


Decentralized Finance (DeFi): A Primer for Professional Investors



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I. Executive Summary

Over the last few decades, nearly every major industry has been reshaped by the digital revolution — except finance.

You see it in the list of the largest companies leading our economy — Apple, Amazon, Facebook, Tesla. But while these and other disruptive, tech-first giants lead most sectors of the market, the global financial industry remains dominated by century-old brick-and-mortar institutions. It's 2021, but the average age of the ten largest financial companies in the U.S. is 126 years; our largest financial institution, JPMorgan Chase, traces its roots back to 1799 and a company founded by Aaron Burr.

These leading financial institutions aren't just operating on business models from prior centuries — the infrastructure they are built on is centered around decades-old technologies like the SWIFT network and ACH payments. This aging infrastructure is severely limiting our ability to innovate. It is more costly to transfer \$300 through Western Union today than it was almost 150 years ago.¹

Attempts to improve this situation — packaged under the jaunty portmanteau “fintech” — have had little impact, focusing largely on the front-end user experience and failing to reconstruct the underlying infrastructure on which finance runs. Venmo, as an example, has a great user-friendly interface, yet it still takes up to three business days for a user to transfer funds from Venmo to their bank account.

All of this has set the stage for Decentralized Finance (DeFi), a growing movement that has the potential to completely change how we think about financial services.

DeFi replaces traditional financial intermediaries with software: Self-executing “smart contracts,” secured by blockchain technology, allow innovators to reimagine everything from lending to trading, asset management, and more.

Today, nearly 3.8 million users have allocated \$212 billion to DeFi applications.² These services can process loans for hundreds of millions of dollars nearly instantaneously, move money around the world for virtually no fee, trade billions of dollars in crypto assets with no intermediaries, and execute many basic financial functions more quickly, cheaply, and flexibly than the legacy system allows.

In contrast to the better-known crypto assets like bitcoin that behave more as commodities, DeFi applications have intrinsic revenue streams — they look a lot more like early-stage equities from a growth and valuation perspective. Yet compared to early-stage fintech equities, DeFi applications have been growing revenue over 20x faster.³

From a top-down perspective, the \$152 billion market capitalization of DeFi applications represents less than 1% of the total market capitalization of global financial services companies. If DeFi were to attain the same penetration relative to its incumbents that other successful disruptive technologies like e-commerce and electric vehicles have achieved (50-70%), it could become a \$15 trillion industry over the next 5-15 years.

In this white paper, we put the Decentralized Finance movement into context, contrast it to the incumbent alternative, and explore how much market share the disruptive technology could capture.

¹ Matt Hougan, “Fintech Is A Colossal Disappointment. DeFi Fixes It,” *Forbes*, October 12, 2021, <https://www.forbes.com/sites/matthougan/2021/10/12/fintech-is-a-colossal-disappointment-defi-fixes-it/>.

² Data from Dune Analytics and DeFi Llama as of October 31, 2021. DeFi users represent unique addresses having interacted with DeFi protocols. Unique addresses do not correspond 1:1 with unique users as one user can control more than one address.

³ For a full analysis of this comparison see Section IV of this paper.

II. What is Decentralized Finance?

Decentralized Finance is one of the most exciting corners of crypto. The goal of DeFi is to create a more accessible, efficient, and transparent financial system by leveraging one of crypto's greatest breakthroughs: programmable money.

The key innovation fueling DeFi is autonomous "smart contracts." These pieces of code, which run on blockchains, can execute complex transactions without the need for a trusted intermediary. As a rudimentary analogy, consider a vending machine: One can insert money on one end and receive the desired item on the other end without any external intervention.⁴

DeFi applies this breakthrough to financial services, and it is completely changing the way we think about the legacy rails of the current system.

DeFi users engage with smart contracts through a robust ecosystem of applications. In many ways these are just like the apps that everyone has on their smartphone, but with one key difference: There is no centralized company running them behind the scenes. Instead, a series of self-executing smart contracts operate the application based on the logic written in their code.

