison of wallet functionality, see "Overview," *Gnosis-Safe.io*, Gnosis Ltd., as of 11 Nov. 2021.)

Many institutions and individuals still rely on centralized custodians who hold coins on their behalf (meaning they control the private keys). Gemini and Coinbase, two large fully regulated US based institutions, have become leaders in this market. In May 2021, Gemini disclosed that it held more than $30 billion in custody.[53] Coinbase is even larger: according to its *initial public offering* (IPO) filing, it held 11 percent of all cryptoassets in the world.[54] As of September 2021, that would be around $200 billion.[55] Now many incumbent financial institutions want in on this market. Since 2020, banks have been scrambling to launch cryptoasset custody, including US Bank, BNY Mellon, State Street, Cowen, Deutsche Bank, Bank of America, Union Bank of Philippines, BBVA (formerly a subsidiary of Banco Bilbao Vizcaya Argentaria), not to mention four of the five largest banks in South Korea.[56] These efforts were given a serious

Figure 4: Worldwide blockchain wallet users



Source of data: "Number of Blockchain Wallet Users Worldwide," Statista.com, Statista GmbH, as of 3 Nov. 2021.

boost when the US Office of the Comptroller of the Currency (OCC) clarified regulations allowing federally regulated banks to engage in cryptoasset custody.[57] Here is a select list of financial firms planning cryptoasset custody services:

- Bitcoin Suisse – A "Swiss regulated financial intermediary" with over five billion Swiss francs in cryptoassets[58]
- BitGo – More than $40 billion[59]
- BNY Mellon – Formed digital assets unit to build industry's first multiple asset digital platform[60]
- Coinbase – $255 billion in assets[61]
- FireBlocks – More than $400 billion in assets as of March 2021[62]
- Gemini – $30 billion of cryptoassets[63]
- Kingdom Trust – $18 billion in its Choice offering[64]
- US Bank – Identified NYDIG, a subsidiary of Stone Ridge, as its first crypto sub-custodian[65]

"DAOs are on-chain entities that facilitate the governance and economic coordination of decentralized protocols. Tokenholders vote on how to disburse funds, allocate budgets, and hire/fire contributors."

ANDREW YOUNG
Chief Executive Officer, Layer2
Co-founder, SX Network

These figures are large but pale in comparison to the total assets custodied by the world's largest financial institutions. US Bank's investment services division has more than $7.7 trillion in assets under custody and administration globally.[66] When all securities are digital assets, the figures across the board will only increase. Perhaps the biggest changes to how we store value are not happening at the individual wallet level but rather at the organizational level, thanks to the rise of DAOs.

A traditional company balance sheet is comprised of a mix of assets and liabilities. The cash balance, or current assets, refers to cash and equivalents sitting inside bank accounts, money market funds and short-term government notes. However, DAOs turn that notion on its head. Andrew Young, CEO of Layer2 and co-founder of the SX Network, said:

> *DAOs are on-chain entities that facilitate the governance and economic coordination of decentralized protocols. The typical DeFi protocol often collects a fee, which is then diverted to an on-chain treasury. Rather than having the core founders control this treasury, DAOs enable DeFi protocols to put tokens in control of them. Tokenholders vote on how to disburse funds, allocate budgets, and hire/fire contributors. DAOs are increasingly governing larger and larger DeFi protocols and their respective treasuries.*[67]

Consider Uniswap, the largest decentralized cryptoasset exchange in the world. As Uniswap has exploded in size, so too has the "on-chain

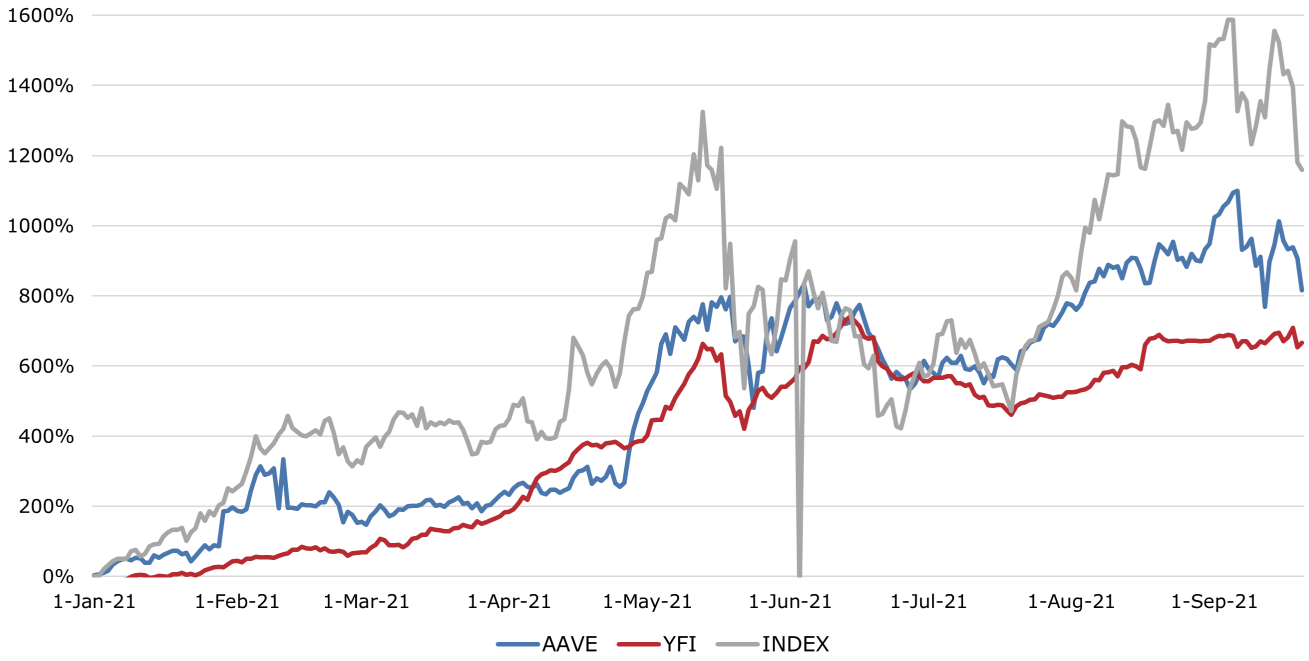
treasury" that holders of Uniswap's governance token (more on that later) have power over. Just how big is Uniswap's on-chain treasury? As of September 2021, it has more than $9 *billion*, a greater stockpile than all but the largest and most well capitalized companies on the planet.[68] By comparison, according to its latest financial statement, Coinbase has less than half that.[69] To be clear, the assets Uniswap holds are not exactly like cash. Most of the value exists in UNI governance tokens, which are not the same as cash even though they're liquid. They are like treasury stock that holders can convert to cash quickly with other governance tokenholders' assent. Still, they are a powerful financial resource that users can deploy in multiple use cases.

Lending value

Measured by TVL, lending is one of the largest DeFi use cases. Decentralized lending platforms support users' desire to lend and borrow cryptoassets. These platforms flip the traditional model on its head: lenders and borrowers transact with each other through smart contracts, not intermediaries. These lending platforms have grown tremendously over the last year; Aave, the largest DeFi platform in the world, holds over $11 billion in assets.[70] (See Figure 5 for AAVE's trading volume compared to YFI and INDEX.)

DeFi loans are typically overcollateralized, meaning for every $1 locked in a lending protocol, a user may get 50 cents of

Figure 5: Aave, Yearn Finance, and Index Cooperative trading volume



Source of data: DeFi Llama, DeFiLlama.com*, as of 30 Sept. 2021.*

Through decentralized lending platforms, successful crypto natives borrow against their digital assets to avoid paying capital gains taxes and get added leverage to improve their returns.

extra leverage. As lenders, users do not rely on borrowers' creditworthiness. Instead, credit works more like a margin loan: if the value of the assets locked in the protocol declines beyond a certain level, the smart contract automatically liquidates those assets and repays the lender. This kind of borrowing works well for traders seeking leverage to amplify their returns—and that's a big market. Wealthy individuals often borrow against their stock holdings to fund their lifestyles, avoid paying capital gains taxes, and get added leverage to improve their returns. In crypto, the situation is no different. To avoid paying capital gains taxes, and in the absence of traditional lenders willing to recognize digital assets, many successful crypto natives borrow against their assets.

An increasingly popular exception to overcollateralized loan is the *flash loan*, where a borrower puts up no collateral to borrow funds for a few seconds. However, the borrowing and repayment of the loan must occur within one transaction, meaning in effect that if the borrower fails to repay, then the transactions can be reversed. Why would someone want to borrow money for a few seconds? Likely to execute a short-term trade such as an arbitrage opportunity. Again, traders could potentially deploy this important innovation at scale in capital markets environments but it's not particularly useful for regular folks looking for a loan.[71]

Thus, as currently designed and implemented, DeFi lending does not yet work for most personal and commercial lending. For example, if we wanted to buy a house for $500,000 and we had $100,000, or 20 percent, ready to put down, the most we could get from this kind of DeFi loan is $50,000. That doesn't make much of a difference, but it still has some benefit: most DeFi lending today is overcollateralized, and so we don't need a credit check. Parties can transact pseudonymously or even fully anonymously. However, for broad mainstream adoption, DeFi lending needs to marry lending protocols with decentralized and reliable digital identities that parties can use for automated "credit checks." That's a multitrillion-dollar opportunity for whoever solves the problem.

Lending, like all other DeFi applications, must also overcome the interoperability challenge by enabling cross-blockchain lending. Various companies have set out to address this, such as Umee, which offers cross-ecosystem lending and borrowing.[72]

Funding and investing

DeFi is full of financial opportunities to earn attractive yields, and tokens have become an immensely powerful means of bolstering project balance sheets. However, finding the best returns can be time consuming and complicated. Enter yield aggregators such as Yearn Finance and Rarible, which hook into different DeFi protocols so that users can optimize yield. Users stake tokens in yield aggregators' platforms and permit the platforms to manage their assets. We can think of them as roboadvisors for DeFi. These yield platforms have grown tremendously, with over $20 billion TVL.

Like traditional exchange traded funds, smart contract-based index funds create value for investors by packaging different assets into a basket or index.

Complementing yield aggregators are DeFi index funds such Index Cooperative, another emerging category of smart contract-enabled financial services. In the traditional world, an *exchange traded fund* (ETF) is a publicly listed fund that tracks the performance of a given benchmark such as the Standard & Poor's 500. ETFs generally allow for daily creation and redemption or destruction of units, based on the market demand. Other structures like closed-end funds or mutual funds can have more stringent redemptions, but the overarching goals are the same: to pool investor capital into a fund and then invest based on a set of criteria.

The decentralized financial system is no different. Smart contract-based index funds have been one of the fastest growing areas within the DeFi ecosystem. Like traditional ETFs, they create value for investors by packaging different assets (in this case, cryptoassets) into a basket or index, so that investors get passive exposure to an entire sector with a click of a button. DeFi index funds are entirely blockchain based: an open-source software protocol and a decentralized governance system oversee them, not a centralized asset manager.

Exchanging value

When cryptocurrency exchange Coinbase went public, its $60 billion market cap surpassed that of the NYSE—the exchange it had listed on—and Nasdaq combined. It was also the first large cap crypto company that institutions felt comfortable owning. While Coinbase is an innovative and immensely valuable company, it is still fundamentally a centralized, regulated exchange and crypto broker, not unlike legacy firms like Morgan Stanley and Nasdaq.

Decentralized exchanges (DEXes) also known as *automated market makers* (AMMs) such as Uniswap, SushiSwap, and PancakeSwap, could replace or enhance stock exchanges and centralized cryptoasset exchanges. AMMs like Bancor are open protocols that enable individuals to exchange any kind of cryptoasset peer to peer (or more precisely, peer to smart contract). These new platforms have grown so much that they are now competing for volumes with more established traditional rivals. None of the emergent DEXes are bigger or more important than Uniswap. (See Figure 6, "Coinbase vs. Uniswap volume," on the next page.)

Decentralized exchanges, also known as automated market makers, compete with and could enhance or replace centralized stock and cryptoasset exchanges.

Bancor's Galia Benartzi explained the origins of AMM: "We understood that liquidity could be designed directly into tokens, and thus the Bancor Protocol was born, a formula and mechanism for making any currency, old or new, automatically liquid to any other—which would become known as the AMM, or automated market maker."[73] Today, Bancor is one of the leading DeFi protocols with $1.4 billion TVL.[74]

DeFi protocols are also all open source, inviting imitators and outright copycats. Uniswap had early success as one of the first AMMs to launch, and it was quickly copied in the summer of 2020 by SushiSwap, which duplicated Uniswap code line for line.

"The success formula: solve your own problems and freely share the solutions."

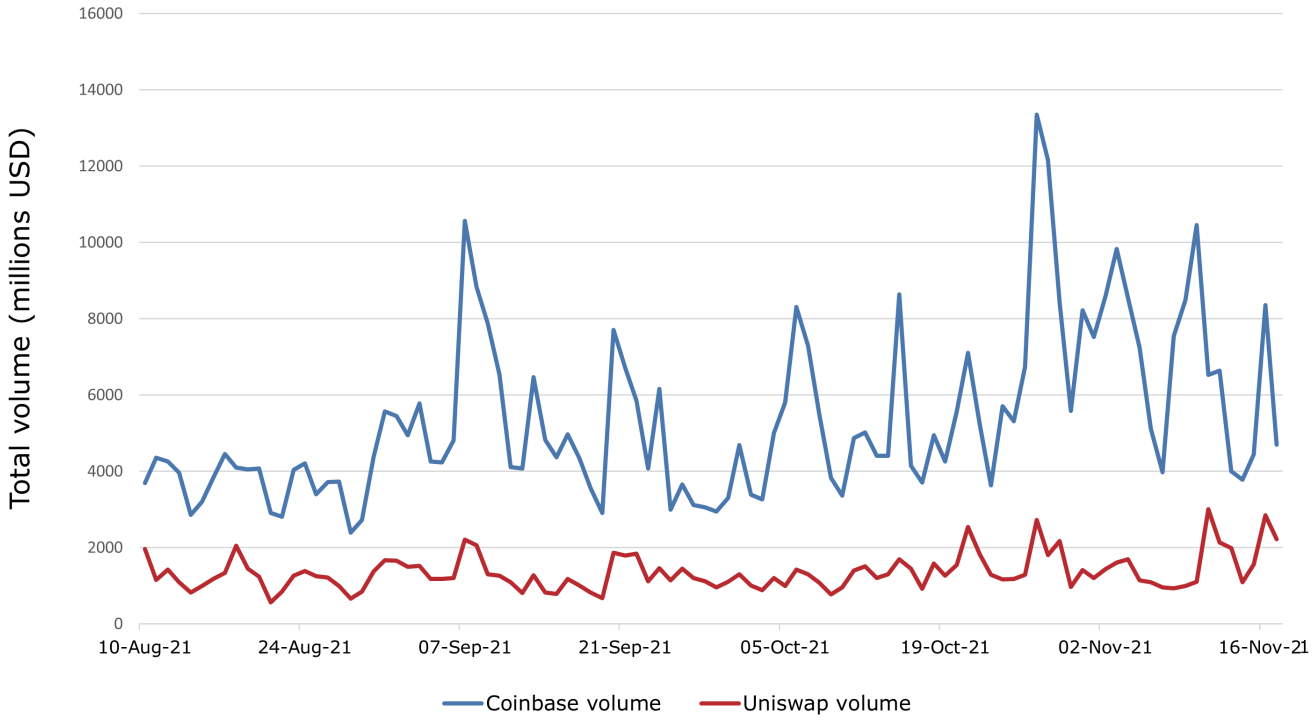
NAVAL RAVIKANT
Co-founder
AngelList

SushiSwap volumes briefly competed with Uniswap, but Uniswap retained its lead. More interestingly, today Uniswap is much larger than it was in the summer of 2020. SushiSwap is also successful. The duplication probably helped Uniswap by increasing awareness for DeFi and drawing in more users. This is the power of open source. Famed entrepreneur and investor Naval Ravikant captured the essence of open source, tweeting the key to success is "solve your own problems and freely share the solutions."[75] This ethos has allowed DeFi to scale rapidly.

The typical DeFi protocol often collects a fee, which is then diverted to an on-chain treasury. Rather than having the core founders control this treasury, DAOs enable DeFi protocols to put tokens in control of them. Tokenholders vote on how to disburse funds, allocate budgets, and how to hire/fire contributors. We will cover DAOs and their corresponding governance tokens in detail in the token taxonomy. Not unlike their centralized counterparts in traditional financial markets, decentralized exchanges are often the most profitable DeFi protocols in the world.

Decentralized exchanges also make it easy for small and illiquid tokens to find a market. Traditionally, centralized exchange platforms would need to accept these tokens, but there would be no market maker to boost liquidity. Here's Benartzi's explanation:

Figure 6: Coinbase vs. Uniswap volume



Sources of data: "Coinbase Exchange," Nomics.com, *Nomics LLC; and "Uniswap,"* CoinGecko.com, *Gecko Labs Pte. Ltd., as of 30 Sept. 2021.*

"Automated market makers level the playing field for digital assets by removing barriers to entry for liquidity."

GALIA BENARTZI
Co-founder and Head of Business Development Bancor Network

> *AMMs eliminate the need for centralized exchanges and traditional order books by equipping digital assets with an inherent convertibility mechanism governed by a balancing formula, which can also be dynamically adjusted. This allows even new and small currencies to be easily bought and sold, a prerequisite for their use, growth, and sustainability. … AMMs level the playing field for digital assets by removing barriers to entry for liquidity, which governed traditional markets and exchanges for hundreds of years.*[76]

DeFi protocols such as DEXes have several structural advantages over traditional financial intermediaries that allows them to scale quickly. For example, Osmosis, a decentralized exchange launched on the Cosmos Network in August 2021, had $500 million TVL within eight weeks.[77] In addition, DeFi protocols (i.e., Ethereum, Solana, Cosmos, etc.) have low infrastructure costs because their users pay the gas fees to support Layer 1 and extremely high margins because they have no head offices, very low headcount, and none of the regulatory fetters of traditional financial institutions.[78] Decentralized exchanges have all these advantages plus a high churn of transactions, where tiny transactions fees pile up quickly.

Insuring value and managing risk

On-chain insurance such as Nexus Mutual and derivatives platforms such as the SX Network, Perpetual Protocol, and dYdX could supplement or replace insurance policies and over-the-counter derivatives.

Insurance and risk management is a $6 trillion market worldwide but underrepresented in the DeFi space. Decentralized insurance platforms and prediction markets enable the trading of *event risk* between participants.[79] These platforms upend the traditional model by allowing anyone to transact with someone else through smart contracts, not intermediaries like insurance companies for insurance or investment banks for derivatives. DeFi protocols like Uniswap and Aave have disrupted markets like trading and lending. Will decentralized insurance see the same kind of growth? What impact will these decentralized models have on legacy insurance institutions and business models?

Derivatives are the single largest asset class in the world, with an estimated notional value estimated to be over quadrillion dollars and used by traders and speculators.[80] By contrast, plenty of people and corporations use derivatives to hedge against risks to their portfolios and profitability.

In early September 2021, dYdX exploded onto the DeFi scene by offering an easy-to-use interface for trading perpetual futures contracts (known as *perps* in crypto trading circles). Historically, futures contracts have had an expiry date: a farmer agrees to sell a livestock business a commodity like corn at a future date. When that date arrives, the livestock owner expects the farmer to deliver the corn; otherwise, how will the livestock owner feed her

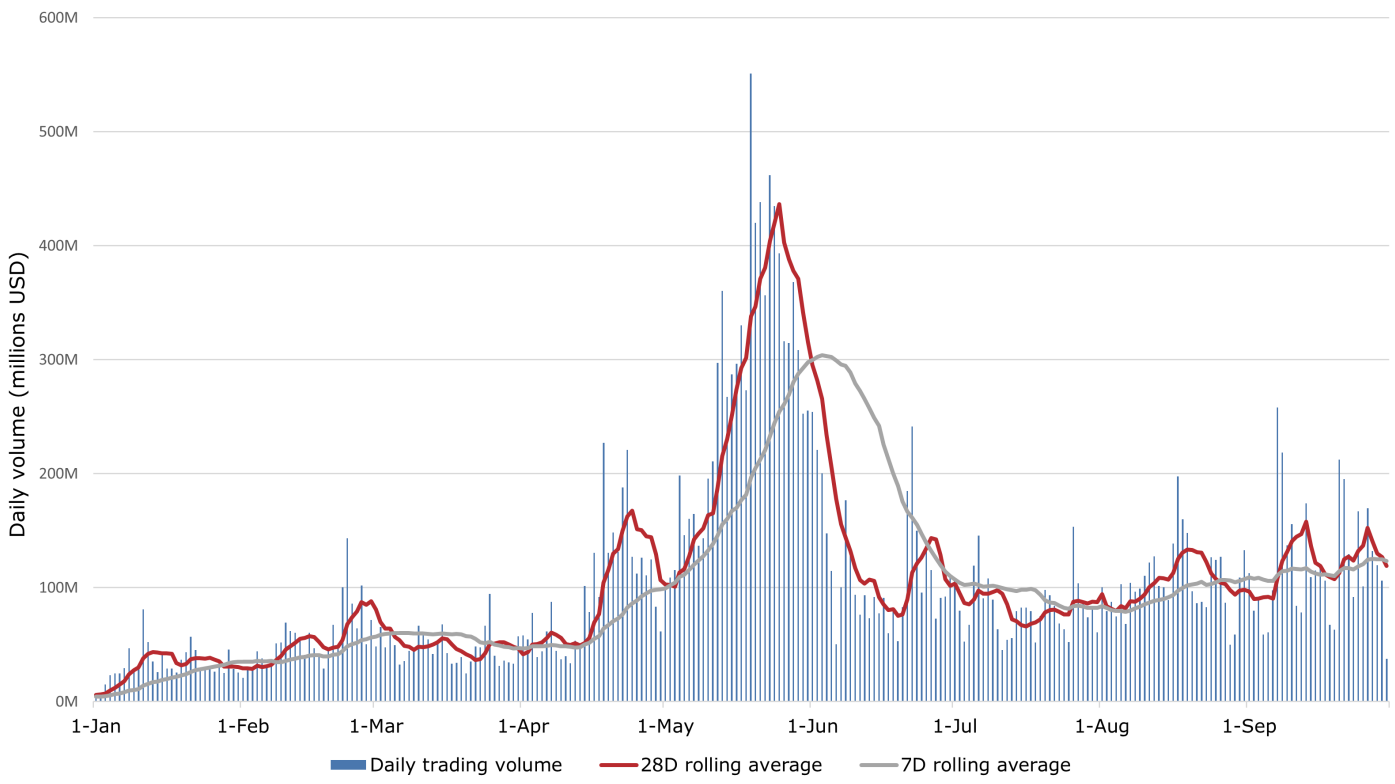
Prediction markets are transparent peer-to-peer financial marketplaces where users bet on the outcomes of future events.

cattle during winter? With cryptoassets (and, to be accurate, many traditional financial assets), there is no need for delivery, and so these contracts don't always need a fixed expiry date. Instead, they can be perpetual, where one side funds the premiums on an ongoing basis until it wants to exit the position, not unlike a swap in traditional finance. In its first quarter, dYdX has become one of the most profitable DeFi derivatives protocols in the world, outpacing more established players.[81] (See Figure 7.)

Users turn to dYdX predominantly for trading and speculation. Why not for traditional insurance products such as life insurance? After all, life insurance is perpetual until the insured dies. Insurance premiums are similar to the premiums traders pay for short positions in perpetual futures contracts. Given that dYdX is barely a year old with a market cap of $1.2 billion, insurers ought to take notice.[82]

Prediction markets are financial marketplaces where people bet on the outcomes of different future events, from sports, elections, and the weather to the values of stocks or other assets. Unlike traditional betting platforms, they are fully peer to peer, transparent, and more flexible. SX Network is a leading prediction market platform, with $120 million in annualized prediction volume (in other words, wagers placed by others on the platform) as of October 2021.[83]

Figure 7: dYdX growth (2021)



Source of data: @ily0ff, "Daily Trading Volume/Perp Daily Volumes," Dune.xyz, *used under the terms of Dune Analytics AS, as of 30 Sept. 2021.*

"Prediction markets are superior to voting systems [because of] the introduction of gain and loss to governance systems."

ANDREW YOUNG
Co-founder, SX Network
Chief Executive Officer, Layer2

SX co-founder Andrew Young set his sights on predictions beyond betting. He said, "Prediction markets are already used in some forms of insurance and risk management systems today. For example, credit event binary options are a type of credit default swap that provides participants with an alternative way of hedging credit risk." The big target? "Using prediction markets, rather than voting, to determine policy" in DAO governance. "The idea is that prediction markets are superior to voting systems [because of] the introduction of gain and loss to governance systems."[84] Tokenholder apathy, it turns out, is as big a problem for DAOs as voter apathy is for democracies. We discuss these challenges in the section on governance tokens.

Analyzing value

Blockchains are transparent, searchable, verifiable, and trustworthy records of all economic activity in each network. They are constantly producing massive amounts of data that users can scrutinize, organize, analyze, and visualize. In other words, they offer users a view of the inner workings of DeFi and the digital asset ecosystem. The growth of DeFi has spawned a new industry of companies and open-source tools to properly analyze this information. Here are a few:

- Messari (Messari.io): This site has become the de facto second screen for most DeFi market participants. With an interactive interface with up-to-the minute data, analysis, and news, Messari's analysts break down on-chain data into clear and actionable research—like Bloomberg for DeFi with a bulge-bracket research department.

- DeFi Llama (DeFiLlama.com): With DeFi Llama, users can see how the TVL of their favorite DeFi project has changed day over day or month over month relative to its market capitalization. They can also search by project or by category such as lending, yield, options, indexes, and staking insurance. Uses can track changes in TVL over time for Layer 1 protocols such as Ethereum and Solana.

- DeFi Pulse (DeFiPulse.com): On DeFi Pulse, users can compare interest rates on various DeFi projects, see the DeFi leaderboard, or invest in a DeFi index fund.

- Etherscan (Etherscan.io): On Etherscan, users can see the entire Ethereum blockchain and check mined blocks, transactions, and addresses, gas (i.e., network fees), nodes (i.e., different participants on the network), and DEXes. Etherscan also covers all ERC-20 tokens (aka protocol tokens of DeFi apps).

- DEXTools (www.DEXTools.io): This site offers real-time data on DEXes so that users can develop strategies and anticipate market movements on platforms such Ethereum, Binance Smart Chain, and Polygon.

- Blockchain.com (www.Blockchain.com): The original site for analyzing on-chain data and still one of the best resources for bitcoin, Blockchain.com tracks every transaction on the Bitcoin blockchain as well as its transaction volume and hash rate (aka difficulty level for miners).

- Ethplorer (Ethplorer.io): This site tracks the price of a user's address balance and shows transfer volumes as well as prior balances, with totals received and sent.

- Blockscout (Blockscout.com/xDAI/mainnet): This open-source block explorer covers everything on Ethereum from transactions and block information to token values, sidechains, and private chains.

ETHStats (ETHStats.net), Yield Farming Tools (YieldFarmingTools.com), and DeBank (DeBank.com) also offer their own levels of in-depth analysis and data gathering for the industry.

Accounting and auditing value

"Accounting is the language of business. You have to be as comfortable with that as you are with your own native language to really evaluate businesses."

WARREN BUFFETT
Chairman and Chief Executive Officer
Berkshire Hathaway Inc.

"Accounting is the language of business," said Warren Buffett. "You have to be as comfortable with that as you are with your own native language to really evaluate businesses."[85] It's so important that some consider double-entry bookkeeping one of the great innovations of all time.[86] According to economist Tim Hartford and others, it enabled Venetian and Tuscan merchants in the 1300s "to keep track of … extraordinarily intricate web[s] of transactions" around the Mediterranean over time, laying the foundation for managing the modern global enterprise.[87]

Who invented it is unknown. But Florentine Friar Luca Pacioli wrote the book on it—that is, he devoted a couple dozen pages to it in his much "translated, copied, and plagiarized" tome on mathematics.[88] Since their publication in the late 1490s, those very lucid and illustrative pages have shaped how business owners have kept inventory and recorded transactions.[89] When they added up their transactions, both entries in the ledger had to "balance" out, which is where we get the term *balance sheet*, and why we "balance the books."

In the Industrial age, we came to rely not just on accountants but comptrollers, auditors, and a vast army of analysts to capture complex financial information, verify its accuracy, and publish it in intelligible ways. Today accounting and auditing are massive industries. The Big Five accounting firms employ hundreds of thousands of people and serve every major corporation, government, and institution on the planet.

In *Blockchain Revolution*, we wrote about blockchains enabling triple-entry bookkeeping, with the third entry (or entries) appearing *on-chain*, that is, every transaction created an entry in a blockchain that anyone can see. At the time, this applied only to bitcoin. We

based our hypothesis on the transparency of the Bitcoin blockchain, where anyone could see in real time all transactions on the network. We extrapolated that, if a distributed public ledger could work for bitcoin transactions, it could work for all transactions on-chain. We firmly believed that, if we could record most economic activity, not only the movement of money, but also financial assets, IP, and even physical goods in this way, then we could reinvent accounting.[90]

For DeFi to go institutional, users and counterparties will need confidence in underlying smart contracts' security. The role of auditors will be to vet and approve the code of these contracts.

Fast forward five years, and that prediction is playing out in real time in DeFi. As we saw in the section on analyzing information, even a novice can gather trustworthy on-chain data, and an expert analyst can create a financial statement at the protocol level with ease.

Some projects are taking it one-step further. In addition to all the on-chain data readily available, Yearn Finance has made its GitHub repository a destination for data about the platform, all of which can be independently verified on-chain.[91] On it, we can track every single Yearn transaction in real time, get transaction records and search protocol income, protocol expenses, income statements, end of month balances and more. We can see revenue projections, charts, tables, and other useful data. In the future some mix of verifiable on-chain raw data, data analysis tools, and verifiable information curated by individual projects like Yearn will replace the quarterly statements and other financial paperwork of today.

In a world where on-chain data gives us a perfect snapshot into the financial health of an organization, what role is there for an auditor? Plenty, it turns out. However instead of auditing data in a spreadsheet, auditors will have to vet and approve the code of smart contracts. After all, if DeFi is going to go institutional, then users and counterparties need confidence in underlying smart contracts' security.

Enter firms like Zeppelin, the leading cryptoasset cybersecurity company that safeguards billions of dollars on behalf of many of the world's leading crypto companies and DeFi protocols, such as Coinbase, Ethereum Foundation, Compound, Aave, and others. Zeppelin's goal is to solve for three security and usability concerns in the DeFi space:

- Security, namely exposure to hacking or attack
- Developer experience, namely lack of proper development and testing tools, which can create errors
- Operations, specifically managing and fixing problems in dapps once deployed, which can be very hard.

If this sounds a bit different from the average Big Four accounting firm's audit department, that's because it is. If most financial information is trustworthy and immutable, then auditors can focus on higher order issues such as system resilience and security. To that end, Zeppelin security audits are becoming increasingly popular, giving users confidence in the platform. In the audit process, Zeppelin's engineers examine a system's codebase and architecture.

They check whether the distributed system is working as intended and then generate a report including actionable tasks. Compound, Maker, Augur, Solidity, Brave, and others all have requested Zeppelin audits. (See the process in Figure 8.)

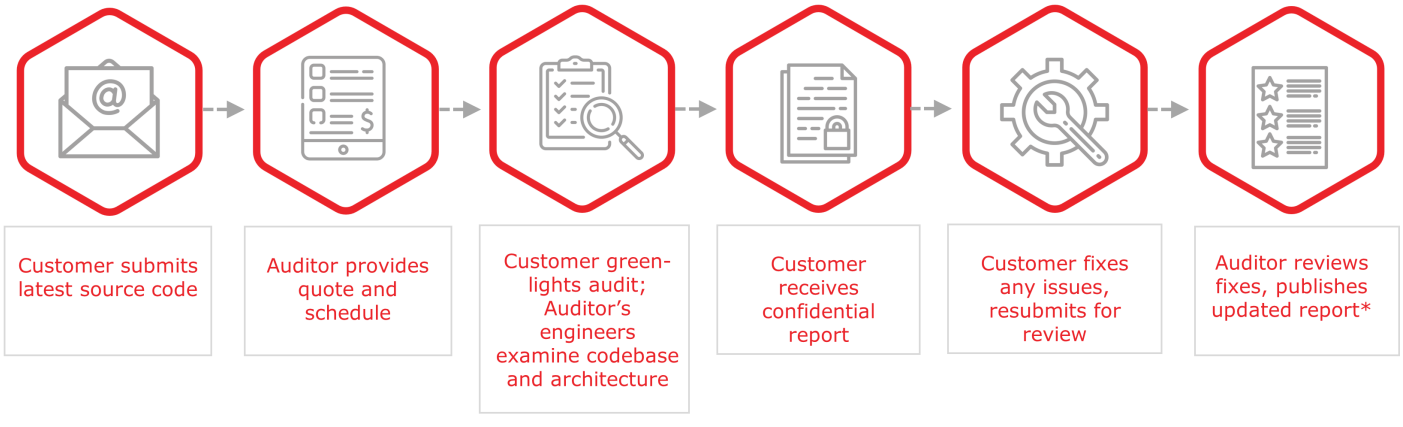
Authenticating identity

We can use an NFT—an entirely unique digital asset such as a Bored Ape, a CryptoPunk, or a CryptoKitty—as an avatar to represent our digital self.

Establishing a reliable and self-sovereign identity online proved difficult through the first era of the Internet. In the Web 2 paradigm, third parties like banks, social media companies, and digital conglomerates give us our identities and allow us to access their services. Web 2's Faustian bargain was signing our own data over to these intermediaries (via their terms of use and service). We gave them rights to use our data for their own gain, and they undermined our privacy in the process. Now we never get to own our identity. Rather, we simply rent it in these walled gardens. As data mining becomes more sophisticated, our rents keep going up. Like any rental, we always bear the risk of eviction—*deplatforming*, in Internet parlance. These are permissioned systems, and their owners decide whether we stay or go.

Blockchain remedies this situation in two ways. First, DeFi and most other blockchain dapps are open, permissionless, and anonymous: we need no third party to prove who we are. Anyone with a MetaMask wallet can access the DeFi world on Ethereum, for example, and needn't show any ID to do that. Second, blockchain enables us to bootstrap a self-sovereign digital identity. The data accruing in our cryptoasset wallets create a vivid chart of our financial past and present. We can use an NFT—an entirely unique digital asset—as an avatar to represent our digital self. These avatars can be fun, such as the Bored Ape or CryptoPunk NFTs. On the Internet, nobody knows you're a dog, but on Web 3, everybody knows you're a Bored Ape, CryptoPunk, or CryptoKitty.

Figure 8: OpenZeppelin audit process



*Customer has option to publish report on auditor's website

Source of information: "Security Audits for Distributed Systems," OpenZeppelin.com*, Zeppelin Audits Ltd., as of 1 Nov. 2021.*

We can now design our own identities and gather our own data rather than accept whatever a platform assigns to us so that it can track our behavior. We can use sovereign digital identities not only for protecting our data but for accessing more goods and services online. Chris Dixon of a16z tweeted, "NFTs give users the ability to own … credentials, governance rights, access passes, and whatever else people dream up next."[92] So our digital wallets could contain, among other things, our frequent flyer IDs, our credentials to access banking, our proof of vaccination, or even our eligibility to vote in an election—in other words, all the components of our identity. However, many people may not want to be custodians of their own information, which could be irretrievable if hacked or stolen. This is a business opportunity for companies and protocols to build user interfaces and apps that are convenient, secure, and easy to use.

"[Non-fungible tokens] give users the ability to own … credentials, governance rights, access passes, and whatever else people dream up next."

CHRIS DIXON
General Partner
Andreessen Horowitz

Could self-sovereign identities work in regulated environments, which require state-based identities? Joseph Weinberg thinks so. He's the co-founder of the Shyft Network, which he called a "decentralized version of SWIFT," referring to the SWIFT's financial messaging system launched in 1973 and widely used today for interbank settlement.[93] Through Shyft, Weinberg seeks to empower users with a decentralized identity framework robust enough to win over regulators and regulated financial institutions. Shyft works like other cryptoasset wallets, but for identity credentials—the critical information to access financial services from permissioned and centralized companies. Just as Fred Smith of FedEx said in 1978, "The information about the package is just as important as the package itself," the information about a payment is as important as the actual payment.[94]

Consider the Financial Action Task Force's so-called "travel rule," which requires financial intermediaries—including cryptocurrency exchanges Binance and Coinbase—to collect and transmit know-your-customer (KYC) data when executing a transaction.[95] Ignoring this rule could put a business in the crosshairs of regulators and law enforcers around the world. Compliance is increasingly important in certain DeFi environments, too, where the objective is to woo trading firms (TradFi), other intermediaries, and their clients.

The Shyft Network is a decentralized version of the SWIFT network, a financial messaging system launched in 1973 and widely used today for interbank settlement.

Various other projects and companies are targeting on-chain, self-custodied identities, among them BrightID, Identity.com, SelfKey, and Sovrin.[96] All are user provisioned, meaning that users decide whether to share their data and with whom. For example, Bloom is an identity solution for private data verification, distribution, and aggregation.[97] Global and tamper proof by design, Bloom incorporates many attestations so that users can interact with DeFi platforms that require user ID. The Bloom team focuses on credit and hopes to offer credit scoring, KYC, account onboarding, and financial access using these data. Blockpass, with its PASS utility token, is another pioneer of on-chain KYC targeting regulated industries.[98]

A taxonomy of digital assets

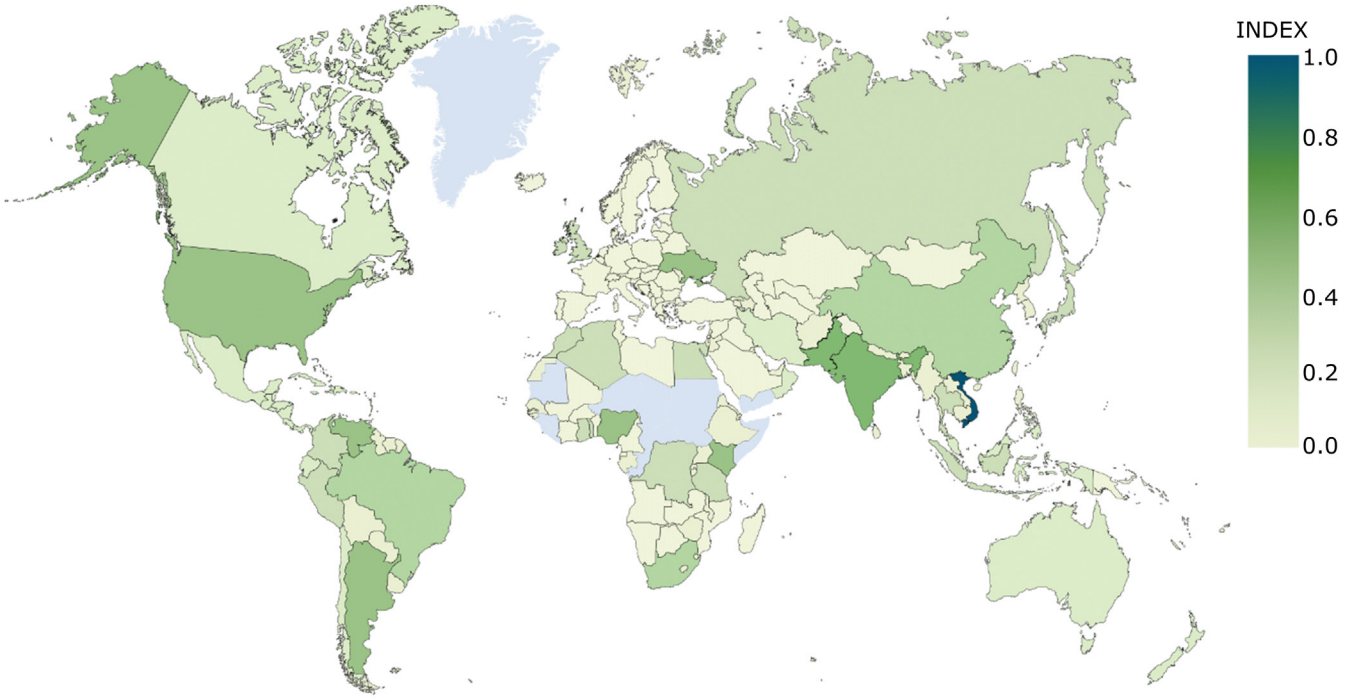
As Harvard Business School professors Marco Iansiti and Karim R. Lakhani noted, "Contracts, transactions, and the records of them are among the defining structures in our economic, legal, and political systems. … Yet these critical tools and the bureaucracies formed to manage them have not kept up with the economy's digital transformation."[99] Blockchain technologies bring asset creation and management into the 21st century. A cryptoasset is a digital asset defined by both public and private data and secured by cryptography within its ecosystem.[100] Thus far, we've identified nine asset categories, detailed here.

Cryptocurrencies aka digital money

Money has evolved from cowrie shells and clay tablets to pieces of eight, bank notes, and bank balances. With the Bitcoin blockchain, money became digital. Bitcoin is the most dominant digital cash, but there are other cryptocurrencies like Zcash and Monero. In general, they follow certain design principles:

- *Resilient and open source*: Parties should be able to use digital cash without relying on private banks, payment networks, or proprietary intellectual property.

Figure 9: Global adoption index



Source of data: Top 20 Table, "Chainalysis Global Crypto Adoption Index, July 2020–June 2021," Chainalysis Blog, *Chainalysis Inc., 2021.*

- *Permissionless and low tech*: Individuals or entities should need no IDs, bank accounts, large bandwidth, or complex or energy-intensive equipment to use it.
- *Private and secure*: Individuals must be able to hold and use it anonymously or pseudonymously.
- *Accessible and easy to use*: Digital cash must be easily attainable and require no special knowledge or expertise to use responsibly.

Numerous factors are working in cryptocurrency's favor, from community zeal to the efforts of legacy payments systems.