This new way to render financial services combines a number of advantages that are associated with disruptive 21st-century companies:

LOWER COST

DeFi has a fundamentally lower cost structure than traditional finance, thanks to two key structural advantages: It removes the need for middlemen in financial transactions, and is built on a world of free or nearly free money transfer.

HIGHER SPEED

DeFi allows for radically faster financial transactions as it removes the need for intermediaries and is built on blockchain infrastructure that offers instantaneous or nearly instantaneous settlement of financial transactions.

WIDER REACH

Just like the internet, crypto is a global phenomenon. DeFi applications can be created or accessed by anyone who has a network connection.

AGILE COMPOSABILITY

DeFi applications can be stacked together like money legos to facilitate new primitives that can execute more complex transactions, leading to much faster innovation cycles and new financial creativity.

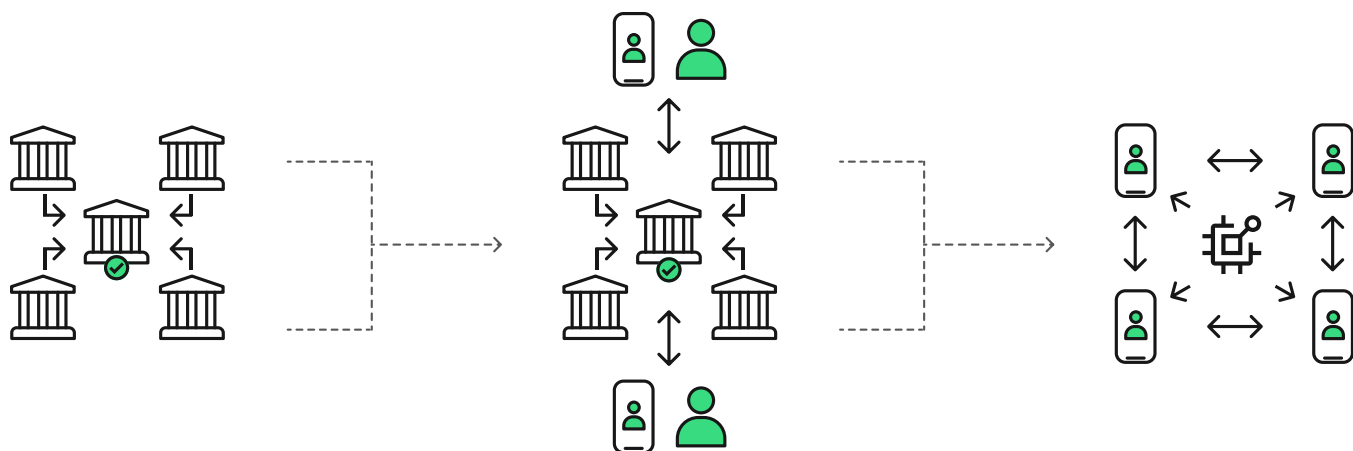
TWO-SIDED MARKETS

The peer-to-peer structure of DeFi unlocks new sources of supply to the financial market, in the same way that Airbnb brought new sources of supply to the short-term rental market and Uber brought new sources of supply to the taxi market.

SELF-EXECUTING SERVICES

DeFi applications consist of a series of self-executing smart contracts. Once deployed to the blockchains they run on, they continue to function without human intervention.

⁴ The concept of smart contracts predates the creation of bitcoin, the first crypto asset. It was introduced in 1997 by computer scientist, legal scholar, and cryptocurrency pioneer Nick Szabo in "The Idea of Smart Contracts," available at <https://nakamotoinstitute.org/the-idea-of-smart-contracts>.



TRADITIONAL FINANCE

Traditional Finance relies on centralized intermediaries

1800s & 1900s

FINTECH

Fintech provides a sleek front end but relies on traditional finance infrastructure

Early 2000s

DECENTRALIZED FINANCE (DEFI)

Decentralized Finance rewires the back end of the traditional system while offering fintech-like front ends

The Future

Source: Bitwise Asset Management.

HOW DEFI TRANSFORMS FINANCIAL SERVICES

It is worth digging into a few of these advantages in greater depth to demonstrate how they arise and what they mean for how DeFi may develop in the future.