Yes, governments are eager to defend the status quo where states and state-based institutions have a monopoly on minting coins and printing bills, and corporations have their sights set on the reinvention of money. But numerous factors are working in cryptocurrency's favor. Consider bitcoin, by far the most valuable. Its community is zealous.[101] It is censorship resistant—holders can use it as they see fit—and it is emerging as a successor to gold as a store of value. It is also benefiting from the efforts of legacy fintech like PayPal, Square, and Visa, all of which are making bitcoin available to their hundreds of millions of users and millions of merchants.[102] Large public companies are also embracing it as a viable alternative to cash and other assets on their balance sheets or in their portfolios.[103]

Bitcoin usage is increasing rapidly. (See Figure 9 on previous page, and Table 1 on the next page.) The banked and unbanked alike can use bitcoin without proof of identity or state censorship.[104] In Nigeria, for example, daily US dollar peer-to-peer trade consistently clocks in at over $1.5 million from a base of zero only a few years ago.[105] Peer-to-peer bitcoin transactions can be zero-fee, a big break from the much higher fees many in Africa are forced to pay for basic financial services, such as those for remittances, which are on average close to nine percent.[106] Repressive regimes cannot easily throttle, control, or monitor usage of bitcoin for, say, a girl's education, birth control, or support of an opposition candidate as they can in the legacy financial world. In 2020, civil protests erupted in Lagos and across Nigeria because of the brutal and illegal actions of the Special Anti-Robbery Squad, a police unit. Within days, the government had frozen the bank accounts of groups supporting the protesters. So they turned to the Bitcoin network, raising funds to sustain the movement.[107]

Protocol tokens

Protocol tokens are the native cryptoassets of the smart contracting protocols that support DeFi, NFTs, and DAOs.

Protocol tokens are the native cryptoassets of the smart contracting protocols that support DeFi, NFTs, DAOs, and virtually every other major use case for blockchain except bitcoin, which is the original Layer 1. Whereas bitcoin serves as censorship-resistant cash for the Internet, protocols like Ethereum, Solana, Cosmos, Avalanche, and Polygon were designed to support dapps and smart contracts. Remember, smart contracts are self-executing pieces of software running in a decentralized trust-minimizing way on a blockchain.

Nearly every single dapp, from Aave and Compound to Osmosis and Yearn Finance, runs on some protocol with its own native or protocol token, such as Ethereum and ETH. To run a dapp on these

networks, dapp users and developers must pay for transactions, often using the network's protocol token. As a dapp, the protocol token constitutes the *transaction* layer of the platform. For example, to transact on Ethereum, users must pay transaction fees (aka gas fees) denominated in ETH, Ethereum's protocol token.[108] DeFi's viral growth has skyrocketed gas fees, driving the size of Ethereum's network to $454 billion accruing to ETH holders.[109] It has also opened a mile-wide lane for other DeFi protocols to capture market share by offering cheaper, faster, and better options. Ethereum's share of DeFi TVL has dropped precipitously from 99 percent to 70 percent in less than a year, ceding ground to Solana, Binance Smart Chain, Terra, Avalanche, Cosmos, and others.[110]

In 2016, venture capitalist Joel Monegro posited that Web 3 protocols would capture far more value than those early iterations of the Internet.[111] The markets have put this "fat protocol thesis" to the test since. Over time, smart contracting platforms have exploded in value; however, their total share of the digital asset market is declining.

Table 1: Crypto ownership by country

Crypto ownership is highest in middle- and lower-income countries.

Country	# crypto owners	% population	Country	# crypto owners	% population
1. Ukraine	5,565,881	12.73%	15. Pakistan	9,051,827	4.10%
2. Russia	17,379,175	11.91%	16. Philippines	4,360,579	3.98%
3. Venezuela	2,941,502	10.34%	17. South Korea	1,942,933	3.79%
4. Singapore	549,903	9.04%	18. Peru	1,233,892	3.74%
5. Kenya	4,580,760	8.52%	19. Belarus	352,498	3.73%
6. USA	27,491,810	8.31%	20. Australia	857,553	3.36%
7. India	100,740,320	7.30%	21. France	2,179,654	3.34%
8. South Africa	4,215,944	7.11%	22. Latvia	62,091	3.29%
9. Nigeria	13,016,341	6.31%	23. Hong Kong	245,012	3.27%
10. Colombia	3,122,449	6.14%	24. Canada	1,206,627	3.20%
11. Vietnam	5,961,684	6.12%	25. Malaysia	1,019,405	3.15%
12. Thailand	3,629,713	5.20%	26. Netherlands	521,404	3.04%
13. United Kingdom	3,360,591	4.95%	27. Ghana	934,482	3.01%
14. Brazil	10,373,187	4.88%	28. Turkey	2,476,418	2.94%

Source of data: Triple A, "Global Crypto Adoption," Triple-A.io*, Triple A Technologies Pte. Ltd., 2021.*

"In five years' time, I see thousands of application-specific blockchains interconnected and flourishing from the ability to transact with each other."

PENG ZHONG
Chief Executive Officer
Tendermint Inc.

Still, Ethereum is larger than any project built on top of it. See Figure 10. In fact, Ethereum's market capitalization is larger than that of the top ten projects on top of Ethereum *combined*. Ethereum's declining share of DeFi TVL compared to other smart contracting platforms is not a sign of waning Ethereum influence but a marker of DeFi's enormous growth. The Ethereum network processes more than one million transactions a day, which is not enough to support the future of financial services. Other protocols will emerge to fill the need. Peng Zhong, CEO of Tendermint, said this move away from "maximalism," this clinging dogmatically to one blockchain, is necessary for the long-term success of the technology:

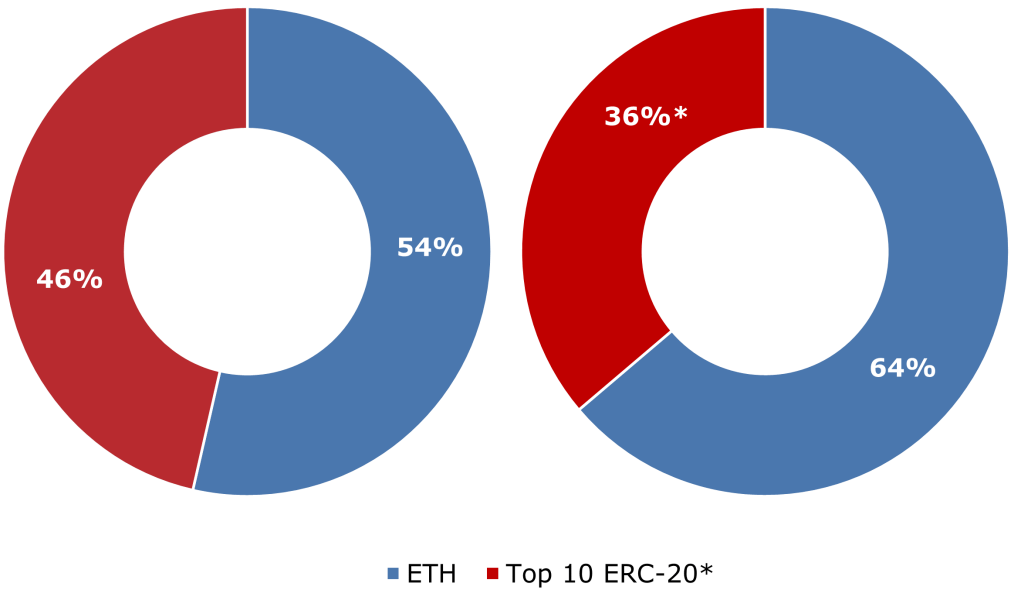
> *In five years' time, I see thousands of application-specific blockchains interconnected and flourishing from the ability to transact with each other. This has huge implications in many areas beyond DeFi, to decentralized organizations, gaming, identity, environment, supply chain, and so many use cases we can't even think of right now.*[112]

Whereas many Layer 1 developers build the technology first and then hope applications will come, certain protocols have launched with a killer dapp (Figure 11, next page). Terra Luna is one example. Terra's co-founder and CEO Do Kwon told us,

> *Crypto has exploded over the last several years, with diverse types of assets, networks, and stablecoins booming in growth. However, many of the major [Layer 1s] and crypto networks like smart contract platforms are focusing more on generalized computation. Terra is different in that it takes the*

Figure 10: Top 10 ERC-20 versus ETH

*Not counting ERC-20 stablecoins



Source of data: "ERC-20 Token Tracker," Etherscan.io*, Block Solutions SDN BHD LLC, as of 30 Sept. 2021.*

reverse approach—creating and issuing a decentralized value-stable currency that can preponderate on multiple chains and is not beholden to the demand of a network's specific advantages.[113]

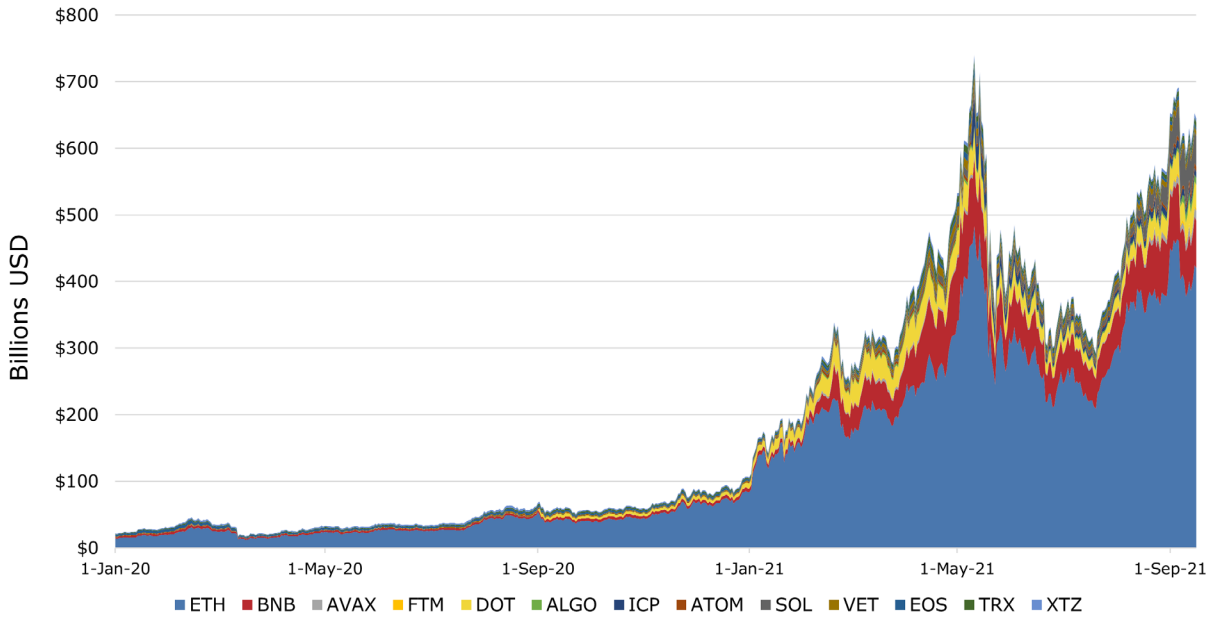
The trilemma

Traditional financial markets shut down daily for repairs and upgrades, whereas DeFi solutions are 24/7/365, patched and upgraded on the fly.

Launching a functioning smart-contracting protocol is no easy feat, especially if the goal is to out-compete Ethereum on cost or throughput. In fact, Layer 1 developers face a choice called the "trilemma" (Figure 12, next page). It's a heuristic for judging the viability of different projects, and it will change as the facts change.

Given the choice among network security, scalability, and decentralization, developers must pick two. In other words, they can have a super secure and super decentralized protocol, but it may struggle to scale in transaction throughput, if not total volume. Bitcoin is a good example of such a protocol. On the other hand, we can have a very fast and decentralized protocol, but it may not be as secure. Some would put Solana in this category. It has millions of users and dozens of dapps, and its gas fees are a tiny fraction of Ethereum's. When it shut down for an entire day in September, some questioned its durability.[114] But traditional financial markets shut down daily, and their systems undergo repairs and upgrades regularly. Blockchain and DeFi are 24/7/365, meaning that developers and code contributors—many of them volunteers—have no way to maintain, patch, or upgrade systems except on the fly.[115] In that context, Solana is an amazing accomplishment.

Figure 11: Layer 1 smart contract growth



Source of data: DeFi Llama, DeFiLlama.com*, as of 30 Sept. 2021.*

Layer 2 as scaling solution

Polygon is probably the best-known Layer 2 scalability solution to Ethereum's Layer 1 short-term bottlenecks.

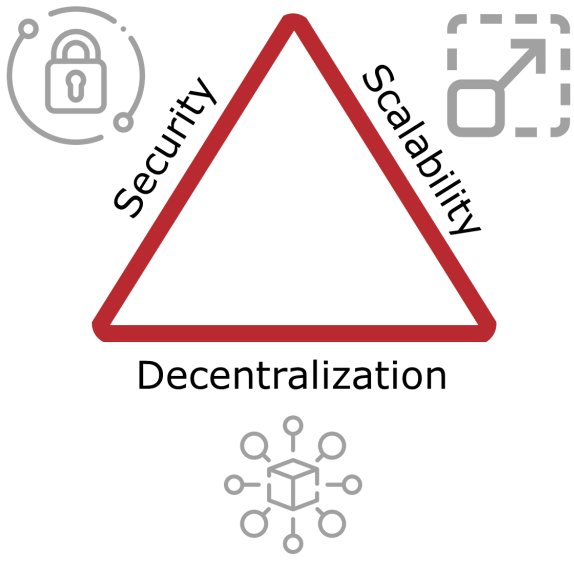
One way to solve the scalability problem is to introduce Layer 2, which runs on top or adjacent to Layer 1. Polygon is probably the most well-known. As Ethereum gas fees shot through the roof, many dapp developers, enterprises, and other users migrated to Polygon where the fees are cheaper. Polygon co-founder Sandeep Nailwal argued,

> *With fees reaching as high as $200 earlier this year, staying on the Ethereum main chain has become unsustainable. By integrating Polygon, the average gas fee per transaction is just $0.00004. The average transaction time is also significantly lower with Polygon, clocking in at two seconds, versus five to ten minutes per transaction without Polygon.*[116]

Similar to Ethereum, Polygon has a native token (MATIC) that acts as a transaction layer. So, the more transactions, the more value accrues to the token.

Because Polygon helped address this short-term bottleneck in Ethereum, there are now hundreds of projects using it. For example, high-end fashion brand Dolce & Gabbana released its debut NFT collection drop, Collezione Genesi, on a Polygon-based marketplace in September. According to Nailwal, other major projects using Polygon include Axie Infinity, DraftKings, Autograph, Lazy.com by Mark Cuban, CryptoPunks, Bored Ape Yacht Club, Beeple, and more.[117]

Figure 12: Blockchain trilemma



Source of idea: Enis Karaarslan and Enis Konacakli, "Data Storage in the Decentralized World: Blockchain and Derivatives," Who Runs the World: Data, eds. Sevinç Gülseçen, Sushil Kumar Sharma, and Emre Akadal (Istanbul University Press, Dec. 2020): Ch. 3, 37–69.

Interoperability through Multichain

Smart contracting platforms must interoperate seamlessly for DeFi and other new blockchain use cases to reach their full potential. Certain smart-contracting platforms like Cosmos and Polkadot were developed at least in part to address this issue. Cosmos has been enormously effective in drawing app developers and services into its network. According to Peng Zhong, CEO of Tendermint, which builds the critical infrastructure underpinning many of Cosmos' applications, "There are already more than 250 blockchain apps and services in the network securing more than $125 billion of digital assets."[118] Here is Tendermint's vision:

> *We're empowering people to build the decentralized web and create a transparent and accountable world through open, distributed, interoperable networks. We envision a sustainable multichain future in which all blockchain ecosystems can connect and thrive from their interactions with each other. This vision is collaborative, not competitive, and our industry-leading technology is already making it happen.*[119]

Non-fungible tokens

Corporate brands and individual artists are exploring NFTs to organize and engage more deeply with communities of fans.

In 1964, media theorist Marshall McLuhan quipped, "The medium is the message."[120] At the time, print, radio, and TV were the dominant media. McLuhan's observation feels more prescient than ever.[121] Consider NFTs, or non-fungible tokens, the provably scarce digital artwork and other digital goods that are enabled by blockchain.

NFTs have taken the art world by storm and are spreading through the culture. In Damien Hirst's foray into NFTs called *The Currency*, he sold 10,000 unique hand-painted variations on his "dot" works. Buyers also got an NFT of their piece. There was a catch: by 27 July 2022 (15:00 BST), buyers must choose between the physical painting or its NFT.[122] Hirst will destroy whichever the buyer doesn't choose.[123] So which medium will buyers choose? McLuhan would recognize the significance of that choice instantly.

Art and other so-called *crypto-collectibles* are the main use case for NFTs today but that is quickly changing. In the not-so-distant future a wide array of unique digital goods and items will be NFT-based and allow individuals to move seamlessly their identity and digital possessions between different online ecosystems, platforms, games, and universes. Already, NFT-based video games are exploding in popularity as millions come online with the promise of having fun and making money. Brands are exploring NFTs to organize communities of fans. Culture at large is being transformed as musicians and other creators explore how NFTs can allow them to not only monetize their creations but also engage on a deeper level with supporters.

Let's focus on art. There are three main categories of art/collectible NFTs. The first are collectibles tied to familiar cultural assets. For example, NBA Top Shots NFTs capture highlights of favorite NBA

players. The second are unique pieces of art, such as Beeple's *Everydays: The First 5000 Days*. The final and most viral category is generative art, often created algorithmically and usually issued in a series with a cap on the total supply, such as CryptoPunks. These have become the calling cards of online communities of early adopters and crypto-insiders and because of that cache, certain series have become increasingly valuable. So why would someone buy an art NFT?

- *First, NFTs are financial assets that we can buy and sell.* August 2021 smashed all records for NFT transaction values: OpenSea, a leading NFT platform, surpassed $3 billion in sales volume that month. Speculators are spending thousands and sometimes millions of dollars on the rights to own rare images. Tom Brady launched the NFT platform Autograph, and Steph Curry changed his Twitter avatar to an NFT he bought for $180,000 to align his brand with this emerging asset class.

- *Second, NFTs are status symbols.* As we spend a fourth of our time online, we care more about the presentation of ourselves in everyday *digital* life—the performative aspect of social interactions, as sociologist Erving Goffman described in his seminal work. Costumes matter. When someone's avatar is a provably scarce visual that the owner verifiably bought for $100,000, that image says a lot about its owner—namely, that the person is in on NFTs and immersed in cryptoassets (and probably wealthy).

- *Third, NFTs enable fans and artists to connect*. Of course, we could be cynical about NFTs as playthings for the super-rich. But most NFTs cost very little, and anyone can buy them. Many NFT collectors are fans; they don't expect to sell their NFTs at a higher price. And many NFT creators are bypassing galleries and auction houses—centralized intermediaries and gatekeepers to the collector world—to reach their fans directly, engage with them around art, and retain more of the value they create.

NFTs will be essential to the growth of a shared-state metaverse*, a super-immersive virtual experience where we can move digital assets among platforms in real time.*

Today, innovators are using NFTs primarily for art and collectibles, but we can harness them for greater ends. For example, NFTs will be essential to the growth of the shared-state *metaverse*, a super-immersive shared online state (perhaps one day paired with hyper-realistic virtual reality) where we can move digital objects between platforms in real time. For example, in the metaverse pioneer Decentraland, we can buy and sell virtual property, among other assets, using the native cryptocurrency MANA. It helped seed the development and adoption of some of the more creative metaverse-crypto collaborations we've seen so far.

Consider Loot, created by prolific crypto entrepreneur Dom Hofmann, creator of Vine. Hofmann created 8,000 loot bags where fans could spend ETH (ether, the native cryptocurrency of Ethereum) to create lists of words such as *gold ring* and *divine hood*, for some future undeveloped videogame. Within moments, people snapped up all the

loot bags. That's when the fun really started: Communities of fans, artists, and creators emerged to imagine how these assets might look and to mint NFTs of these derivative works. The value of loot bags with rare words skyrocketed in value. A whole game of games arose around Hofmann's *idea* of a videogame—not an actual game.

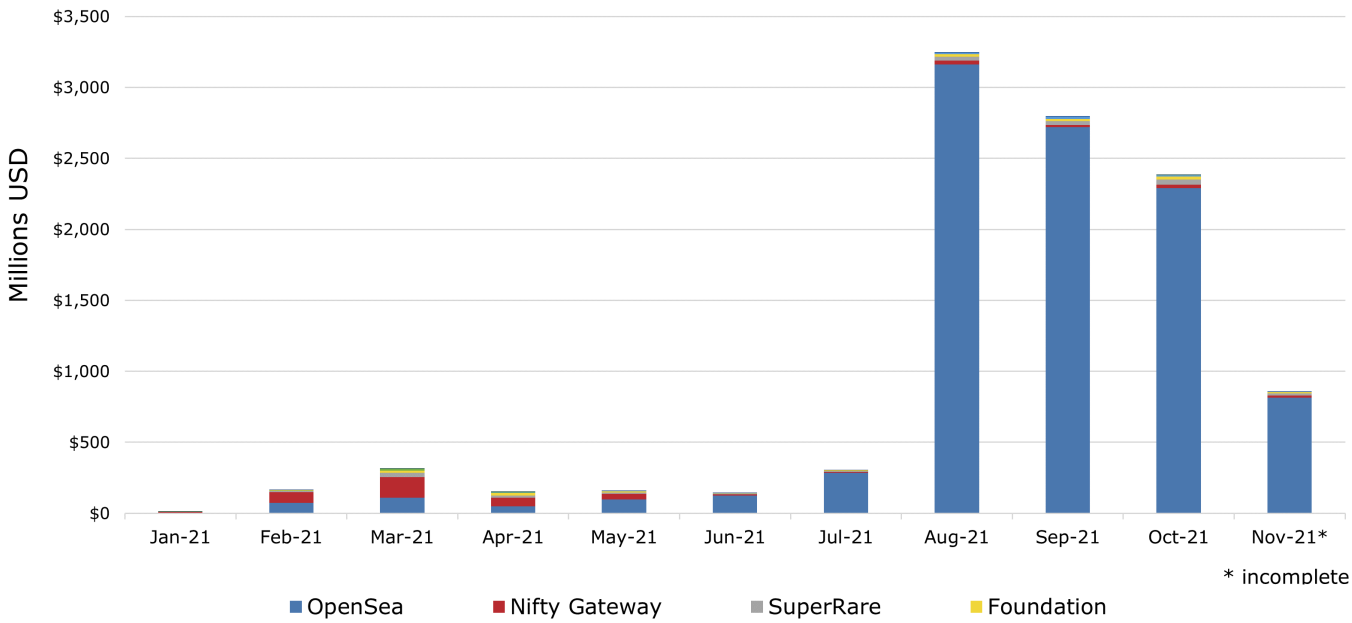
"We really saw the future of the gaming industry and, rightly, we've seen the emergence of this metaverse emerging market worker."