Take costs and speed, for example. DeFi apps have lower operating expenses than traditional financial service providers because they use low-cost public infrastructure (blockchains) on the back end, and because they are decentralized and automated: that is, governed by code without the need for offices, employees, overhead, or other related costs.

These advantages fundamentally change how certain financial services can be provisioned.

Let's examine the process of taking out a bank loan in the competing systems:

- In traditional finance, individuals who want to take out a loan from a bank first have to become a customer of the bank through a customized and often tedious application process. This typically requires disclosing sensitive personal information like their social security number and home address, in lengthy forms specific to the lending institution. To receive the loan, the individual must typically drive to or call a bank during their business hours, meet with a loan officer, apply for and negotiate the loan terms, and, if approved, sign a variety of legal documents and contracts that are full of complex legal jargon. The process takes days and requires significant overhead.

- In DeFi, individuals seeking a loan can connect to a decentralized lending and borrowing platform, deposit collateral, and draw a loan against these collateral assets in a process that can take less than five minutes. Anyone from anywhere in the world can do this at any time, as long as they have internet access. They never have to interact with a bank employee, fill out an application, negotiate terms, wait for approval, or sign complex legal documents.

There are of course some limitations to the DeFi process, including that currently DeFi loans must be fully collateralized. But there are massive advantages as well, including significantly lower costs and exponentially faster turnaround times.

It would be naive to conclude, however, that DeFi is simply replicating the existing system with a few incremental improvements to speed and efficiency. To do so would be a failure to conceptualize DeFi's future potential impact, much like Nobel Prize-winning economist Paul Krugman's infamous failure to conceptualize the future impact of the internet, when he predicted in 1998 that "By 2005 or so, it will become clear that the internet's impact on the economy has been no greater than the fax machine's."⁵

Over time we predict that DeFi will not only extend its reach into the traditional aspects of the financial services industry, as we have already seen, but will also enable entirely new services that have not been conceived of before. Disruptive innovations tend to not only modify but also expand the markets they impact. We don't think the experience of DeFi will be different.

⁵ Paul Krugman, "Why most economists' predictions are wrong," Red Herring Online, June 1998, <https://web.archive.org/web/19980610100009/http://www.redherring.com/mag/issue55/economics.html>.

DEFI ALLOWS FOR RADICALLY FASTER INNOVATION IN FINANCIAL SERVICES

Another key advantage of DeFi is that it can innovate much faster than the traditional financial system.

The driver behind this faster innovation is “composability,” also referred to as “money legos” in the DeFi industry: the idea of easily assembling and rearranging different components of the system.

Composability allows for financial services to be built and operated through a modular, open-source framework. This is how the internet was initially built and a big reason why it was so successful. Instead of each company building the full stack of their operations from scratch, they compete by taking advantage of what everyone else has already built and becoming the interface to this new and more efficient system.

For example, this is how a bank might build its credit operation in traditional finance compared to doing so in DeFi:

- In traditional finance, if Bank A were looking to develop a novel credit operation, it would need to build all or most of the required components from scratch. It would need to develop a client deposit base to accumulate capital for lending, establish collateralization ratios and overall intelligence on credit parameters, build an operation to chart late payments or recover collateral from those in default, and so on. Importantly, if Bank B, Bank C, and Bank D wanted to engage in the same operations, each would need to rebuild the same infrastructure and repeat the same steps from scratch.
- In DeFi, Bank A could develop an application that interacts with existing DeFi applications, selecting from a wide range of possible functions: lending and borrowing, trading, asset management, insurance, or others. These applications rely on open-source software, meaning that they have already been battle-tested and optimized by a global community of users. If Bank B, Bank C, and Bank D want to improve or customize the system, they can simply copy and paste the Bank A code base and make it their own, as long as they make it available to everyone else.

It is as if any entrepreneur could take J.P. Morgan's installed infrastructure and build on top of it, without having to engage in a multi-year effort to strike a business development partnership, including the need to share fees from the new app.

It is hard to overstate the impact that composability can have on financial services. As Chris Dixon, co-head of the crypto division of famed venture capital investment firm Andreessen Horowitz and one of the most influential tech investors of our time, put it: “Composability is to software as compounding interest is to finance.”⁶

This is not a theoretical, potential framework. DeFi applications are already powering financial services for a large and increasing number of people every day.