JEFF ZIRLIN
Co-founder and Growth Lead
Sky Mavis

Whereas Loot is still highly speculative, Axie Infinity is already an immensely popular NFT-based videogame that consistently draws over 1.5 million daily active users. Jeff Zirlin, co-founder and growth lead of Sky Mavis, said the goal with Sky Mavis' Axie Infinity was to "introduce the world to a scary and fun new technology through something relatable and nostalgic."[124] Players must first fund their entry into the game. Once they're in, they play and compete to earn Axies, the in-game assets. Axies are players in the game but also tradable assets that players can sell for hundreds or thousands of dollars. According to Zirlin, Axie NFTs have fetched $2 billion in the aggregate. By gamifying NFTs, Axie can retain players. Nine-tenths of people who play are still playing after 30 days.[125]

Axie's popularity is surging in the global south, particularly the Philippines where playing this game has become a lucrative job. Young Filipinos are earnings thousands of dollars staying home and playing Axie. Journalist Vittoria Elliott described how this surge has also created a new industry where "players are often sponsored by managers or guilds, who fund their entry into the game—a high barrier, with current costs that can go upwards of $1,500—in

Figure 13: NFT marketplaces monthly volume



Source of data: "NFT Marketplaces," The Block, TheBlockCrypto.com*, as of 15 Nov. 2021.*

return for a cut." According to Elliott, "Guilds can sprawl hundreds of members managing various accounts, honing Axie characters and churning the value of the Axie Infinity Shard token ever higher."[126] Axie players have made so much money that the Philippine government now wants a cut of the action, claiming Axie rewards are income subject to tax.[127] Earning money for playing video games is not new. Twitch streamers and other e-gaming celebrities can make millions. But the NFT-enabled play-to-earn phenomenon is democratizing that.

Axie Infinity players have made so much money that the Philippine government wants to tax Axie rewards as income.

The popularity of Axie has sent the value of its native token soaring. In early October 2021, the fully diluted market capitalization hit $40 billion.[128] That was as much as Electronic Arts, maker of popular titles like the Madden NFL game ($40.9 billion), and nearly as much as Roblox ($43.5 billion) and Nintendo ($53.8 billion), perhaps the best-known videogame company in the world.[129]

In McLuhan's day, an analog broadcast medium was transforming how we consumed information. NFTs and the underlying blockchain are a digital medium for value, changing the nature of digital goods and how we consume culture and interact online. Why is this important? Because it reveals the immense power of digital assets that we can own, trade, and transport across different environments and jurisdictions. Chris Dixon, a partner at Andreessen Horowitz said, "Tokens give users property rights: the ability to own a piece of the Internet."[130] The ability to own unique and scarce digital assets—such as our digital identities—and move freely around the Internet without the risk of duplication or seizure by a centralized platform is a profound shift from how finance works today. The medium is the message. Time to tune in.

Stablecoins

Stablecoins are digital assets that track the value of some well-known and understood asset, typically the US dollar. They are, in effect, programmable fiat currency, but most governments don't recognize them as legal tender. Still, stablecoins are the dominant media of exchange in the digital asset ecosystem and have grown at a prodigious rate—surpassing $125 billion in circulating supply, compared with less than $2 billion two years ago.[131]

Stablecoins pegged to the US dollar are among the dominant media of exchange in the digital asset ecosystem.

There are two kinds of stablecoins: centralized and decentralized. The larger category today is centralized stablecoins issued by companies, backed by reserves, and created largely to meet the insatiable demand for cryptoassets. To wit, Circle's USDC recently surpassed $30 billion in circulating supply and handles about $3.5 billion a *day* in volume—more than 10 times that of Venmo, the most popular payment app in the United States.[132]

Perhaps the most famous centralized stablecoin is Facebook's project, originally named Libra. Facebook had hoped to back Libra with a basket of other fiat currencies, including the US dollar and the euro. In Facebook's view, Libra would bank the unbanked, connect the unconnected, and position Facebook as a leader in the Internet

of value, not just the Internet of information. The US government had other ideas. After much lobbying, Facebook cut the scope and ambition of the project, reimagining its stablecoin as a US dollar–backed called Diem. That didn't fly either. Regulators seem loath to green light any such coin while the name Facebook remains toxic. Instead, Facebook launched its digital wallet Novi and chose the Paxos Trust Company's US dollar–backed stablecoin (USDP) and Coinbase's custody services for its pilot in the United States and Guatemala.[133]

Facebook launched its digital wallet Novi and chose the Paxos USD–backed stablecoin (USDP) for its pilots in the United States and Guatemala.

Representing only one percent of all stablecoins in circulation, the Pax dollar is a bit player compared to such centralized stablecoins as USDC or USDT. For Paxos, the deal is a potential game changer. "This news represents a tide shift in digital assets, as it's the first time that stablecoins are readily available in a consumer wallet outside of the crypto ecosystem," said Walter Hessert, head of strategy and business development at Paxos.[134] Paxos understands the significance of this deal, if not the risks associated with a tech giant so often in regulatory crosshairs, as they team up to integrate stablecoins into the payment landscape. (Facebook has since announced the change of its corporate name to Meta.[135])

Decentralized stablecoins have similarly exploded in value, though are still smaller than their centralized cousins. DAI, a decentralized stablecoin maintained by MakerDAO, has over $6 billion in circulation and does around $500 million a day in volume, which is more than Venmo.[136] Algorithmic stablecoins are a subset of decentralized stablecoins. UST, created on the Terra Luna blockchain, is one of the fastest growing and most widely used stablecoins in the DeFi ecosystem today. With over $2.5 billion in circulating supply, UST supports Terra Luna's burgeoning DeFi ecosystem, which has over $8.7 billion in TVL today. Do Kwon, the creator of Terra Luna told us:

> *From the start, building decentralized products that have the potential to augment the demand for UST, Terra's primary product, was our singular focus. Similar to the US dollar, ossifying demand for UST via a growing economy enveloping the currency is the best way to ensure the long-term success and sustainability of the ecosystem.*[137]

Kwon's goal is to make UST the de facto stablecoin for the DeFi ecosystem, "with the mandate to issue the most robust, censorship-resistant stablecoin that DeFi requires to blossom."

There is some debate about how truly "decentralized" many of these algorithmic stablecoins are, leading the accusation by some that they're *decentralized in name only* (DINO), a clever acronym that riffs off the *Republican in name only* (RINO) tag of the Trump Era. Any point of centralization gives regulators a way to crack down. This might soon be put to the test. Decentralized stablecoins help keep DeFi decentralized as well. After all, if the main payment rails for DeFi are centrally controlled stablecoins, how decentralized are they really? Or as Do Kwon said, "Without adequately decentralized stablecoins, DeFi will be subject to many of the same confined

gateways and limitations of the legacy financial system for which it seeks to offer an alternative. Governments can force uptake of CBDCs."[138]

"Without adequately decentralized stablecoins, DeFi will be subject to many of the same confined gateways and limitations of the legacy financial system."

DO KWON
Co-founder and Chief Executive Officer
Terraform Labs

Centralized stablecoins are likely to face greater oversight of such regulators as the US Securities and Exchange Commission (SEC) and the US Commodity Futures Trading Commission (CFTC). In early November 2021, the President's Working Group on Financial Markets, along with the OCC and the Federal Deposit Insurance Corporation, released a report on stablecoins.[139] They recommended that Congress swiftly pass laws that would subject custodial wallet providers to federal oversight and require stablecoin issuers to register as insured depository institutions and be supervised as such.[140]

Many industry watchers expect more stringent regulations to follow suit. SEC Chair Gary Gensler, who many hoped would be more open to the industry, has proven a tough critic. In a statement on the report, Gensler said, "We at the SEC and our sibling agency, the [CFTC], will deploy the full protections of the federal securities laws and the Commodity Exchange Act to these products and arrangements, where applicable."[141]

On various occasions Gensler has compared the crypto industry to the Wild West, repeating the comparison again in a recent interview with the *Washington Post*, "We've got a lot of casinos here in the Wild West … . And the poker chip is these stablecoins."[142] This comparison is unfair to the many regulated stablecoins such as USDC and trivializes the size, importance, and reach of the $125 billion stablecoin market. It's also just plain wrong—poker chips can only be spent in casinos, and sometimes only in the casino that issues them, kind of like Chuck E. Cheese money. Stablecoins are a highly liquid, widely accepted medium of exchange not confined to any one application or company.

"If widely adopted, stablecoins could serve as the basis of an alternative payments system oriented around new private forms of money."

LAEL BRAINARD
Governor
Federal Reserve Board

A more nuanced critique of stablecoins came from Federal Reserve Board Governor Lael Brainard who said, "If widely adopted, stablecoins could serve as the basis of an alternative payments system oriented around new private forms of money," adding later that "a predominance of private monies may introduce consumer protection and financial stability risks because of their potential volatility and the risk of run-like behavior."[143] To be sure, centralized stablecoins should be fully backed by reserves, subject to regulation and periodic audits and fully transparent about their holdings to avoid these issues.

Some have suggested that stablecoins pose a threat to the government's monopoly on printing money. The opposite is probably true. Former Federal Reserve Board Governor Randal Quarles offered a starkly different view from his colleague Brainard, revealing, among other things, a clear lack of consensus in the world's most powerful central bank. In a recent speech, he argued that stablecoins could improve the speed and efficiency of the payments infrastructure and that innovation like this should be supported. He also quipped:

"We do not need to fear stablecoins. … A US dollar stablecoin might support the role of the dollar in the global economy."

RANDAL K. QUARLES
Former Governor
Federal Reserve Board

> *We do not need to fear stablecoins. … The Federal Reserve has traditionally supported responsible private sector innovation. Consistent with this tradition, I believe that we must take strong account of the potential benefits of stablecoins, including the possibility that a US dollar stablecoin might support the role of the dollar in the global economy.*[144]

This makes sense. Banks have often worked hand in glove with the Federal government to extend United States influence into different parts of the world. Quarles added that "a global US dollar stablecoin network could encourage use of the dollar by making cross-border payments faster and cheaper, and it potentially could be deployed much faster and with fewer downsides than a CBDC." Quarles said, "The concern that stablecoins represent the unprecedented creation of private money and thus challenge our monetary sovereignty is puzzling, given that our existing system involves—indeed depends on—private firms creating money every day."[145] Indeed.

Table 2: Stablecoins

Stablecoin	Symbol	Type	Market cap	1Y growth	YTD growth
Tether	USDT	Centralized	$66,510,000,000	4.45x	3.15x
USD Coin	USDC	Centralized	$27,500,000,000	13.42x	6.86x
Binance USD	BUSD	Centralized	$12,500,000,000	35.42x	10.86x
Dai	DAI	Decentralized	$6,400,000,000	11.86x	5.42x
TerraUSD	UST	Decentralized	$2,520,000,000	189.47x	13.89x
TrueUSD	TUSD	Unclear	$1,420,000,000	2.90x	5.16x
Pax Dollar	USDP	Unclear	$939,000,000	3.83x	3.83x
Liquidity USD	LUSD	Decentralized	$720,000,000	0.49x	0.49x
Reserve Rights	RSR	Centralized	$538,000,000	4.61x	2.27x
Neutrino USD	USDN	Decentralized	$466,000,000	17.48x	3.89x
HUSD	HUSD	Unclear	$456,000,000	3.41x	2.68x
Fei USD	FEI	Decentralized	$414,000,000	0.19x	0.19x
Frax	FRAX	Decentralized	$319,000,000	12.27x	12.27x
sUSD	SUSD	Unclear	$259,000,000	11.26x	11.26x
Gemini Dollar	GUSD	Centralized	$181,000,000	14.87x	11.31x

Source of data: Stablecoin View, CoinMarketCap.com, *CoinMarketCap OpCo LLC, as of 30 Sept. 2021.*

Securities tokens

In a programmable token, we can automate a contractual right to a common share of an enterprise, a right to a stream of cash flows, and/or a right to vote on certain enterprise matters.

The securities market, which includes stocks, bonds, derivatives, and investment funds, is the mother of all markets. At its core, a security is nothing more than a contract. Take the humble stock—the bearer of a common share has a contractual right to a piece of a common enterprise, a right to a stream of cash flows, should that enterprise pay a dividend, and the right to vote on certain enterprise matters. We can program and automate each one of those concepts in a token so that securities markets run more efficiently, fairly, and inclusively because:

- Trades settle instantly rather than in days.
- Voting takes place instantaneously and transparently on-chain so that everyone can see results.
- Anyone with Internet access can trade them and participate in wealth creation.

However, which tokens are securities is open to interpretation. Three categories of tokens function like securities:

- *DeFi securities tokens and funds.* DeFi securities often take the form of pooled investment funds, such as DeFi index funds.,
- *Synthetic securities.* These trade on centralized exchanges (e.g., FTX) and decentralized platforms (e.g., Mirror). They give investors a way to participate in securities markets that investors would not be able to access, such as the market for private stock (e.g., Coinbase pre-IPO) or shares listed in other countries.
- *TradFi-issued tokens.* Banks and other intermediaries issue these stocks and bonds, often on a crypto-native rail and a traditional rail and then record ownership on a blockchain as well as on an off-chain registry.

DeFi index funds: Securitizing crypto

Many of the largest asset managers in the traditional financial world are passive ETFs and index funds. DeFi index funds are small relative to DeFi as a whole and subatomic compared to ETFs, which have over $7.5 *trillion in assets*.[146] The biggest one is Index Co-op, a DAO launched by Set Protocol. It teamed up with DeFi Pulse and other well-known entities to develop the DeFi Pulse Index. Today, Index Co-Op has around $400 million, which is small relative to the entire DeFi space. Despite its modest size today, Index Co-op has its sights set on a much bigger opportunity—to become the DeFi Blackrock, a decentralized autonomous asset manager that allows anyone to develop a passive investment fund.

Synthetic securities

Various exchanges and platforms offer investors synthetic versions of traditional securities in public companies like Apple or Google, or pre-IPO shares in upcoming listings such as Coinbase. However, not all these assets are tokens, and none confer ownership of the underlying shares. In effect, holders have price exposure (i.e., they can make or lose money) but no rights or obligations of shareholders, such as voting rights.

Not unlike traditional equities market, the derivatives market associated with these synthetics is highly active. For example, the popular global exchange FTX offers nearly 50 USD synthetic pairs: investors can trade around 50 different assets against the US dollar. In a recent 24-hour period, the total trading volume for synthetic equities hit $1.5 million. By contrast, the trading volume for synthetic equities futures in the same period was nearly $5 million.

Table 3: Synthetic equities trading volume

Select September 2021 futures, 24-hour trading period

Symbol	Company	Value	Symbol	Company	Value
MSTR-0924	MicroStrategy	$1,505,803.07	NFLX-0924	Netflix	$44,563.73
BNTX-0924	BioNTech	$517,209.60	UBER-0924	Uber	$43,934.91
BILI-0924	Bilibili	$416,148.58	ZM-0924	Zoom	$33,634.85
MRNA-0924	Moderna	$360,229.16	FB-0924	Facebook	$31,365.74
AMC-0924	AMC Entertainment	$196,632.75	AMZN-0924	Amazon	$30,401.57
TLRY-0924	Tilray	$153,556.09	AMD-0924	Advanced Micro Devices	$29,564.43
AAPL-0924	Apple	$150,591.85	ABNB-0924	Airbnb	$26,163.70
CRON-0924	Chronos Group	$143,308.41	BB-0924	BlackBerry	$15,597.26
SQ-0924	Square	$140,573.31	NIO-0924	Nio	$11,185.15
GME-0924	GameStop	$138,382.28	SLV-0924	iShares Silver Trust	$8,949.97
GOOGL-0924	Alphabet	$122,963.43	USO-0924	United States Oil Fund	$4,195.32
TSLA-0924	Tesla	$81,068.45	GLD-0924	SPDR Gold Shares	$2,818.12
BYND-0924	Beyond Meat	$80,116.90	TSM-0924	Taiwan Semiconductor	$2,706.75
PYPL-0924	PayPal	$76,895.03	TWTR-0924	Twitter	$2,222.31
BABA-0924	Alibaba	$63,239.98	NOK-0924	Nokia	$1,955.20
PFE-0924	Pfizer	$45,253.07			

Source of data: Tokenized Stock Futures, FTX.com*, FTX Trading GmbH, as of 24 Sept. 2021.*

Two lessons: first, derivatives are a more liquid market; and second, these figures are paltry compared to traditional cash equities markets. Still, the growth of such a new asset has been impressive.

For FTX, this is a sideshow to its main business as a cryptoasset and crypto-derivatives platform. Not so for synthetic trading app Mirror built on the Terra Luna platform and designed exclusively for synthetic trading. Users of Mirror tokenize stocks by depositing collateral such as the Terra stablecoins into Mirror contracts. Do Kwon of Terra Luna said:

"Synths [help] investors to diversify their portfolio risk and participate in both TradFi and DeFi simultaneously."

DO KWON
Co-founder and Chief Executive Officer
Terraform Labs

> *Mirror is a decentralized, community governed, synthetic assets protocol on Terra that provides an open-source framework for issuing and trading tokenized assets pegged to their real-world counterparts. Mirror provides asset exposure to many people in financially disenfranchised regions of the world who are blocked from major wealth-generating markets.*
>
> *However, mAsset exposure is explicitly price exposure and does not confer ownership of the underlying asset, which simply uses oracles and arbitrage incentives to mediate its peg to the underlying real-world asset. Due to its open-source nature, myriad applications can be built on top of Mirror beyond its current iteration, such as options, futures, and more that wield the underlying mAssets of "synths."*
>
> *Demand for synths is significant because it offers uncorrelated (top crypto markets) asset exposure on-chain—helping investors to diversify their portfolio risk and participate in both TradFi and DeFi simultaneously. Naturally, the potential TAM for synthetics is enormous, and we're only in the early stages of exploring their potential.*[147]

mAssets are truly tokens, native to the Terra Luna blockchain and not derivatives on a centralized exchange. So, although they are basically an experimental market, they contain the blueprint for blockchain-enabled securities.

TradFi initiatives

Blockchain enables instant clearing, settlement, and record-keeping for assets, including securities. Thus, TradFi institutions are looking to leverage it for their own businesses. However, there are various barriers to securities tokens scaling in this environment. First, legacy attitudes make some industry participants skeptical and reluctant to change. Second, installed market infrastructure and technologies makes switching to a "crypto-native" format challenging. Third, customers are used to the old ways and may not want to switch over. Fourth, it is difficult to "tokenize" something that already exists in analog format. It's much easier to start from scratch with a new issue in a purely crypto-native format. Most financial assets already exist.