DEFI IS ONE OF THE FASTEST-GROWING SECTORS OF CRYPTO

The growth of the DeFi sector has been impressive, whether you look at the number of applications, users, or capital deployed in the system.

APPLICATIONS

DeFi applications today represent 6% of the total market capitalization of crypto assets, and the use cases for DeFi are expanding rapidly.⁷ DeFi Llama, a leading aggregator of DeFi data, counts more than 534 individual DeFi applications, serving areas as diverse as trading, asset management, insurance and more.

In addition, a growing number of applications across the digital economy integrate DeFi infrastructure in their applications. For example, crypto gaming apps like Axie Infinity use DeFi applications like Uniswap to facilitate trading, buying, and selling of their in-game collectibles.

Future applications are on the horizon as well: DeFi lending applications like Aave are working on ways to allow users to post other types of assets like NFTs (non-fungible tokens) as collateral for loans, for example.

We explore the most popular types of applications in the next section of this white paper.

USERS

The number of users operating in the DeFi ecosystem is growing rapidly as well. Today, DeFi boasts an estimated 3.8 million users, compared to just 0.8 million users only a year ago.⁸ These users are scattered around the world, with verified DeFi activity taking place in 154 countries.⁹

⁶ Chris Dixon (@cdixon), “Composability is to software as compounding interest is to finance,” Twitter, October 22, 2021, <https://twitter.com/cdixon/status/1451703067213066244?s=20>.

⁷ Data from CoinGecko as of October 31, 2021. Market capitalization calculated using circulating supply. Circulating supply is comparable to shares readily available in the public market, and excludes supply locked for vesting, held by insiders, etc.

⁸ Data from Dune Analytics as of October 31, 2021. DeFi users represent unique addresses having interacted with DeFi protocols. Unique addresses do not correspond 1:1 with unique users as one user can control more than one address.

⁹ The Chainalysis 2021 Global DeFi Adoption Index tracks DeFi adoption across 154 countries. The report found DeFi adoption grew 881% from July 2020 to June 2021. See Chainalysis, “The 2021 Geography of Cryptocurrency Report,” October, 2021, <https://go.chainalysis.com/rs/503-FAP-074/images/Geography-of-Cryptocurrency-2021.pdf>

Because DeFi users are also the owners of the applications, they are incentivized to be evangelists — to remain loyal, actively spread the word, and organically grow the platform. This is not true of banks and can lead to viral growth not possible with brick-and-mortar institutions.

CAPITAL DEPLOYED

One of the most popular metrics to gauge the size of both individual DeFi applications and the ecosystem as a whole is Total Value Locked (TVL). It represents the aggregate amount of capital that is deployed in (i.e., locked in) DeFi applications at a certain time.