Table 4: Securities token offerings from traditional financial firms

Date	Parties	Jurisdiction	Technology	Digital Asset
Jan. 2017	Commonwealth Bank and Queensland Treasury Corp.	Australia	Unspecified permissioned blockchain	First government bond using blockchain
June 2017	Daimler and Landesbank Baden-Württemberg	Germany	Unspecified distributed ledger technology	Schuldschein issuance, i.e., informal loan agreement
Sept. 2017	Commerzbank, KfW Banking Group, and MEAG	Germany	R3 Corda	Euro commercial paper
Nov. 2017	Nivaura, Allen & Overy, and LuxDeco	United Kingdom	Ethereum-based blockchain	First automated cryptocurrency bond issuance
Feb. 2018	Telefónica Deutschland Holding AG, Landesbank Baden-Württemberg, and DZ BANK AG	Germany	Unspecified distributed ledger technology	Schuldschein issuance
April 2018	National Bank of Canada (NBC) and J.P. Morgan	Canada	Quorum blockchain	Yankee certificate of deposit
Aug. 2018	World Bank and Commonwealth Bank of Australia	Australia	Private Ethereum-based blockchain	First Kangaroo bond
Aug. 2018	Bank of Montreal and Ontario Teachers' Pension Plan	Canada	Unspecified distributed ledger technology	First Canadian dollar fixed income issuance
Oct. 2018	Oesterreichische Kontrollbank AG	Austria	Ethereum public blockchain	Data notarization for government bond auction
Feb. 2019	BBVA Group for MAPFRE	Spain	Unspecified distributed ledger technology	First structured green bond
Feb. 2019	Continental, Commerzbank and Siemens	Germany, Luxembourg	Corda-based blockchain platform	Money market security
April 2019	Société Générale SFH	France	Ethereum blockchain	First covered bond as a security token
June 2019	European Investment Bank (EIB), Euroclear, Banco Santander, and Ernst & Young	Belgium, Luxembourg, and Spain	Unspecified distributed ledger technology	European commercial paper
July 2019	YES BANK and Vedanta Ltd.	India	MonetaGo's R3 Corda implementation	First Commercial Paper Issuance
Aug. 2019	International Bank for Reconstruction and Development, Commonwealth Bank of Australia, RBC Capital Markets, and TD Securities	Australia	Private Ethereum-based blockchain	Kangaroo bond (Bond-i tap)
Sept. 2019	Banco Santander	Spain	Ethereum blockchain	First end-to-end blockchain bond
Sept. 2019	Daimler and Landesbank Baden-Württemberg	Germany	R3 Corda-based Marco Polo blockchain network	Trade finance
May 2020	Société Générale SFH and Banque de France	France	Ethereum-based Forge platform	Feasibility of CBDC
Sept. 2020	Bank of Thailand	Thailand	IBM Blockchain	Government savings bond issuance
Dec. 2020	UnionBank, Standard Chartered	Philippines	Unspecified distributed ledger technology	Retail bond issuance
Jan. 2021	Vonovia	Germany	Stellar blockchain	Fully digital registered bond
April 2021	Société Générale Assurances	France	Tezos public blockchain	First structured product (auto callable EMTNs)*
April 2021	EIB, Goldman Sachs, Santander and Société Générale	France	Ethereum, a public blockchain	Digital bond issuance; feasibility for CBDC

*EMTNs = Euro medium term notes

Sources of data: Cheang Ming, "The World Bank Is Preparing for the World's First Blockchain Bond," CNBC.com, *NBC Universal Media LLC, 10 Aug. 2018; Wolfie Zhao, "Auction of a Bond Worth Around $1.3 Billion,"* CoinDesk, *Digital Currency Group, 25 Sept. 2018, updated 13 Sept. 2021; and "New FinTech Applications in Bond Markets,"* ICMAGroup.org, *International Capital Market Assoc., 2021.*

In spite of these challenges, there have been dozens of successful securities tokens offerings, from entities like Santander, Société Générale, the World Bank, Banco Bilbao Vizcaya Argentaria, Bank of Montreal, MUFG Union Bank, and others. (See Table 4, previous page.)

Moreover, as regulated securities tokens become more popular, there is a growing demand for market infrastructure such as exchanges to transact in them. Tzero, INX, ISTOX, and others are trying to fill this gap, but they are still tiny compared to the broader cryptoasset ecosystem and financial markets in general. Perhaps securities like equities will become less relevant over time as we organize more economic activity in DAOs where governance tokens, not "common shares," give users and holders influence over the direction of these entities.

Table 5: Largest DAO treasuries

Name	Total treasury	Liquid treasury
Uniswap	$11,032,128,273	$4,467,296,235
ENS	$4,814,784,391	$398,406,844
Compound	$1,019,076,566	$37,806,182
Lido	$1,013,369,806	$1,013,369,806
Aave	$710,995,680	$710,995,680
Olympus DAO	$695,596,511	$695,596,511
Gitcoin	$643,282,372	$212,022,218
Synthetix	$459,754,748	$459,754,748
MakerDAO	$315,896,435	$315,896,435
Tornado Cash	$293,734,661	$14,213,094
Badger	$281,435,598	$281,435,598
Yearn.Finance	$162,664,196	$162,664,196
SushiSwap	$143,079,883	$143,079,883
Alchemix	$124,448,531	$124,448,531
Balancer	$113,243,653	$113,243,653
DXdao	$112,487,482	$112,487,482
API3	$109,938,536	$109,938,536
BarnBridge	$108,304,172	$108,304,172
Nouns DAO	$67,661,963	$67,661,963
Index Coop	$65,258,192	$65,258,192

Source of data: David Mihal, OpenOrgs.info*, openorgs.info, as of 9 Nov. 2021.*

Governance tokens

Recall that DAOs are on-chain entities that facilitate the governance and economic coordination of decentralized protocols, often with a large token treasury—effectively a war chest belonging to a piece of software.

DAO treasuries are a by-product of this new decentralized and autonomous model for organizing human activity, earning money, and distributing funds.

MakerDAO, which maintains and regulates the DAI stablecoin, charges a small fee for minting DAI which accrues to the protocol's treasury as so-called "protocol revenue." As of August 2021, MakerDAO had earned over $63 million in fees for the year.[148] While modest compared to any large company, the MakerDAO model for a DAO, which can earn money and distribute funds, will become the model for the digital asset world and beyond.

Indeed, DAO treasuries are a by-product of this new model for organizing human activity. This is a radical departure from the traditional system, which relies on corporations as the main human artifact for creating value in the economy. Indeed, for a century, the main theories of management have enabled managers to build corporations, which have largely been hierarchical, insular, and vertically integrated.

Table 6: Decentralized automomous organizations

Rank	Name	Symbol	Price	Market Cap	Purpose
17	Uniswap	UNI	$24.38	$15,322,034,286	Governs changes to protocol logic and allocation of governance funds
48	Aave	AAVE	$309.80	$4,096,103,346	Governs changes and upgrades to the Aave protocol
62	Maker	MKR	$3,057.33	$3,038,834,163	Governs policy for DAI stablecoin, collateral types, and governance itself
70	Dash	DASH	$234.60	$2,445,744,011	Governs budgets and projects funded
74	Compound	COMP	$346.10	$2,087,350,332	Governs adding assets, changing collateral factors, interest rate model, or other parameter/ variable of protocol
84	Curve DAO	CRV	$4.05	$1,673,923,053	Governs incentive structure, fee payment method, and long-term earnings method for liquidity providers
87	Decred	DCR	$117.54	$1,593,825,589	Governs spending and changes to software and policy
90	SushiSwap	SUSHI	$10.77	$1,370,256,190	Governs changes to ecosystem
92	UMA	UMA	$20.88	$1,339,644,245	Governs building projects
103	Synthetix	SNX	$9.84	$1,131,621,642	Governs ecosystem improvements and configuration changes
110	0x	ZRX	$1.25	$1,055,644,716	Governs community treasury, not protocol upgrades
178	Badger DAO	BADGER	$33.57	$345,990,148	Governs building products and infrastructure for BTC DeFi

Sources of data: "DAOs," CoinMarketCap.com*, CoinMarketCap OpCo LLC, as of 15 Nov. 2021, and each DAO's website.*

DAOs are eating the enterprise: how they function, raise funds, create value, hire people, and meet regulatory requirements.

However, DAOs allow us to rethink many functions of the firm beyond just storing value: how they are funded and managed, how they create value, who they employ, where they are domiciled, how they are regulated, and how they perform basic functions such as marketing, accounting, and incentivizing people. Marc Andreessen once explained why software is eating the world.[149] A prime example: DAOs are eating the corporation.

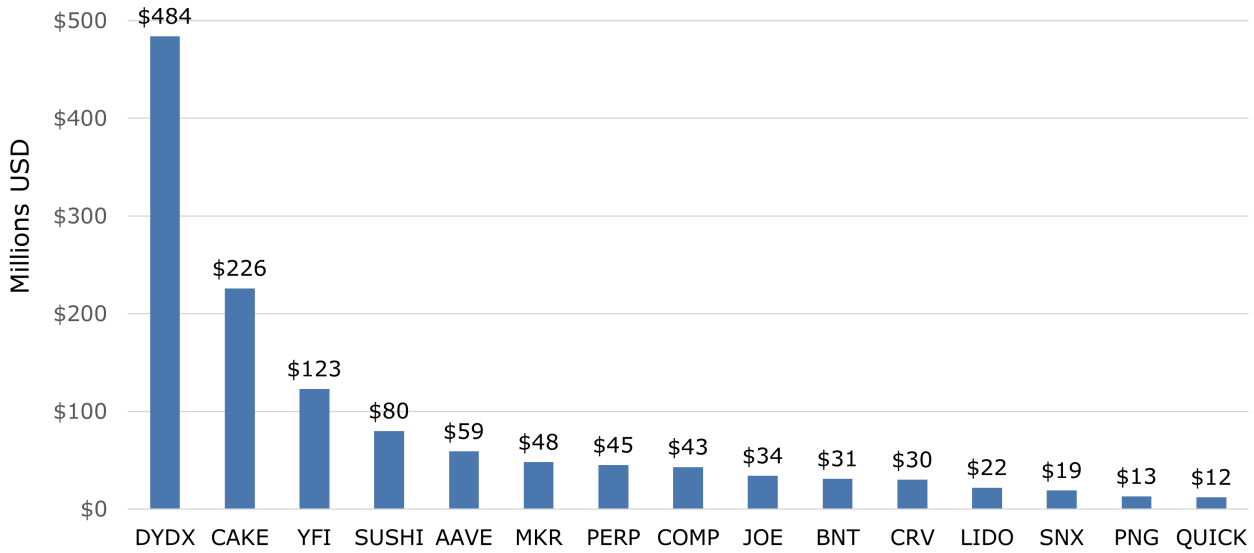
Whether DAOs are better suited for creating products and services and for delivering value to stakeholders remains unproven in a wider range of settings beyond DeFi protocols. But DAOs can perform many functions at least as well as traditional companies, including making money. See Figure 14.

Exchange tokens

Crypto exchange tokens are native to centralized exchanges, such as Binance and FTX. Typically, these tokens provide rewards and discounts, improve liquidity, and provide other incentives to use a given exchange. They are similar to governance tokens of decentralized exchanges in that they are essential to the exchange's functionality and incentivize user growth. Unlike those tokens, however, they are more centrally managed and don't often confer governance rights.

The market capitalizations of the biggest exchange tokens have nevertheless exploded in value, especially as those exchanges launch adjacent DeFi projects where the tokens will have added utility, such as BNB, the native token for Binance.

Figure 14: DeFi protocol annualized revenue



Source of data: "Protocol Revenue," TokenTerminal.com*, as of 30 Sept. 2021.*

The BNB utility token has increasing utility (i.e., usefulness) and declining supply, which is generally a recipe for rising value.

At the beginning of October 2021, BNB had a market capitalization of $70 billion.[150] That was more than twice as much as the market cap of NASDAQ ($31 billion) at the time, and BNB wasn't even equity in the company, at least not in the traditional sense.[151]

However, Binance is the largest and most profitable cryptoasset exchange in the world, and its native token has enormous utility inside the app and on its DeFi project, Binance Smart Chain. BNB is a utility token for discounted trading fees and referral levels: the more BNB tokens a user holds, the higher the percentage return for making referrals. As Binance grows and diversifies, holders of BNB will be able to use it for travel bookings, entertainment, online services, and other financial services. Every quarter, Binance uses one-fifth of its profits to destroy or "burn" its tokens permanently. In other words, the token has increasing utility (i.e., usefulness) and declining supply, which is generally a recipe for rising value.[152] In addition, BNB is the protocol token for the Binance Smart Chain, which supports its own ecosystem of dapps. This added functionality contributes to the immense value of BNB.

Table 7: Top centralized exchange tokens

Exchange Token	Symbol	Price	Market cap
Binance Coin	BNB	$536.07	$89,236,858,026
Crypto.com Coin	CRO	$0.5174	$13,030,616,762
FTX Token	FTT	$48.87	$6,833,322,146
UNES SED LEO	LEO	$3.16	$3,002,001,013
KuCoin Token	KCS	$22.44	$1,807,429,457
Huobi Token	HT	$9.82	$1,565,017,100
OKB	OKB	$24.36	$1,461,808,876
LINK	LN	$184.29	$1,097,152,731
GateToken	GT	$5.88	$810,528,603
WOO Network	WOO	$1.41	$810,528,603
WazirX	WRX	$1.22	$389,973,592
Bitpanda Ecosystem Token	BEST	$1.07	$387,922,498
ASD	ASD	$0.4501	$296,929,995
MX Token	MX	$2.38	$239,774,838

Source of data: "Centralized Exchange," CoinMarketCap.com*, CoinMarketCap OpCo LLC, as of 18 Nov. 2021.*

Though Binance is the largest exchange, FTX is rapidly gaining ground. FTX also has an exchange token whose value is geared to trading. FTX token serves as collateral for futures positions, discounts on trading fees, and staking and earning interest. Like Binance, FTX burns a portion of FTX periodically, banking on the same model of supply and demand to increase the aggregate value of the FTX token.

Exchange tokens are a hybrid of loyalty points and equity: they improve the customer's experience and expose users to the economic success of the platform.

While FTX and Binance are the highest profile exchange tokens, there are many others such as OKB, which offers discounts for trading fees, ICO access, and OKEx ecosystem access.[153] The Huobi Token lowers transaction fees, offers VIP discounts, and gives users access to exclusive events.[154] KuCoin acts like equity in that it pays a dividend to tokenholders based on trading fees.[155] In addition, holders get trading fee discounts, additional trading pairs, customer support fast passes, and other perquisites. Exchange tokens are a hybrid of loyalty points and equity: like loyalty points, they improve the quality of a customer's experience tremendously; and like equity, they offer users direct economic exposure to the success of the platform.

Natural asset tokens

At first glance, using a digital medium to manage a physical commodity seems a strange fit. How does one deliver physical oil, pork bellies, timber, or iron ore on a blockchain? However, we have various examples of using digital assets to express physical assets in the real world. Most commodities trade in the futures market, not the spot market, meaning when we buy oil, for example, we're buying a contract obligating us to buy oil at a future date. Futures are *contracts* and so we can make them smart. Earlier we discussed how decentralized futures markets such as dYdX are exploding in popularity as a way for speculators and investors to get exposure to cryptoassets. However, we can easily apply the underlying mechanics of a perpetual futures smart contract to virtually any futures market in the world, including commodities futures. Of course, this does not solve the physical delivery, but it could automate the front-end of the market, improving speed and efficiency and perhaps even cutting down on risk.

We can easily apply the underlying mechanics of a perpetual futures smart contract to virtually any futures market in the world.

Other nascent markets like carbon offsets could be scaled radically with the self-executing nature of smart contracts and immutable nature of blockchains. Global warming is a global crisis that requires a global solution. Carbon offsets could play an important role. Companies need to offset their carbon footprint to meet standards set by governments, international accords, and increasingly many investors who are agitating for change. The best way to do that is by de-carbonizing our business model and our supply chain. That can take time. Carbon offsets can fill the gap in the meantime. There will be more demand for credits than what current projects, such as forestry conservation initiatives, can support.

"We don't want to shake the system so much that we would lose the stability that is needed."

CHRISTINE LAGARDE
President
European Central Bank

What's required is a transparent, liquid market for carbon offsets with a common set of technical standards and a decentralized ledger for registering and retiring them. There are a few interesting projects addressing this issue. MCO2, a large global carbon market, is tokenizing carbon credits. XELS, which uses blockchain to trade carbon credits, listed recently on Bittrex, a large exchange. Single.Earth is trying to link carbon credits to token markets, and recently raised $7.9 million from EQT ventures. CarbonX wants to take this a step further, creating a way for individuals (and not just companies and governments) to earn credits as a reward for reducing their footprint.[156]

Central bank digital currencies

The rise of bitcoin and other nonstate-based monies compels central banks to confront the possible end to government monopolies on money. Christine Lagarde, president of the European Central Bank, captured the threat and opportunity of blockchain and cryptocurrencies in an interview with CNBC: "I think the role of the disruptors and anything that is using distributed ledger technology, whether you call it crypto, assets, currencies, or whatever ... [T]hat is clearly shaking the system." She added, "We don't want to shake the system so much that we would lose the stability that is needed."[157]

There is risk and opportunity for central bankers in this new future. The fact is central bankers have often "failed to stem macroeconomic crises and may have, in fact, exacerbated negative outcomes by incentivizing excessive risk-taking and moral hazard via unconventional monetary tools such as quantitative easing and negative interest rates."[158]

Central bank digital money could improve the efficiency, reach, and responsiveness of financial markets. Its advocates in the United States and the rest of the Western world argue it could more easily accommodate unbanked people, reduce costs, add clarity and muscle to monetary policy, and reveal risk.

In China, a different picture emerges. People's ability to move and store value and fully participate in the economy already depends on their government-issued social credit score. Smoking in nonsmoking zones, driving recklessly, or playing too many video games could lower citizens' scores and decrease their access to flights, luxury goods and services, or the best colleges.

Now China wants to kill cash and introduce a CBDC to keep a closer eye on how people spend money.[159] Without cash, the government could simply switch off a person's access to credit, payments, and savings if the person disagrees with the government, a form of financial deplatforming. Unsurprisingly, China has cracked down on bitcoin.[160] This battle between the most powerful surveillance state ever created and the most powerful stateless money ever created will be worth watching.[161]

If cash disappears, do we want an administrative state imposing draconian rules that suppress free trade or limit how we use our money?

Whichever path the United States and others choose—and they may not launch their own CBDCs—central banks must ensure that any CBDCs have similarities to cash. Cash is essential to financial freedom because it allows for anonymous transactions and private exchanges of money outside state surveillance.

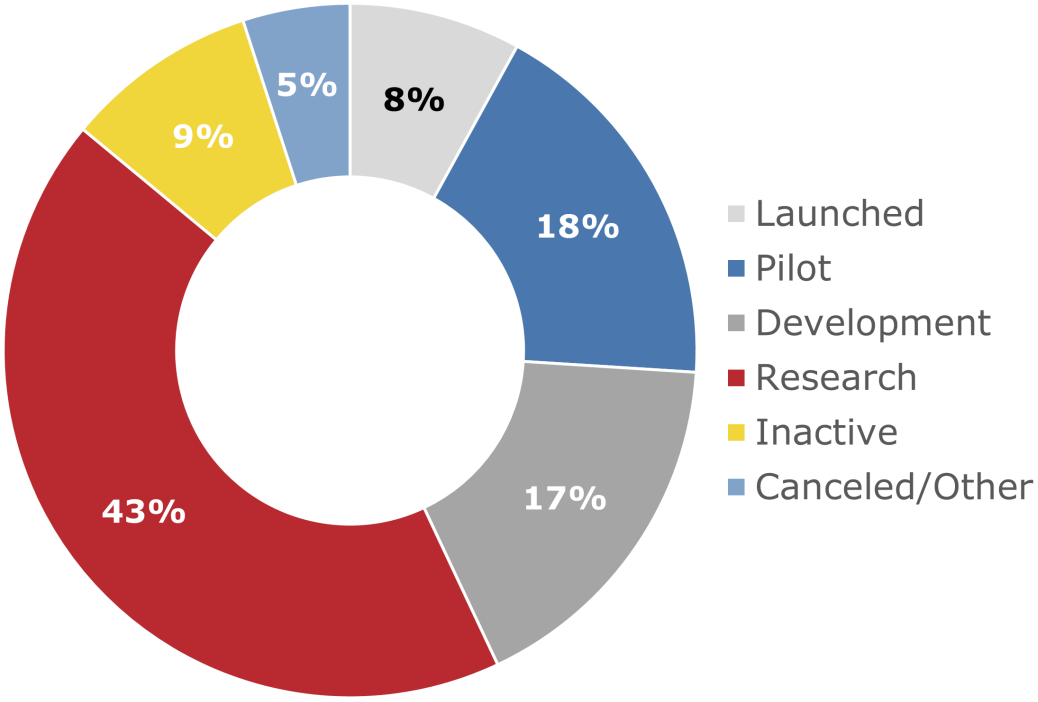
But cash is in terminal decline. For decades, credit card payments have chipped away at cash's role in our economy. The pandemic accelerated that decline as reports (later proved false) that cash was a carrier of COVID-19 caused many merchants to switch to card-only.

The demise of cash highlights the need for a digital alternative to ensure private, safe payments between individuals. If cash disappears, as we argue it may, do we really want an administrative state imposing draconian rules that limit how we spend and save our money and suppress free trade? That is one future of CBDCs. If governments go down that path, more people will drop out of the formal economy.

Issuers of CBDCs in free societies like the United States or Canada must overcome several implementation challenges. For example, with CBDCs, how do users preserve their privacy for certain economic transactions? How do citizens prevent governments from blocking users, so that they can't access basic financial services?

Figure 15: Status of CBDC experiments

Of the 90 countries exploring CBDCs, seven countries (8%) have launched their digital currencies.



Source of data: "Central Bank Digital Currency Tracker," AtlanticCouncil.org, *Atlantic Council, as of 15 Nov. 2021.*

Programmable money has lots of benefits, but one troubling idea is "money that expires." For example, the government may want to get its citizens to spend more to boost the economy and could say, "If you don't spend $1,000 on Black Friday, your money will expire!" So money would be a privilege that governments bestowed. In other words, money would be an asset that citizens rented rather than owned. If money is speech, then this effectively puts an expiry date on our free speech rights.

Implementation challenges of DeFi

In *Blockchain Revolution*, we dedicated an entire chapter to reasons blockchain might fail or stall out. Let's revisit these with a focus on DeFi.[162]

The technology is not ready for prime time

After a decade of incubation, this industry is scaling rapidly. Its market value is over $2 trillion. Every savvy corporation in the world is developing a cryptoasset strategy.

When we first raised this concern in 2016, the Bitcoin network was worth a few billion dollars and Ethereum had yet to launch. Dapps such smart contracts and DAOs had not yet been realized. Internet enthusiasts who used bitcoin were battling over its future—remember the block size wars?[163] Corporations held few digital assets, and governments barely noticed the industry. We saw great potential but questioned whether the technology could cross the chasm to mainstream adoption.