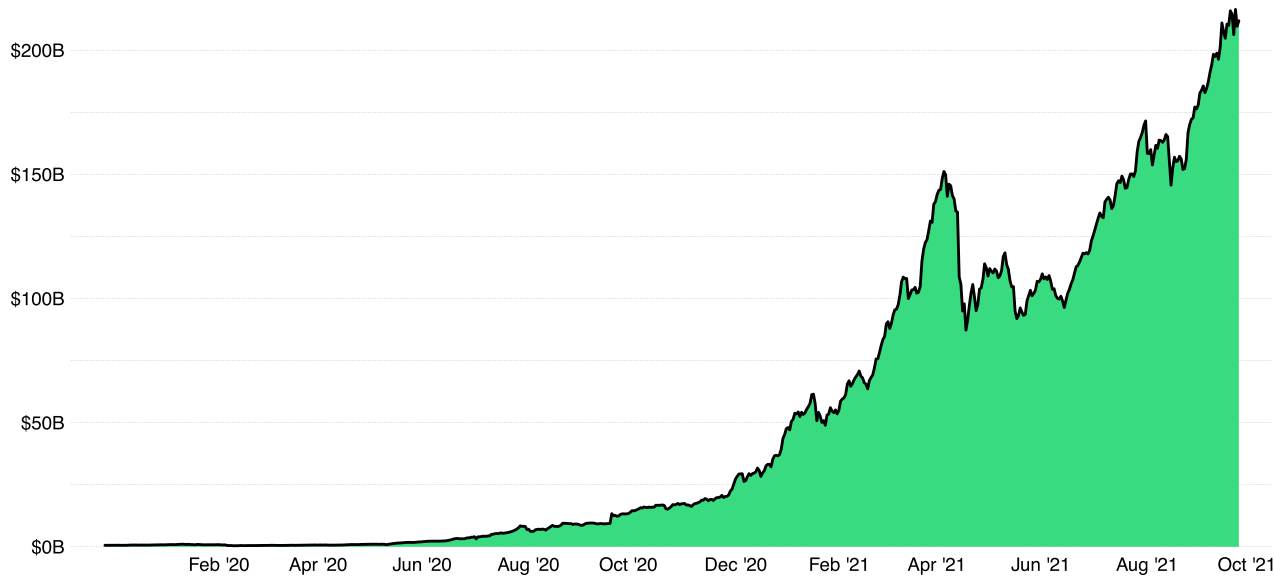
TVL is far from perfect — for instance, different DeFi applications may measure TVL differently — and crypto researchers are still working on improving standards of measurement. However, if not taken too rigidly, it can paint a picture of how the industry has been evolving and growing over time.¹⁰

As of October 31, 2021, the TVL across all DeFi platforms has reached \$212 billion, having grown more than 10x since January 2021 and 350x since January 2020.

The “hockey stick growth” that can be seen in the accompanying chart is typical of tech adoption curves as they begin to move beyond early adopters into a broader mainstream audience. The biggest challenge in any system is getting it off the ground; after that, a flywheel effect can emerge. DeFi seems to be following that trend.

CAPITAL DEPLOYED IN DEFI HAS GROWN MORE THAN 350X SINCE JANUARY 2020

Total Value Locked (TVL) across all DeFi platforms, January 1, 2020 to October 31, 2021 (USD billions)



Source: Bitwise Asset Management. Data from DeFi Llama as of October 31, 2021.
Excludes \$47 billion of reported TVL associated with protocols not generally considered to be DeFi, including stablecoins and infrastructure protocols like Chainlink, among others.

¹⁰ The “Total Value Locked” of a protocol is simply taken as the sum dollar valuation of all collateral deposited in that specific application, regardless of its functionality. Potential issues with TVL are examined in detail by CoinMetrics in “Understanding Total Value Locked (TVL)”, available at: <https://coinmetrics.substack.com/p/coin-metrics-state-of-the-network-0c0>

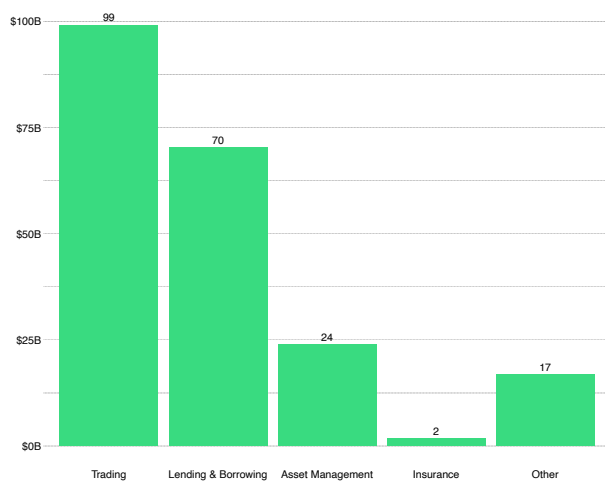
III. The DeFi Landscape

The main subsectors that make up the DeFi ecosystem mirror those of traditional finance services: Lending and Borrowing, Trading, Asset Management, and Insurance.

Lending and Borrowing along with Trading currently dominate the space, representing 80% of TVL in DeFi. The next sections cover these two leading categories in depth and provide an overview of the other exciting and emerging categories pushing the boundaries of what DeFi can do.

DEFI PLATFORMS HAVE ATTRACTED OVER \$212 BILLION IN CRYPTO ASSETS

Total Value Locked (TVL) in DeFi, by sector (USD billions)



Source: Bitwise Asset Management. Data from DeFi Llama as of October 31, 2021. Excludes \$47 billion of reported TVL associated with protocols not generally considered to be DeFi, including stablecoins and infrastructure protocols like Chainlink, among others.

LENDING AND BORROWING

As one of the original and most common financial services, it is no surprise that lending and borrowing quickly became one of the first and most widely adopted use cases for DeFi.

Brian Brooks, former head of the Office of Comptroller of the Currency (OCC) and Chief Legal Officer of Coinbase, aptly defined DeFi applications as self-driving banks.¹¹ Brooks' analogy is perfectly suited for lending and borrowing applications, as they are effectively automated banks in which users can deposit crypto assets in exchange for interest income or borrow crypto assets by posting collateral.

These applications enable lenders to deposit crypto assets, which are then pooled together with other similar assets

¹¹ Brian Brooks, "Get ready for self-driving banks," *Financial Times*, January 12, 2021, <https://www.ft.com/content/c1caca5b-01f7-41be-85a4-3ecb883f2417>

in a "liquidity pool." Each pool has a lending and borrowing interest rate that is algorithmically determined to ensure it reflects market supply and demand — when demand for capital increases, interest rates rise accordingly (and vice versa).

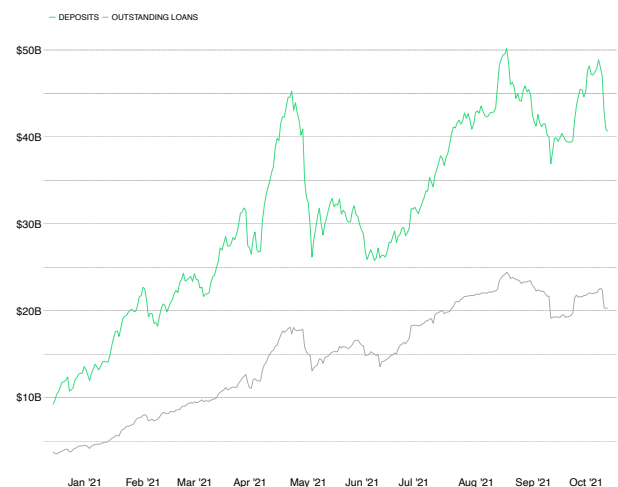
Currently, the main users of these platforms are traders who post collateral to operate on leverage. As such, the activities that the DeFi lending and borrowing platforms engage in are most akin to the activities of prime brokers in the traditional finance industry. In addition, innovative use cases are quickly emerging, such as uncollateralized "flash loans" for high-frequency arbitrage trading, and money market services that allow institutions to access crypto yields in a familiar and compliant user interface.¹²

The top three lending and borrowing applications in DeFi are Aave, Compound, and Maker. As of October 31, 2021, these three applications collectively boasted \$41 billion in deposits (an increase of 341% year-to-date) and \$20 billion in outstanding loans (an increase of 441% year-to-date).

While these platforms might differ in their user interface, structure of incentives for different types of users, specific risk and return parameters, governance standards, and other factors, all of them allow for loans to be processed with extreme efficiency and speed, without any human review — 24/7/365.

COLLATERAL DEPOSITED IN THE TOP THREE LENDING & BORROWING APPS IS UP \$31 BILLION IN 2021

Deposits and outstanding loans in Aave, Compound and Maker platforms (USD billions)



Source: Bitwise Asset Management. Data from Dune Analytics as of October 31, 2021

¹² "Flash loans" are a relatively new DeFi product where the loan is both issued and repaid in the same transaction, typically within seconds. Primarily used by high-frequency arbitrage traders, flash loans illustrate the kind of innovation in financial products that blockchains and DeFi apps make possible.

TRADING

Trading is the other dominant subsector of DeFi, led by Decentralized Exchanges (DEXes). They are the crypto equivalents of the New York Stock Exchange or Nasdaq, or the decentralized equivalents of a centralized crypto brokerage like Coinbase. They offer a way for users to exchange crypto assets without the need for a trusted third party.