After a decade, this industry is scaling rapidly. The value of the market today is over $2 trillion. Cryptoassets have created more value than every single unicorn launched after the financial crisis of 2007–2008. Today, 10 million people use MetaMask monthly. Nearly 30 percent of Nigerians use bitcoin as an alternative to banks. Gemini and Coinbase custody cryptoassets on behalf of Fortune 500 companies. El Salvador became the first country to make bitcoin legal tender. DeFi user growth is parabolic. NFTs have smashed into the mainstream, capturing the cultural Zeitgeist. DAOs have multibillion dollar treasuries. New protocols like Solana, Cosmos and others are rapidly scaling Layer 1 throughput. Stablecoin values are over $125 billion. Coinbase went public. Every single corporation in the world is (or at least should be) developing a cryptoasset and blockchain strategy.

The energy use is unsustainable

The future of DeFi and distributed applications is proof of stake (PoS) and not proof of work (PoW). Just look at the stunning rise of Terra Luna, Cosmos, Solana, and other PoS networks supporting much of the DeFi innovation today. Even Ethereum is preparing to migrate to a PoS consensus mechanism. Still, bitcoin will persist as a significant asset and network in this ecosystem. Bitcoin miners harness vast computing power to secure the Bitcoin network.[164] Those computers

use a lot of energy—by some estimates as much as the country of Chile.[165] This has led to charges of energy waste.[166] Something "wastes" energy only to those who think it serves no useful function. The Bitcoin network secures $1 trillion in value and serves millions of people, including many without access to traditional payment networks. Miners often co-locate to where power is abundant and free, which often means renewable hydroelectric or geothermal sources. Today, renewable energy powers at least 39 percent of Bitcoin mining, and that share is growing rapidly.[167]

Making bitcoin greener may attract new investors to the asset class. Carbon credit tokens are a form of environmental self-monitoring.

Another solution is to offset the carbon footprint of the Bitcoin network with carbon credits. For example, Ninepoint Partners (where I work) has partnered with environmental fintech CarbonX to offset fully the carbon footprint of the Ninepoint Bitcoin ETF.[168] CarbonX, along with the Crypto Carbon Ratings Institute, will provide carbon emission analysis, carbon offsetting services, and carbon footprint analysis of the Bitcoin network.[169] Ninepoint is paying the costs of doing this. Making bitcoin greener may attract new investors to the asset class. In my view, Ninepoint's efforts are a form of environmental self-monitoring. We hope others will follow.

Governments will stifle or twist it

Governments will not kill blockchain and DeFi, but they may regulate it so that people, capital, and other resources move to other jurisdictions. This is a pivotal moment in this trajectory of digital assets, DeFi, and blockchain. Governments are used to traditional custodial financial intermediaries, but DeFi is noncustodial. Regulators are used to overseeing companies and individuals, whereas DeFi is built on clever code and math. By failing to understand how the technology works, governments could inadvertently derail one of the fastest growing and most promising sectors in the economy today. For example, policymakers want to designate many cryptoasset businesses as registered securities platforms. However, securities platforms need transfer agents and clearing houses. As venture capitalist Adam Cochran explained:

By failing to understand this technology, governments could inadvertently derail one of the fastest growing and most promising sectors in the economy today.

> *Both are centralized, custodial agents who sit between an exchange and customer. Transfer agents' jobs are essentially to record ownership, maintain records, distribute dividends, and cancel/issue various stock certificates. All things that DeFi replaces with the ERC-20 standard and a dashboard that queries the chain. A clearinghouse validates and finalizes the transaction…something that is entirely unnecessary in blockchain land because of T-Instant settlement.*[170]

In other words, DeFi is irreconcilable with this requirement. Labeling every digital asset a security is problematic. Rep. Tom Emmer (R-Minn.), a member of the rapidly growing blockchain caucus in Congress, raised concerns with SEC Chair Gensler's approach: "If Gensler deems a coin with a $1 billion market cap and tens of thousands of investors a security, what happens to those investors? The value of the token will plummet, and retail investors won't be able to trade it."[171] At this point, government cannot stop any of this.

Cryptoassets are systemically important and will be regulated. The devil is in the details.

Powerful incumbents of the old paradigm will usurp it

By integrating cryptoassets, powerful incumbents of the old paradigm are accelerating DeFi growth and user adoption, not stifling it.

Powerful incumbents of the old paradigm have adopted cryptoassets and are looking seriously at DeFi and other applications. They have not "usurped" anything. If they tried, they'd likely fail. Consider stablecoins, a tiny sliver of this whole pie: Stablecoins are integrating more into the financial system. AngelList, a leading platform for VC investment now accepts stablecoins for eligible investments.[172] MasterCard announced plans to integrate stablecoins into its network. It also plans to integrate with CBDCs if and when they come into existence.[173] VISA now supports transaction settlement with the USDC stablecoin, which crossed $30 billion in circulating supply.[174] PayPal, a longtime cryptoasset innovator, has explored its own stablecoin.[175] Payment giants want a firm foothold in the world of programmable fiat. Whether they're able to adapt in time is up for debate. At the time this paper went to print, VISA announced it was taking another leap forward into stablecoins, by announcing it would launch its own Layer 2 "universal payments channel" where customers could use different stablecoins and CBDCs for payments globally.[176]

We've already covered how dozens of traditional financial firms have launched custody solutions for cryptoassets.[177] The integration of cryptoassets and DeFi into traditional industries is accelerating innovation, growth, and user adoption, not stifling it.

The incentives are inadequate for adoption: The bootstrapping problem

"Web 3 introduces a powerful new tool for bootstrapping networks: token incentives."

CHRIS DIXON
General Partner
Andreessen Horowitz

Our concerns here proved unwarranted. The opposite is true: tokens serve as an immensely powerful incentive for mass collaboration and adoption by turning early adopters and users into economic participants in the network.

Chris Dixon tweeted, "In the Web 2 era, overcoming the bootstrapping problem meant heroic entrepreneurial efforts, plus in many cases spending lots of money on sales and marketing."[178] This difficult and costly process led to only a few networks reaching global scale. Once they were firmly entrenched, it became difficult for new networks targeting similar users to compete (think Facebook). Dixon continued: "Web 3 introduces a powerful new tool for bootstrapping networks: token incentives. … The basic idea is: early on during the bootstrapping phase when network effects haven't kicked in, provide users with financial utility via token rewards to make up for the lack of native utility."[179]

Users have no barriers to launching a token and trying their hand at network building. More projects might fail than in previous technology cycles, since the denominator (y=projects launched) will

be so much higher, underscoring tokens' role in incentivizing mass collaboration, coordination, and value creation. (For one visualization of bootstrapping, see Chris Dixon's blog post, "Crypto Tokens: A Breakthrough in Open Network Design," of 27 May 2017.)

Blockchain is a job killer

Yes, Web 3 is changing the nature of the labor market, but it appears to be creating more work than it is destroying. We're seeing new kinds of jobs.

In *Blockchain Revolution*, we questioned whether blockchain would disintermediate many white-collar jobs such as accounting, legal work, and even management. Yes, Web 3 is changing the nature of the labor market, but it appears to be creating more work than it is destroying. We're seeing new kinds of jobs such as digital artists, professional videogame players, liquidity miners, and NFT dealers. Software developers are working for DAOs.[180]

In the Web 2 era, a bright young person might set her sights on a career in Silicon Valley or Wall Street. But the large intermediaries considered graduates only from top schools, placing formal accreditations at the top of the list. They'd require a person to show up to an office, undergo intensive training, and report to a boss in a chain of command to the top.

Web 3 with such innovations as DAOs, have minimal formal hierarchy, management teams, home offices, and so forth. But traditional job postings in finance on sites like Indeed are soaring, up 118 percent from a year ago.[181] Given heightened concern of a regulatory crackdown, more companies are hiring compliance officers.[182] Yes, Facebook and Goldman Sachs still attract top talent, but their monopoly is weakening, evidenced by the flight of quality engineers to DeFi and other blockchain projects.

Governance is like herding cats

DAOs still need to overcome the challenge of voter apathy, where tokenholders—like stockholders—leave decision making to a few large, tuned-in stakeholders.

Blockchain and DAO governance are evolving in real-time. Today, users and tokenholders manage a dozen DAOs with treasuries in excess of $1 billion. However, DAOs have limitations such as voter apathy.[183] Tokenholders often ignore governance approvals that require their assent, leaving decision making to a few large, tuned-in stakeholders.[184] That's similar to most proxy votes for corporations in traditional finance. Moreover, radical decentralization may work for certain industries, but vertical integration may suit situations such as pharmaceutical manufacturing.

These governance challenges are familiar to any shareholder of a public company or citizen of a democracy. When we wrote *Blockchain Revolution*, we questioned the ability of PoS networks to push updates (i.e., the block size debates) and the actual viability of PoS as a system for organizing and securing a blockchain. So, in comparison, today's problems stem from prior governance successes, such as the launch of dozens of working Layer 1 smart-contracting platforms. Thus, DAOs still need to overcome this challenge. SX Network's solution to tokenholder apathy is to use prediction markets to encourage DAO governance participation, effectively gamifying

governance.[185] We'll see if that works or if some people by their nature simply do not care enough to participate.

Criminals will use it

Criminals use cash far more than crypto because crypto usage leaves a digital trail that FBI agents can track.

Let's put this fallacy to bed for good: *criminals use cash far more than crypto*. In fact, they use crypto a lot less. Why? Because blockchains leave a tamper-resistant digital trail that any half-decent Federal Bureau of Investigation agent can use to bust a would-be criminal. Chainalysis estimated that one percent of bitcoin transactions are linked to illicit activity.[186] Chainalysis has built an estimated $3 billion business using blockchains to bust criminals and keep institutions safe.

Conclusion

The first era of the Internet upended information industries like news, advertising, and music. The second era of the Internet, enabled by blockchain and other digital assets will make those disruptions look quaint. Financial services, foundational to all industry, enterprise, and human economic activity, is undergoing a metamorphosis from a lumbering caterpillar, devouring everything in its path, to a soaring butterfly.

Yes, DeFi has its fair share of issues. Many of these applications are built on Ethereum, a network overloaded by the popularity of DeFi. Other platforms like Solana have had growing pains. Many dapps have clunky user interfaces, though that is changing rapidly. Let's not overstate their popularity today: Uniswap has only two million users. Regulators have questioned how decentralized some of these platforms truly are and have their sights set on tighter rules that could cause uncertainty and volatility. These are important implementation challenges to overcome. The winners will be those who overcome them.

The DeFi winners will be those that successfully manage such implementation challenges as scalability, ease of use, centralization, and regulatory uncertainty.

British Historian Eric Hobsbawm said the "short 20th century," which began in 1914 with the outbreak of the First World War, ended in 1989 with the collapse of the Soviet Union.[187] Francis Fukuyama called it "the end of history."[188] While the scales of geopolitics tilted dramatically that year, these forecasts for radical change were overstated. Perhaps the COVID crisis of 2020 marks the end of the long 20th century and the true beginning of the 21st century.

While DeFi is inclusive, a new assertive cohort of (often young) crypto native users is defining a financial counterculture analogous to the counterculture of the 1960s. In the same way some young baby boomers rebelled against the institutions and cultural mores of their parents' generation, today's crypto-native generation is rebelling against a strict and permissioned financial system, the rigid hierarchy of institutions in art and culture, and the closed and stifling systems

of Web 2. In 1960s, counterculture icon Timothy Leary encouraged his followers to "turn on, tune in, and drop out."[189] Today's youth are applying that mantra to technology—turning their brains on to digital assets, tuning into DeFi and its myriad applications, and dropping out of the legacy financial system. In the process, they are transforming every aspect of the industry.

The beginning of this new 21st century belongs to them.

If bitcoin was the spark for the financial services revolution, then DeFi and digital assets are the accelerant.

If bitcoin was the spark for the financial services revolution, then DeFi and digital assets are the accelerant. The fire will engulf firms that fail to innovate, adapt, and embrace this hot new industry. The conflagration will suck oxygen from centralized systems and spread them into a new decentralized web. The financial and economic phoenix that rises will be virtually unrecognizable from the system we have today.

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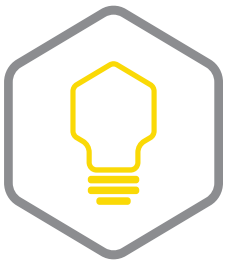

About the author

Alex Tapscott is an entrepreneur, author, and seasoned capital markets professional focused on the impact of the emerging technologies (such as blockchain and cryptocurrencies) on business, government, and society. He is managing director of the Digital Asset Group, a division of Ninepoint Partners LP, an investment firm with $8 billion in assets under management and institutional contract. Ninepoint's Bitcoin ETF (BITC-TSX) is the first carbon-neutral spot Bitcoin ETF in the world. Alex also chairs the advisory council of Prophecy DeFi (PDFI-CSE).

He is co-author (with Don Tapscott) of the critically acclaimed nonfiction bestseller, *Blockchain Revolution* (New York: Penguin Portfolio, 2016 and 2018), which has been translated into more than 15 languages and sold more than 500,000 copies worldwide.[190] He also edited and wrote a preface to *Financial Services Revolution* on how DeFi is transforming the financial industry.[191]

Tapscott is sought after worldwide for his expertise by business and government audiences. He has delivered over 200 lectures and executive briefings at such firms as Goldman Sachs (Talks at GS), Google, Allianz, IBM, Microsoft, and Accenture.[192] His TEDx talk, "Blockchain is Eating Wall Street" has been viewed over 797,500 times. Tapscott has also written for the *New York Times*, *Harvard Business Review*, *Globe and Mail*, *National Post*, and many other publications.

In 2017, Tapscott co-founded the Blockchain Research Institute, a global think tank investigating blockchain strategies, opportunities, and use cases.[192] Previously, Tapscott was director of institutional equity sales at Canaccord Genuity. Tapscott is a graduate of Amherst College (Cum Laude) and a CFA charter holder. He lives in Toronto.

Disclosures

Alex is an active investor in a number of cryptoassets and related businesses, and he may have positions in some of the entities included in this report. Alex's uncle Bill Tapscott is chief executive officer and his father Don Tapscott is chairman of CarbonX.

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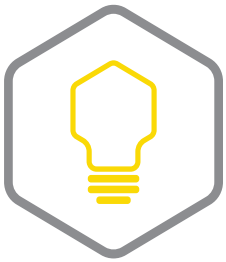

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Notes

1. Alex Tapscott, "Blockchain Is Eating Wall Street," *TEDxSanFrancisco*, TED Conferences LLC, 26 Oct. 2016 (00:18:45). YouTube, www.youtube.com/watch?v=WnEYakUxsHU, with 797,766 views as of 6 Nov. 2021.
2. Satoshi Nakamoto to Hal Finney, "Re: Bitcoin P2P E-cash Paper," *Cryptography Mailing List*, Metzger, Dowdeswell & Co. LLC, 14 Nov 2008 (14:29:22). www.mail-archive.com/cryptography%40metzdowd.com/msg10001.html, accessed 16 Oct. 2021.
3. Satoshi Nakamoto, "Bitcoin: A Peer-to-Peer Electronic Cash System," White Paper, *Bitcoin.org*, 1 Nov. 2008. www.bitcoin.org/bitcoin.pdf.
4. Matthew Martin, "Difference Between Website and Web Application (Web App)," *Guru99.com*, Guru99 Tech Pvt. Ltd., updated 7 Oct. 2021. www.guru99.com/difference-web-application-website.html, accessed 16 Oct. 2021.
5. "The Top 10 Most Significant Data Breaches of 2020," *Aria Cybersecurity Solutions Blog*, 29 April 2021. blog.ariacybersecurity.com/blog/the-top-10-most-significant-data-breaches-of-2020, accessed 15 Oct. 2021.
6. Chris Dixon (@cdixon), Twitter post, 20 Sept. 2021 (2:55 pm). twitter.com/cdixon/status/1440026971979800579, accessed 16 Oct. 2021.
7. Chris Dixon (@cdixon), Twitter post, 20 Sept. 2021 (2:56 pm). twitter.com/cdixon/status/1440026974903230464, and Chris Dixon (@cdixon), Twitter post, 20 Sept. 2021 (2:56 pm). twitter.com/cdixon/status/1440026978048958467, accessed 16 Oct. 2021.
8. DeFi Pulse, as of n.d. defipulse.com, accessed 16 Oct. 2021.
9. "Top 100 DeFi Coins by Market Capitalization," *CoinGecko.com*, Gecko Labs Pte. Ltd., as of 30 Sept 2021. www.coingecko.com/en/defi.
10. Sandeep Nailwal, e-mail exchange with Alex Tapscott, 2 Oct. 2021.
11. Ben Davenport, "What Is Multisig and What Can It Do?" Coin Center, 1 Jan. 2015. www.coincenter.org/education/advanced-topics/multi-sig, accessed 15 Oct. 2021.
12. When the NASDAQ exchange began operations in 1971, the name was an acronym standing for the National Association of Securities Dealers Automated Quotations. Adam Hayes, "Nasdaq," *Investopedia.com*, Dotdash Meredith, InterActiveCorp., last updated 6 Nov. 2021. www.investopedia.com/terms/n/nasdaq.asp, accessed 6 Nov. 2021.
13. In mathematical terms, *dYdX* means "the derivative of y with respect to x." Mathematics Stack Exchange, math.stackexchange.com/questions/340744/what-do-the-symbols-d-dx-and-dy-dx-mean, accessed 15 Oct. 2021.
14. "Big Four Accounting Firms," *CorporateFinanceInstitute.com*, CFI Education Inc., n.d. corporatefinanceinstitute.com/resources/careers/companies/big-four-accounting-firms-services-overview, accessed 6 Nov. 2021.
15. For in-depth research, see our recommended readings in Brian Behlendorf, Stephen Curran, and Nathan George, "Blockchain and the Future of Digital Identity," panel moderated by Don Tapscott, *New Directions for Government* webinar series, Blockchain Research Institute and Hyperledger, 11 May 2021. www.dropbox.com/s/5lwwjh470vg4o46/Tapscott_Blockchain%20and%20the%20Future%20of%20Digital%20Identity_Blockchain%20Research%20Institute_Hyperledger.pdf?dl=0.
16. For more information on how public key infrastructure (PKI) establishes identity, please see "Introduction to PKI," www.ncsc.gov.uk/collection/in-house-public-key-infrastructure/introduction-to-public-key-infrastructure, accessed 15 Oct. 2021.
17. Messari (@MessariCrypto), Twitter post, 21 Sept. 2021 (10:32 am). twitter.com/MessariCrypto/status/1440322964390486024, accessed 4 Oct. 2021.
18. We introduced this concept in the paperback edition of *Blockchain Revolution*.
19. "DAOs Are the New Companies. What's on Their Balance Sheets?" *Open-Orgs.info*, created by David Mihal, n.d. open-orgs.info, accessed 4 Nov. 2021.
20. Benjamin Sutton, "What You Need to Know from the Art Market 2020 Report," *Artsy.net*, Art.sy Inc., 5 March 2020. www.artsy.net/article/artsy-editorial-art-market-2020-report, accessed 4 Nov. 2021.
21. BNB and FTT values, *CoinMarketCap.com*, CoinMarketCap OpCo LLC, as of 7 Nov. 2021. coinmarketcap.com.
22. See Mirror Finance's documentation here: docs.mirror.finance.
23. Stablecoin asset values, *CoinMarketCap.com*, CoinMarketCap OpCo LLC, as of 4 Oct. 2021. coinmarketcap.com.

24. "Central Bank Digital Currency Tracker," GeoEconomics Center, Atlantic Council, as of 30 Sept 2021. www.atlanticcouncil.org/cbdctracker, accessed 4 Nov. 2021.

25. "Uniswap vs. Coinbase and Binance Trade Volume," *TheBlockCrypto.com*, Block Crypto Inc., as of 30 Sept 2021. www.theblockcrypto.com/data/decentralized-finance/dex-non-custodial/uniswap-vs-coinbase-and-binance-trade-volume-7dma.

26. Chayanika Deka, "Yearn Finance TVL across All Products Hits New Record of $5 Billion," *Tron Weekly*, 17 June 2021. www.tronweekly.com/yearn-finance-tvl-5-billion, accessed 4 Nov. 2021.

27. Clare O'Hara and Sean Silcoff, "Wealthsimple Announces $750-Million Financing Investor Group, Including Drake, Ryan Reynolds," *The Globe and Mail*, Globe and Mail Inc., 3 May 2021. www.theglobeandmail.com/business/article-wealthsimple-announces-landmark-750-million-financing-from-investor, accessed 30 Sept. 2021.

28. Ryan Watkins and Roberto Talamas, "Q2'21 DeFi Review," *Messario.io*, Messari Inc., 13 July 2021. messari.io/article/q2-21-defi-review, accessed 4 Oct. 2021.

29. Ryan Watkins and Roberto Talamas, "Q2'21 DeFi Review," *Messario.io*, Messari Inc., 13 July 2021. messari.io/article/q2-21-defi-review.

30. Marshall Hargrave, "Bulge Bracket," *Investopedia.com*, Dotdash Meredith, InterActiveCorp., 8 Nov. 2020. www.investopedia.com/terms/b/bulgebracket.asp, accessed 4 Oct. 2021.

31. Ethan Buchman, e-mail exchange with Alex Tapscott, 10 July 2019.

32. Peng Zhong, e-mail exchange with Alex Tapscott, 30 Sept. 2021.

33. Cuy Sheffield, "Crypto Is Going Mainstream: What You Need to Know," *Visa Navigate*, Visa USA Inc., April 2021. navigate.visa.com/na/money-movement/crypto-currency-the-real-opportunity, accessed 4 Oct. 2021.