Importantly, most of these decentralized exchanges are not based on order books like their traditional counterparts, but use a completely new mechanism to bootstrap and sustain trading activity, known as Automated Market Making (AMM).¹³

Traders on DEXes don't trade against each other, but against a liquidity pool that aggregates the capital of market makers who supply assets to that trading pair. In this way, DEXes can be thought of as two-sided marketplaces similar to Airbnb or Uber.

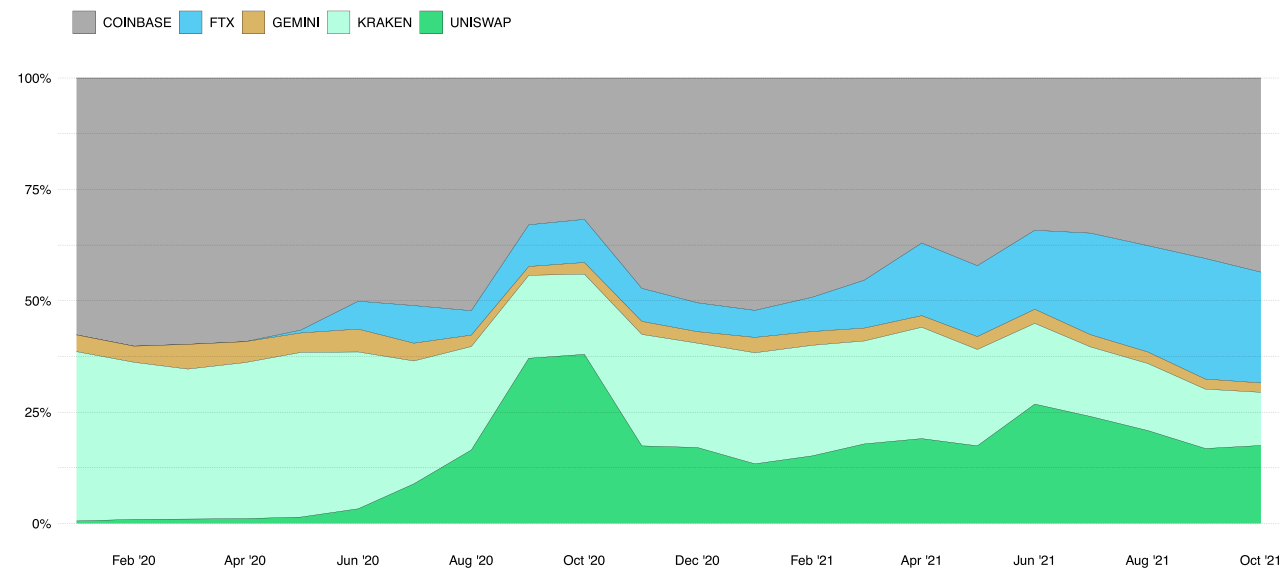
Uber connects drivers and their vehicles with passengers in need of a ride. Airbnb connects homeowners looking for extra cash flow with renters willing to pay for a place to stay. Decentralized exchanges connect market makers looking for yield on their crypto assets with traders willing to pay for access to liquidity.

All of this activity is mediated by autonomous smart contracts and executed with near instantaneous settlement. There is no intermediary — DEXes don't have an operating company with thousands of employees, a trading floor, or a corporate headquarters.

Still, some of the largest DEXes rival their traditional counterparts in terms of trading volume, cost, and efficiency. As the chart below shows, Uniswap, the leading DEX, has captured 18% of the trading volume of the leading spot crypto exchanges, rivaling better-known Coinbase and FTX.

UNISWAP RIVALS CENTRALIZED EXCHANGES IN MARKET SHARE

Relative share of trading volume of leading crypto exchanges, January 1, 2020 to October 31, 2021



Source: Bitwise Asset Management. Data from The Block, CoinGecko and CryptoCompare as of October 31, 2021.