34. Tim Fries, "Interview: Terra CEO Discusses Luna, Mirror, Chair Terraswap, More," *The Tokenist*, The Tokenist Media LLC, 20 March 2021. tokenist.com/interview-terra-ceo-discusses-luna-mirror-chai-terraswap-more, accessed 4 Oct. 2021.

35. Chainalysis Team, "The 2021 Global Crypto Adoption Index: Worldwide Adoption Jumps Over 880% with P2P Platforms Driving Cryptocurrency Usage in Emerging Markets," *Chainalysis Blog*, Chainalysis Insights, 18 Aug. 2021. blog.chainalysis.com/reports/2021-global-crypto-adoption-index, accessed 4 Oct. 2021.

36. Chainalysis Team, "The 2021 Global Crypto Adoption Index: Worldwide Adoption Jumps Over 880% With P2P Platforms Driving Cryptocurrency Usage in Emerging Markets," *Chainalysis Blog*, Chainalysis Insights, 18 Aug. 2021. blog.chainalysis.com/reports/2021-global-crypto-adoption-index, accessed 4 Oct. 2021.

37. Nelson Renteria, Tom Wilson, and Karin Strohecker, "In a World First, El Salvador Makes Bitcoin Legal Tender," *Reuters.com*, Thomsen Reuters, 9 June 2021. www.reuters.com/world/americas/el-salvador-approves-first-law-bitcoin-legal-tender-2021-06-09, accessed 15 Oct. 2021.

38. Luke Conway, "All the Countries Where Bitcoin Adoption Is Being Considered," *The Street Crypto*, Arena Group, 8 June 2021. www.thestreet.com/crypto/bitcoin/politicians-from-these-countries-have-called-for-bitcoin-adoption, accessed 15 Oct. 2021.

39. "GDP (current US$)," *World Bank Data*, World Bank Group, as of 15 Oct. 2021. data.worldbank.org/indicator/NY.GDP.MKTP.CD, accessed 15 Oct. 2021.

40. "The World's Unbanked Population," *Acuant Blog*, Acuant Inc., 25 Nov. 2020. www.acuant.com/blog/the-worlds-unbanked-population, accessed 15 Oct. 2021.

41. "Bitcoin Avg. Transaction Fee Historical Chart," *BitInfoCharts.com*, as of 30 Sept. 2021. bitinfocharts.com/comparison/bitcoin-transactionfees.html#3m, accessed 4 Nov. 2021.

42. Joseph Poon and Thaddeus Dryja, "The Bitcoin Lightning Network: Scalable Off-Chain Instant Payments," White Paper V0.5.9.2, *Lightning Network*, 14 Jan. 2016. lightning.network/lightning-network-paper.pdf, accessed 16 Oct. 2021.

43. Yogita Khatri, "Bitcoin's Lightning Network Capacity Reaches an All-Time High," *TheBlockCrypto.com*, Block Crypto Inc., 29 Sept. 2021, updated 16 Oct. 2021. www.theblockcrypto.com/linked/119025/bitcoin-lightning-network-capacity-reaches-all-time-high.

44. Remi Lederman, "Strike Launches Its API Platform for Businesses and Partners with Twitter to Power Instant Global Payments Using Bitcoin," *BusinessWire.com*, Business Wire Inc., 23 Sept. 2021. www.businesswire.com/news/home/20210923005851/en/Strike-Launches-Its-API-Platform-for-Businesses-and-Partners-With-Twitter-to-Power-Instant-Global-Payments-Using-Bitcoin, accessed 15 Oct. 2021.

45. Yogita Khatri, "Bitcoin's Lightning Network Capacity Reaches an All-Time High," *TheBlockCrypto.com*, Block Crypto Inc., 29 Sept. 2021, updated 16 Oct. 2021. www.theblockcrypto.com/linked/119025/bitcoin-lightning-network-capacity-reaches-all-time-high.

46. Do Kwon, e-mail exchange with Alex Tapscott, 27 Sept. 2021.

47. Martin Baumann and Charlie Morris, "The Emerging Terra Ecosystem," *CMCC.vc Insights*, CMCC Global Asset Management Ltd., June 2021. www.cmcc.vc/insights/the-emerging-terra-ecosystem, accessed 4 Oct. 2021.

48. "Crypto Asset Custody for Institutions," *Coinbase.com*, Coinbase Inc., n.d. custody.coinbase.com; and "Gemini Custody," *Gemini.com*, Gemini Trust Co. LLC, n.d. www.gemini.com/custody, accessed 4 Oct. 2021.

49. "MetaMask Surpasses 10 Million [Monthly Active Users], Making It The World's Leading Noncustodial Crypto Wallet," *ConsenSys.net Blog*, ConsenSys Software Inc., 31 Aug. 2021. consensys.net/blog/press-release/metamask-surpasses-10-million-maus-making-it-the-worlds-leading-non-custodial-crypto-wallet, accessed 4 Oct 2021.

50. "Comparison Chart: Bitski vs. MetaMask vs. TokenPocket vs. Trust Wallet," *SourceForge.net*, Slashdot Media LLC, n.d. sourceforge.net/software/compare/Bitski-vs-MetaMask-vs-TokenPocket-vs-Trust-Wallet; and "Comparison Chart: Ledger vs. Rainbow Wallet vs. TokenPocket vs. Trezor," *SourceForge.net*, Slashdot Media LLC, n.d. sourceforge.net/software/compare/Ledger-vs-Rainbow-Wallet-vs-TokenPocket-vs-Trezor, accessed 15 Oct. 2021.

51. Phantom (@Phantom), Twitter Post, 29 Sept. 2021 (12:49 pm). twitter.com/phantom/status/1443256406673485830, accessed 15 Oct. 2021.

52. Eric Winer, "Cold Storage, Keys & Crypto: How Gemini Keeps Assets Safe," *Product Blog*, Gemini Trust Co. LLC, 12 Feb. 2019. www.gemini.com/blog/cold-storage-keys-crypto-how-gemini-keeps-assets-safe, accessed 15 Oct. 2021.

53. "Gemini Surpasses $30 Billion in Crypto under Custody," *Product Blog*, Gemini Trust Co. LLC, 11 May 2021. www.gemini.com/blog/gemini-crypto-under-custody, accessed 15 Oct. 2021.

54. Coinbase Global Inc. Form S-1 Registration Statement Under the Securities Act of 1933, as filed with the SEC on 25 Feb. 2021. www.sec.gov/Archives/edgar/data/1679788/000162828021003168/coinbaseglobalincs-1.htm, accessed 15 Oct. 2021.

55. Bilal Jafar, "Coinbase Custody Accounted for 11% of All Cryptocurrency Assets in 2020," *FinanceMagnates.com*, Finance Magnates Ltd., 3 Feb. 2021. www.financemagnates.com/cryptocurrency/news/coinbase-custody-accounted-for-11-of-all-cryptocurrency-assets-in-2020, accessed 15 Oct. 2021.

56. Hugh Son, "US Bank Launches Bitcoin Custody Service as Institutions Race to Cater to Crypto Demand," *CNBC.com*, NBC Universal Media LLC, 5 Oct. 2021. www.cnbc.com/2021/10/05/bitcoin-custody-us-bank-launches-service-as-institutions-race-to-cater-to-crypto-demand.html, accessed 15 Oct. 2021.

57. "Federally Chartered Banks and Thrifts May Provide Custody Services for Crypto Assets," News Release 2020-98, Office of the Comptroller of the Currency, US Dept. of Treasury, 22 July 2020. www.occ.gov/news-issuances/news-releases/2020/nr-occ-2020-98.html, accessed 15 Oct. 2021.

58. "Your Swiss Cryptocurrency Investment Partner," *BitcoinSuisse.com*, Bitcoin Suisse AG, as of 11 Nov. 2021. www.bitcoinsuisse.com.

59. Vildana Hajric, "Novogratz's Galaxy Buys BitGo in $1.2 Billion Crypto Deal," *Bloomberg News*, Bloomberg LP, updated 5 May 2021. www.bloomberg.com/news/articles/2021-05-05/novogratz-s-galaxy-buys-crypto-custodian-bitgo-for-1-2-billion, accessed 4 Oct. 2021.

60. "BNY Mellon Forms New Digital Assets Unit to Build Industry's First Multi-Asset Digital Platform," Newsroom, Bank of New York Mellon Corp., 11 Feb. 2021. www.bnymellon.com/us/en/about-us/newsroom/press-release/bny-mellon-forms-new-digital-assets-unit-to-build-industrypercent27s-first-multi-asset-digital-platform-130169.html, accessed 4 Oct. 2021.

61. "About Coinbase," *Coinbase.com*, Coinbase Inc., as of 11 Nov. 2021. www.coinbase.com/about.

62. "BNY Mellon Picks Digital Asset Custody Firm Fireblocks Which Raises $133 Million," *Ledger Insights*, Ledger Insights Ltd., 18 March 2021. www.ledgerinsights.com/bny-mellon-picks-digital-asset-custody-firm-fireblocks-which-raises-133-million, accessed 4 Oct. 2021.

63. Gemini Trust Co. LLC, "Gemini Acquires Leading Crypto Custody Technology," Press Release, *PRNewswire.com*, Cision US Inc., 9 June 2021. www.prnewswire.com/news-releases/gemini-acquires-leading-crypto-custody-technology-301308519.html, accessed 11 Nov. 2021

64. "Choice," *ChoiceApp.io*, Kingdom Trust Co., as of 11 Nov. 2021. www.choiceapp.io/kingdomtrust.

65. "New Cryptocurrency Custody Services for Institutional Investment Managers," Press Release, *USBank.com*, US Bancorp, 5 Oct. 2021. www.usbank.com/about-us-bank/company-blog/article-library/cryptocurrency-custody-services.html, accessed 6 Oct. 2021.

66. "US Bank Acquires Debt Servicing and Securities Custody Services Client Portfolio of MUFG Bank," *US Bancorp Investor Relations*, US Bancorp, 6 Jan. 2021. ir.usbank.com/news-releases/news-release-details/us-bank-acquires-debt-servicing-and-securities-custody-services, accessed 15 Oct. 2021.

67. Andrew Young, e-mail exchange with Alex Tapscott, 1 Oct. 2021.

68. "DAOs Are the New Companies. What's on Their Balance Sheets?" *Open-Orgs.info*, n.d. open-orgs.info; and Ty Haqqi, "15 Companies with the Most Cash Reserves in America," *Yahoo Finance*, Apollo Global Management Inc., 22 May 2021. finance.yahoo.com/news/15-companies-most-cash-reserves-182708211.html, accessed 15 Oct. 2021.

69. Coinbase SEC Filings, investor.coinbase.com/financials/sec-filings/default.aspx, accessed 15 Oct. 2021.

70. Cointelegraph Consulting, "Aave's Avenue to Over $11 Billion in TVL," *Cointelegraph.com*, 12 May 2021. cointelegraph.com/news/cointelegraph-consulting-aave-s-avenue-to-over-11-billion-in-tvl, accessed 15 Oct. 2021.

71. Adriana Hamacher, "What Are Flash Loans? The DeFi Lending Phenomenon Explained," *Decrypt Learn*, Decrypt Media Inc., 28 June 2021. decrypt.co/resources/what-are-flash-loans-the-defi-lending-phenomenon-explained, accessed 15 Oct. 2021.

72. Peng Zhong, e-mail exchange with Alex Tapscott, 30 Sept. 2021

73. Galia Benartzi, e-mail exchange with Alex Tapscott, 1 Oct. 2021.

74. "Bancor Network Token," *CoinGecko.com*, as of 30 Sept 2021. www.coingecko.com/en/coins/bancor-network.

75. Naval (@Naval), Twitter Post, 3 Oct. 2021 (3:09 pm). twitter.com/naval/status/1444741381579177984, accessed 15 Oct. 2021.

76. Galia Benartzi, e-mail exchange with Alex Tapscott, 1 Oct. 2021.

77. "Coins: Osmosis," *CoinGecko.com*, Gecko Labs Pte. Ltd., as of 30 Sept 2021. www.coingecko.com/en/coins/osmosis.

78. Ryan Watkins (@RyanWatkins_), Twitter Post, 20 July 2021 (7:44 pm). twitter.com/RyanWatkins_/status/1417631595742236675, accessed 15 Oct. 2021.

79. Adam Hayes, "Event Risk," *Investopedia.com,* Dotdash Meredith, InterActiveCorp., 15 July 2020. www.investopedia.com/terms/e/eventrisk.asp, accessed 17 Oct. 2021.

80. J.B. Maverick, "How Big Is the Derivatives Market?" *Investopedia.com*, Dotdash Meredith, InterActiveCorp., 28 April 2020. www.investopedia.com/ask/answers/052715/how-big-derivatives-market.asp, accessed 17 Oct. 2021.

81. "Top Derivatives Tokens by Market Capitalization," *CoinMarketCap.com*, CoinMarketCap OpCo LLC, as of 17 Oct. 2021. coinmarketcap.com/view/derivatives.

82. "dYdX," *CoinMarketCap.com*, CoinMarketCap OpCo LLC, as of 17 Oct. 2021. coinmarketcap.com/currencies/dydx.

83. See "SportX," *CoinMarketCap.com*, CoinMarketCap OpCo LLC, coinmarketcap.com/currencies/sportx for data.

84. Andrew Young, e-mail exchange with Alex Tapscott, 1 Oct. 2021.

85. "CNBC Excerpts: Billionaire Investor Warren Buffett on CNBC's *Squawk Box* Today," *CNBC.com*, NBC Universal Media LLC, 2 March 2015. www.cnbc.com/2015/03/02/cnbc-excerpts-billionaire-investor-warren-buffett-on-cnbcs-squawk-box-today.html, accessed 17 Oct. 2021.

86. Tim Harford, "Is This the Most Influential Work in the History of Capitalism?" *50 Things That Made the Modern Economy*, BBC World Service, 23 Oct. 2017. www.bbc.com/news/business-41582244, accessed 15 Oct. 2021.

87. Tim Harford, "Is This the Most Influential Work in the History of Capitalism?" See also *The Origins of Accounting Culture: The Venetian Connection*, eds. Chiara Mio, Massimo Sargiacomo, Roberto Di Pietra, Stefano Coronella, and Ugo Sostero (New York: Taylor & Francis, 2018). www.google.com/books/edition/The_Origins_of_Accounting_Culture, accessed 15 Oct. 2021.

88. Tim Harford, "Is This the Most Influential Work in the History of Capitalism?" See also Luca Pacioli, *Su[m]ma de Arithmetica Geometria Proportioni [et] Proportionalita* (Venice: Paganinus de Paganinis, 1494). Internet Archive, archive.org/details/summadearithmeti00paci/page/n171/mode/2up, accessed 15 Oct. 2021.

89. *The Origins of Accounting Culture: The Venetian Connection*, eds. Chiara Mio, Massimo Sargiacomo, Roberto Di Pietra, Stefano Coronella, and Ugo Sostero (New York: Taylor & Francis, 2018). www.google.com/books/edition/The_Origins_of_Accounting_Culture, accessed 15 Oct. 2021.

90. Don Tapscott and Alex Tapscott, *Blockchain Revolution* (New York: Penguin Portfolio, 2016): 77–79. www.google.com/books/edition/Blockchain_Revolution/NqBiCgAAQBAJ.

91. "Yearn Quarterly Finance Report: Q2-2021," *GitHub.com*, GitHub Inc., 10 Sept. 2021. github.com/yearn/yearn-pm/blob/master/financials/reports/2021Q2-yearn-quarterly-report.pdf, accessed 15 Oct. 2021.

92. Chris Dixon (@cdixon), Twitter Post, 26 Sept. 2021 (2:57 pm). twitter.com/cdixon/status/1442201639994068997, accessed 15 Oct. 2021.

93. Ian Allison, "Shyft Debuts 'Decentralized Version of SWIFT' for FATF 'Travel Rule,'" *CoinDesk*, Digital Currency Group, 14 July 2020, updated 14 Sept. 2021. www.coindesk.com/business/2020/07/14/shyft-debuts-decentralized-version-of-swift-for-fatf-travel-rule, accessed 15 Oct. 2021.

94. "FedEx Marks 40th Anniversary with Community Service, Eye to the Future," Press Release, FedEx Corp., 17 April 2013. newsroom.fedex.com/newsroom/fedex-marks-40th-anniversary-with-community-service-eye-to-the-future, accessed 15 Oct. 2021.

95. "Virtual Assets," Financial Action Task Force–General Authority for Investment and Free Zones, *FATF-GAFI.org*, n.d. www.fatf-gafi.org/publications/virtualassets/documents/virtual-assets-fatf-standards.html, accessed 16 Oct. 2021.

96. Note that some projects on this site such as uPort may have changed or are no longer active. defiprime.com/decentralized_kyc_identity, accessed 15 Oct. 2021. See also Lukas Stockburger, Georgios Kokosioulis, Alivelu Mukkamala, Raghava Rao Mukkamala, and Michel Avital, "Blockchain-Enabled Decentralized Identity Management: The Case of Self-Sovereign Identity in Public Transportation," *Blockchain: Research and Applications*, Elsevier, 26 May 2021. Science Direct, www.sciencedirect.com/science/article/pii/S2096720921000099.

97. Jesse Leingruber, Alain Meier, and John Backus, "Bloom Protocol," Early Community Draft Version 3, *Bloom.co*, 27 Jan 2018. bloom.co/whitepaper.pdf, accessed 16 Oct. 2021.

98. Blockpass UK Ltd., n.d. www.blockpass.org, accessed 15 Oct. 2021.

99. Marco Iansiti and Karim R. Lakhani, "The Truth About Blockchain," *Harvard Business Review* 95, no. 1 (Jan.–Feb. 2017): 118–127. hbr.org/2017/01/the-truth-about-blockchain, accessed 30 Sept. 2021.

100. Dan Jewell, Angus Eames, and James Carter, "The Law Commission's Review of the Law on Digital Assets and Smart Contracts," *DLAPiper.com*, DLA Piper LLP, 9 Nov. 2020. www.dlapiper.com/en/us/insights/publications/2020/11/the-law-commissions-review-of-the-law-on-digital-assets-and-smart-contracts, accessed 30 Oct. 2021.

101. John Baldwin, "In Digital We Trust: Bitcoin Discourse, Digital Currencies, and Decentralized Network Fetishism," *Nature.com*, Springer Nature Ltd., 13 Feb. 2018. www.nature.com/articles/s41599-018-0065-0, accessed 15 Oct. 2021.

102. "Visa," *Fortune Rankings*, Fortune.com, Fortune Media Group Holdings Ltd., 2 June 2021. fortune.com/company/visa, accessed 15 Oct. 2021.

103. Shawn Tully, "Elon Musk may be betting on Bitcoin—but here's what 50 other CFOs really think about it," *Fortune Rankings*, Fortune.com, Fortune Media Group Holdings Ltd., 17 Feb 2021. fortune.com/2021/02/17/bitcoin-elon-musk-tesla-tsla-btc-investment-cfos-experts, accessed 5 Nov 2021.

104. Portions of this section first appeared in Alex Tapscott, "Bitcoin Offers Freedom from Political Repression—and That's a Key to Its Future," *Fortune.com*, Fortune Media Group Holdings Ltd., 18 Feb. 2021. fortune.com/2021/02/18/bitcoin-censorship-political-repression-deplatforming-china-belarus-russia-nigeria-crypto, accessed 4 Oct. 2021.

105. Sandila Handagama, "Nigeria Protest Show Bitcoin Adoption Is Not Coming: It's Here," *CoinDesk*, Digital Currency Group, 21 Oct. 2020. www.coindesk.com/nigeria-bitcoin-adoption, accessed 15 Oct. 2021.

106. "Nigeria NG: Average Transaction Cost of Sending Remittances to a Specific Country," *CEIC Data*, ISI Emerging Markets Group Co., 1 Dec. 2011–1 Dec. 2017. www.ceicdata.com/en/nigeria/payment-system/ng-average-transaction-cost-of-sending-remittances-to-a-specific-country, accessed 15 Oct. 2021.

107. "Nigeria: Punitive Financial Moves Against Protesters," *HRW.org*, Human Rights Watch, 13 Nov. 2020. www.hrw.org/news/2020/11/13/nigeria-punitive-financial-moves-against-protesters#, accessed `6 Oct. 2021.

108. "Gas and Fees," *Ethereum.org*, last updated by @minimalsm, 29 Sept. 2021. ethereum.org/en/developers/docs/gas, accessed 15 Oct. 2021.

109. Ethereum (ETH), *CoinMarketCap.com*, CoinMarketCap OpCo LLC, as of 17 Oct. 2021. coinmarketcap.com/currencies/ethereum, accessed 15 Oct. 2021.

110. "Total Value Locked All Chains," *DeFi Llama*, DeFiLlama.com, as of 30 Sept. 2021. defillama.com/chains, accessed 15 Oct. 2021.

111. Joel Monegro, "Fat Protocols," *Blog*, Union Square Ventures, 8 Aug. 2016. Wayback Machine, web.archive.org/web/20191026011419/https://www.usv.com/writing/2016/08/fat-protocols, accessed 15 Oct. 2021.

112. Peng Zhong, e-mail exchange with Alex Tapscott, 30 Sept. 2021.

113. Do Kwon, e-mail exchange with Alex Tapscott, 27 Sept. 2021.

114. Charlie Wells and Olga Kharif, "What the Solana Blackout Reveals About the Fragility of Crypto," *Bloomberg News*, Bloomberg LP, 18 Sept. 2021. www.bloomberg.com/news/articles/2021-09-18/solana-trading-how-outage-reveals-vulnerability-of-crypto-blockchains, accessed 4 Oct. 2021.

115. Joanna Ossinger, "Solana Promises 'Detailed Post-Mortem' After 17-Hour Outage," *Bloomberg News*, Bloomberg LP, 15 Sept. 2021, updated 16 Sept. 2021. www.bloomberg.com/news/articles/2021-09-16/solana-network-of-top-10-sol-token-applies-fixes-after-outage, accessed 4 Oct. 2021.

116. Sandeep Nailwal, e-mail exchange with Alex Tapscott, 2 Oct. 2021.

117. Sandeep Nailwal, e-mail exchange with Alex Tapscott, 2 Oct. 2021.

118. Peng Zhong, e-mail exchange with Alex Tapscott, 30 Sept. 2021.

119. "About Project," *Cosmos.Network Jobs*, Interchain Foundation, n.d. jobs.cosmos.network/project/tendermint, accessed 7 Nov. 2021.

120. Marshall McLuhan, *Understanding Media: The Extensions of Man*, intro. by Lewis H. Lapham (Cambridge: MIT Press, Oct. 1994), reissued ed. mitpress.mit.edu/books/understanding-media.

121. Some of this material first appeared in Alex Tapscott, "With NFTs, the Digital Medium Is the Message," *Fortune.com*, Fortune Media Group Holdings Ltd., 4 Oct. 2021. fortune.com/2021/10/04/nfts-art-collectibles-medium-is-the-message, accessed 15 Oct. 2021.

122. Caroline Goldstein, "Damien Hirst's New NFT Project Forces Buyers to Choose Between Owning a Digital Token or a Work on Paper," *ArtNet News*, Artnet Worldwide Corp., 13 July 2021. news.artnet.com/art-world/damien-hirst-the-currency-1988535, accessed 4 Oct. 2021.

123. Caroline Goldstein, "Damien Hirst's NFT Initiative, Which Asks Buyers to Choose Between a Digital Token and IRL Art, Has Already Generated $25 Million," *ArtNet News*, Artnet Worldwide Corp., 25 Aug. 2021. news.artnet.com/market/damien-hirst-nft-update-2002582, accessed 4 Oct. 2021.

124. Frank Chaparro, "Axie Infinity Is Launching a Decentralized Chain," *TheBlockCrypto.com*, Block Crypto Inc., 1 Oct. 2021. www.theblockcrypto.com/linked/119283/axie-infinity-is-launching-a-decentralized-exchange, accessed 4 Oct. 2021.

125. Frank Chaparro, "A Conversation with Jeff Zirlin," *The Scoop*, Ep. 61, Season 3, Block Crypto Inc. and Bakkt, 22 Sept. 2021. www.theblockcrypto.com/linked/119283/axie-infinity-is-launching-a-decentralized-exchange, accessed 4 Oct. 2021.

126. Vittoria Elliott, "Workers in the Global South Are Making a Living Playing the Blockchain Game Axie Infinity," Report, *Rest of World*, Rest of World Media Inc., 19 Aug. 2021. restofworld.org/2021/axie-infinity, accessed 15 Oct. 2021.

127. Vittoria Elliott, "Some Axie Infinity Players Amassed Fortunes—Now the Philippine Government Wants Its Cut," News, *Rest of World*, Rest of World Media Inc., 30 Sept. 2021, restofworld.org/2021/axie-players-are-facing-taxes, accessed 15 Oct. 2021.

128. "Axie Infinity," *CoinGecko Coins*, Gecko Labs Pte. Ltd., as of 1 Oct. 2021. www.coingecko.com/en/coins/axie-infinity.

129. Ryan Watkins (@ryanwatkins_), Twitter Post, 1 Oct. 2021 (5:25 pm). twitter.com/RyanWatkins_/status/1444050982946672647, accessed 4 Oct. 2021.

130. Chris Dixon (@cdixon), Twitter Post, 26 Sept. 2021 (2:57 pm). twitter.com/cdixon/status/1442201638895177729, accessed 4 Oct. 2021.

131. Stablecoins, *TheBlockCrypto.com*, Block Crypto Inc., as of 22 Sept. 2021. www.theblockcrypto.com/data/decentralized-finance/stablecoins.

132. CENTRE Consortium, "USDC Crosses 30 Billion in Circulation," *Centre Blog,* 23 Sept. 2021. www.centre.io/blog/usdc-crosses-30-billion-in-circulation, accessed 4 Oct. 2021. Find Grant Thornton's audit reports here: www.centre.io/usdc-transparency.

133. Imani Moise and Siddharth Venkataramakrishnan, "Facebook Promotes Paxos in Stablecoin Race," *Financial Times,* Financial Times Ltd., 25 Oct. 2021. www.ft.com/content/22670cf1-d957-48b4-89fd-3307cd6aa752; and Nikhilesh De, "Facebook's Novi Taps Paxos, Coinbase Ahead of Diem Rollout," *CoinDesk*, Digital Currency Group, 19 Oct. 2021. www.coindesk.com/business/2021/10/19/facebooks-novi-taps-paxos-coinbase-ahead-of-diem-rollout, accessed 25 Oct. 2021.

134. Walter Hessert, "USDP Chosen for Novi Pilot," *Paxos Blog*, Paxos Trust Co. LLC, 19 Oct. 2021. paxos.com/2021/10/19/usdp-chosen-for-novi-pilot, accessed 20 Oct. 2021.

135. Elizabeth Dwoskin, "Facebook Is Changing Its Name to Meta as It Focuses on the Virtual World," *Washington Post*, WP Co. LLC, 28 Oct. 2021. www.washingtonpost.com/technology/2021/10/28/facebook-meta-name-change, accessed 4 Nov. 2021.

136. "DAI," *CoinGecko Coins*, Gecko Labs Pte. Ltd., as of 30 Sept 2021. www.coingecko.com/en/coins/dai; and David Curry, "Venmo Revenue and Usage Statistics (2021)," *Business of Apps*, Soko Media Ltd., 6 May 2021. www.businessofapps.com/data/venmo-statistics, accessed 4 Oct. 2021.

137. Do Kwon, e-mail exchange with Alex Tapscott, 27 Sept. 2021.

138. Do Kwon, e-mail exchange with Alex Tapscott, 27 Sept. 2021.

139. "President's Working Group on Financial Markets Releases Report and Recommendations on Stablecoins," Press Release, US Dept. of Treasury, 1 Nov. 2021. home.treasury.gov/news/press-releases/jy0454, accessed 4 Nov. 2021.

140. "President's Working Group on Financial Markets (PWG), the Federal Deposit Insurance Corp., and the Office of the Comptroller of the Currency," Fact Sheet, US Dept. of Treasury, 1 Nov. 2021. home.treasury.gov/news/press-releases/jy0456, accessed 4 Nov. 2021.

141. Chair Gary Gensler, "President's Working Group Report on Stablecoins," Statement, *SEC.org*, US Securities and Exchange Commission, 1 Nov. 2021. www.sec.gov/news/statement/gensler-statement-presidents-working-group-report-stablecoins-110121, accessed 4 Nov. 2021.

142. Pippa Stephens and Jordan Smith, "SEC Chair Gary Gensler Wants to Crack Down on the 'Wild West' of Crypto," *NBC After Hours*, CNBC.com, NBC Universal Media LLC, 14 Sept. 2021. www.cnbc.com/2021/09/14/sec-chair-gary-gensler-wants-to-crack-down-on-the-wild-west-of-crypto.html, accessed 15 Oct. 2021.

143. Lael Brainard, "Private Money and Central Bank Money as Payments Go Digital: An Update on CBDCs," Speech (via webcast), Consensus by *CoinDesk* 2021 Conference, Washington, DC, 24 May 2021. Federal Reserve, www.federalreserve.gov/newsevents/speech/brainard20210524a.htm, accessed 4 Oct. 2021.

144. Randal K. Quarles, "Parachute Pants and Central Bank Money," Speech, 113th Annual Utah Bankers Association Convention, Sun Valley, ID, 28 June 2021. Federal Reserve, www.federalreserve.gov/newsevents/speech/quarles20210628a.htm, accessed 4 Oct. 2021.

145. Randal K. Quarles, "Parachute Pants and Central Bank Money," Speech, 113th Annual Utah Bankers Association Convention, Sun Valley, ID, 28 June 2021.

146. Statista Research Dept., "Development of Assets of Global Exchange Traded Funds (EFTs) from 2003 to 2020," *Statista.com*, Ströer SE & Co. KGaA, 18 Feb. 2021. www.statista.com/statistics/224579/worldwide-etf-assets-under-management-since-1997, accessed 4 Oct. 2021.

147. Do Kwon, e-mail exchange with Alex Tapscott, 27 Sept. 2021

148. Francois-Xavier Lord, "MakerDAO Valuation," *Messario.io*, Messari Inc., 5 Aug. 2021. messari.io/article/makerdao-valuation, accessed 15 Oct. 2021.

149. Marc Andreessen, "Why Software Is Eating the World," *Wall Street Journal*, Dow Jones & Co. Inc., 20 Aug. 2011. www.wsj.com/articles/SB10001424053111903480904576512250915629460, accessed 15 Oct. 2021.

150. Binance Coin (BNB), *CoinMarketCap.com*, CoinMarketCap OpCo LLC, as of 4 Oct. 2021. coinmarketcap.com/currencies/binance-coin.

151. "Nasdaq Inc.," *Google Finance*, Google LLC, as of 4 Oct. 2021. www.google.com/finance/quote/NDAQ:NASDAQ.

152. Binance CEO CZ, "15th BNB Burn: Quarterly Highlights and Insights from CZ," *Binance Blog*, Binance Holdings Ltd., 15 April 2021. www.binance.com/en/blog/421499824684901944/15th-bnb-burn-%7C-quarterly-highlights-and-insights-from-cz, accessed 4 Oct. 2021.

153. OKB, *CoinMarketCap.com*, CoinMarketCap OpCo LLC, as of 4 Oct. 2021. coinmarketcap.com/currencies/okb.

154. Huobi Token, *CoinMarketCap.com*, CoinMarketCap OpCo LLC, as of 4 Oct. 2021. coinmarketcap.com/currencies/huobi-token.

155. KuCoin Token, *CoinMarketCap.com*, CoinMarketCap OpCo LLC, as of 4 Oct. 2021. coinmarketcap.com/currencies/kucoin-token.

156. Mike Butcher, "Single.Earth to Link Carbon Credits to Crypto Token Market, Raises $7.9M from EQT Ventures," *TechCrunch.com*, Apollo Global Management Inc., 6 July 2021. techcrunch.com/2021/07/06/single-earth-to-link-carbon-credits-to-crypto-token-market-raises-7-9m-from-eqt-ventures, accessed 16 Oct. 2021.

157. Elizabeth Schulze, "Cryptocurrencies Are 'Clearly Shaking the System,' IMF's Lagarde Says," *CNBC.com*, NBC Universal Media LLC, 10 April 2019. www.cnbc.com/2019/04/11/cryptocurrencies-fintech-clearly-shaking-the-system-imfs-lagarde.html, accessed 11 Sept. 2019.

158. Adam Hayes, "Decentralized Banking: Monetary Technocracy in the Digital Age," *MCIS 2016 Proceedings*, Association for Information Systems, 26 Oct. 2016. AIS e-library, aisel.aisnet.org/mcis2016/3, accessed 15 Oct. 2021.

159. "China Aims to Launch the World's First Official Digital Currency," *Economist.com*, Economist Newspaper Ltd., 25 April 2020. www.economist.com/finance-and-economics/2020/04/23/china-aims-to-launch-the-worlds-first-official-digital-currency, accessed 15 Oct. 2021.

160. Global Legal Research Directorate, *Regulation of Cryptocurrency in Selected Jurisdictions* (Washington, DC: Law Library of Congress, June 2018). www.loc.gov/item/2018298388; and Scott Nover, "China's Latest Crypto Crackdown Is Its Toughest Yet," *QZ.com*, Quartz Media Inc., 26 Sept. 2021. qz.com/2065015/how-chinas-new-ban-on-crypto-breaks-from-the-past, accessed 15 Oct. 2021.

161. Portions of this section appeared in Alex Tapscott, "Bitcoin Offers Freedom from Political Repression—and That's a Key to Its Future," *Fortune Commentary*, Fortune Media Group Holdings Ltd., 18 Feb. 2021. fortune.com/2021/02/18/bitcoin-censorship-political-repression-deplatforming-china-belarus-russia-nigeria-crypto, accessed 16 Oct. 2021.

162. Here we shortened the original list from ten to eight by removing "Distributed Autonomous Agents Will Form Skynet" and "Big Brother Is Still Watching You" as we cover it under "Governments Will Stifle or Twist It."

163. Tobixen, "A Brief History of the Bitcoin Block Size War," *Steemit.com*, Steemit Inc., ~7 Nov. 2017. steemit.com/bitcoin/@tobixen/a-brief-history-of-the-bitcoin-block-size-war, accessed 15 Oct. 2021.

164. Portions of this section appeared in Alex Tapscott, "Bustin Bitcoin Myths: Seven Misconceptions about the currency," *Fortune Commentary*, Fortune Media Group Holdings Ltd., 17 March 2021. fortune.com/2021/03/17/bitcoin-myths-bubble-miners-energy-waste-stablecoin, accessed 4 Oct. 2021.

165. "Bitcoin Energy Consumption Index," *Digiconomist.net*, as of 6 Nov. 2021. digiconomist.net/bitcoin-energy-consumption.

166. Shawn Tully, "Famed Economist Jeffrey Sachs Rails Against Bitcoin: Highly Polluting and 'Almost Like Counterfeiting,'" *Fortune Finance*, Fortune Media Group Holdings Ltd., 16 March 2021. fortune.com/2021/03/16/bitcoin-jeffrey-sachs-critiques-btc, accessed 15 Oct. 2021.

167. Will Daniel, "Bitcoin's Energy Consumption Has Jumped 80% Since the Beginning Of 2020, According to a Study from Cambridge," *Business Insider: Markets Insider*, Insider Inc. and Finanzen.net GmbH, 12 March 2021. markets.businessinsider.com/news/currencies/bitcoin-energy-consumption-cambridge-study-cryptocurrencies-bitcoin-mining-climate-change-2021-3, accessed 15 Oct. 2021.

168. "Ninepoint Bitcoin ETF," *Ninepoint Partners*, n.d. gogreenbitcoin.com, accessed 5 Nov. 2021.

169. "Introducing CarbonX: Personal Carbon Trading," CarbonX Personal Carbon Trading Inc., n.d. www.carbonx.ca and www.carbon-ratings.com, accessed 4 Nov. 2021.

170. Adam Cochran (@adamscochran), Twitter Post, 16 Sept. 2021 (9:19 am). twitter.com/adamscochran/status/1438492766154240012.

171. Tom Emmer (@RepTomEmmer), Twitter Post, 5 Oct. 2021 (2:51 pm). twitter.com/RepTomEmmer/status/1445461701567160320, accessed 15 Oct. 2021.

172. AngelList (@angellist), Twitter Post, 28 Sept. 2021 (1:17 pm). twitter.com/AngelList/status/1442901252552101888, accessed 15 Oct. 2021.

173. Raj Dhamodharan, "Why Mastercard Is Bringing Crypto onto Its Network," *Mastercard Newsroom*, Mastercard International Inc., 10 Feb. 2021. www.mastercard.com/news/perspectives/2021/why-mastercard-is-bringing-crypto-onto-our-network, accessed 15 Oct. 2021.

174. "Digital Currency Comes," *VISA Everywhere Blog*, Visa USA Inc., 26 March 2021. usa.visa.com/visa-everywhere/blog/bdp/2021/03/26/digital-currency-comes-1616782388876.html, accessed 15 Oct. 2021.

175. Ryan Weeks, "PayPal Has Held Exploratory Talks About Launching a Stablecoin: Sources," *TheBlockCrypto.com*, Block Crypto Inc., 3 May 2021. www.theblockcrypto.com/post/103617/paypal-has-held-exploratory-talks-about-launching-a-stablecoin-sources, accessed 15 Oct. 2021.

176. Jeff John Roberts, "Visa Unveils 'Layer 2' Network for Stablecoins, Central Bank Currencies," *Decrypt News: Business*, Decrypt Media Inc., 30 Sept. 2021. decrypt.co/82233/visa-universal-payment-channel-stablecoin-cbdc, accessed 15 Oct. 2021.

177. Hugh Son, "US Bank Launches Bitcoin Custody Service as Institutions Race to Cater to Crypto Demand," *CNBC.com*, NBC Universal Media LLC, 5 Oct. 2021. www.cnbc.com/2021/10/05/bitcoin-custody-us-bank-launches-service-as-institutions-race-to-cater-to-crypto-demand.html, accessed 15 Oct. 2021.

178. Chris Dixon (@cdixon), Twitter Post, 1 Oct. 2021 (6:50 pm). twitter.com/cdixon/status/1444072368859533316, accessed 15 Oct. 2021.

179. Chris Dixon (@cdixon), Twitter Post, 1 Oct. 2021 (6:50 pm). twitter.com/cdixon/status/1444072370788978691 and twitter.com/cdixon/status/1444072374798675970, accessed 15 Oct. 2021.

180. "DAO Jobs: Find Great Crypto Jobs at a DAO," Cryptocurrency Jobs, as of 5 Nov. 2021. cryptocurrencyjobs.co/dao.

181. AnnElizabeth Konkel, "Job Seeker Interest Spikes in Crypto and Blockchain," *Indeed Hiring Lab*, Indeed Inc., 3 Aug. 2021. www.hiringlab.org/2021/08/03/job-seeker-interest-spikes-crypto-and-blockchain, accessed 15 Oct. 2021.

182. Mengqi Sun, "Crypto Firms Beef Up Compliance Hiring as Regulatory Scrutiny Mounts," *Wall Street Journal*, Dow Jones & Co. Inc., 30 Sept. 2021. www.wsj.com/articles/crypto-firms-beef-up-compliance-hiring-as-regulatory-scrutiny-mounts-11632994202, accessed 15 Oct. 2021.

183. Kyung Taeck Minn, "Towards Enhanced Oversight of 'Self-Governing' Decentralized Autonomous Organizations: Case Study of the DAO and Its Shortcomings," *NYU Journal of Intellectual Property and Entertainment Law* 9, No. 1, 24 Jan. 2020. jipel.law.nyu.edu/vol-9-no-1-5-minn, accessed 15 Oct. 2021.

184. Roy Learner, "Blockchain Voter Apathy," *Wave Financial Blog*, Wave Financial Group, 29 March 2019. medium.com/wave-financial/blockchain-voter-apathy-69a1570e2af3. See also Nic Carter, "A Cross-Sectional Overview of Cryptoasset Governance and Implications for Investors," Dissertation, University of Edinburgh Business School, 2016/2017. niccarter.info/papers, accessed 15 Oct. 2021.

185. "SX Network: The Blockchain for Prediction Markets," *SportX Bet Blog*, SX Network, 22 Sept 2021. medium.com/sportx-bet/sx-network-the-blockchain-for-prediction-markets-603badcdad3b, accessed 15 Oct. 2021.

186. Chainalysis Team, "Crypto Crime Summarized: Scams and Darknet Markets Dominated 2020 by Revenue, But Ransomware Is the Bigger Story," *Chainalysis Blog*, Chainalysis Inc., 19 Jan. 2021. blog.chainalysis.com/reports/2021-crypto-crime-report-intro-ransomware-scams-darknet-markets; and Michael J. Morell, "Report: An Analysis of Bitcoin's Use in Illicit Finance," *Cipher Brief,* Cipher Online Media Inc., 13 April 2021. www.thecipherbrief.com/report-an-analysis-of-bitcoins-use-in-illicit-finance, accessed 15 Oct. 2021.

187. David Herman, "The Silences of Eric Hobsbawm," *Salmagundi* No. 204–205, Fall 2019. salmagundi.skidmore.edu/articles/184-the-silences-of-eric-hobsbawm, accessed 15 Oct. 2021.

188. Win McCormack, "Fukuyama's Inner Civic Republicanism (Part 1): The End of History, 30 Years on," *The New Republic*, 17 Oct. 2019. newrepublic.com/article/155260/francis-fukuyama-anniversary-end-history-inner-civic-republicanism, accessed 15 Oct. 2021.

189. Timothy Leary (1920-1996), "The Effects of Psychotropic Drugs," Dept. of Psychology, President and Fellows of Harvard College, n.d. psychology.fas.harvard.edu/people/timothy-leary, accessed 15 Oct. 2021.

190. Don Tapscott and Alex Tapscott, *Blockchain Revolution: How the Technology Behind Bitcoin and Other Cryptocurrencies Is Changing the World* (New York: Penguin Portfolio, 2018). www.amazon.com/Blockchain-Revolution-Technology-Cryptocurrencies-Changing-dp-1101980141/dp/1101980141, accessed 6 Sept. 2020.

191. *Financial Services Revolution: How Blockchain Is Transforming Money, Markets, and Banking*, edited with preface by Alex Tapscott (Toronto: Blockchain Research Institute/Barlow Book Publishing, 5 Feb. 2020). www.amazon.com/Financial-Services-Revolution-Blockchain-Transforming/dp/1988025494.

192. Alex Tapscott, "The Blockchain Revolution," *Talks at GS*, inter. Tom Jessop, Goldman Sachs, New York, 12 July 2016 (00:07:47). www.goldmansachs.com/insights/talks-at-gs/alex-tapscott.html, accessed 6 Nov. 2021.

193. The Tapscott Group d/b/a Blockchain Research Institute, n.d. www.blockchainresearchinstitute.org.

blockchainresearchinstitute.org

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