¹³ Automated Market Making (AMM) was conceptualized in 2016 by Ethereum co-founder Vitalik Buterin. The concept was further explored in his 2018 blog post "Improving front running resistance of x*y=k market makers," available at: <https://ethresear.ch/t/improving-front-running-resistance-of-x-y-k-market-makers/1281>

Decentralized exchanges can differ in user interface, types of users, types of assets their mechanisms are optimized for, speed and cost of transactions, governance standards, and other factors.

More recently, some decentralized exchanges have been experimenting with new features. SushiSwap, one of the leaders of the sector, is a prime example. Beyond traditional spot trading, it now offers lending and borrowing features, a platform to buy and sell NFTs, and even a token launchpad for new DeFi applications to raise capital.

Uniswap is the clear leader among DEXes in terms of trading volumes. In October 2021 the application handled \$60 billion of the \$103 billion total DeFi trading volume — an impressive 58% dominance over the sector.

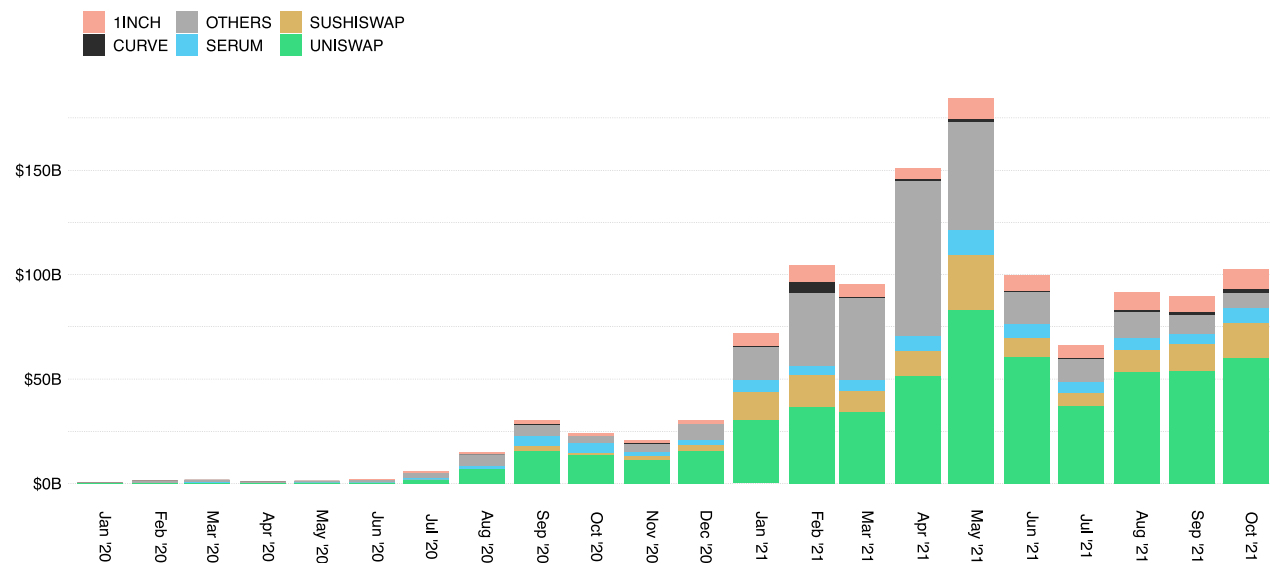
Just like in traditional finance, DeFi trading is not limited to spot markets. Futures and other types of derivatives contracts can also be coded into and carried out by smart contracts. As a result, derivatives have emerged as a significant subsector of trading within DeFi.

DeFi applications focused on this part of the market include Synthetix, dYdX, and many others. Some features that these applications offer include derivatives contracts, options, and even synthetic assets that aim to mirror the return of real-world assets like stocks, currencies, and commodities.

Derivatives have been a controversial subsector of DeFi more recently, particularly in the U.S., where regulators including the SEC and the CFTC have voiced concerns around some of their securities-like characteristics.¹⁴ Yet demand for such types of products outside the U.S. indicates that applications able to bridge this regulatory gap could be rewarded with a sizable, largely untapped addressable market.¹⁵

DECENTRALIZED TRADING PLATFORMS HAVE HANDLED \$1.1 TRILLION OF VOLUME IN 2021

Total monthly trading volume on decentralized exchanges (USD billions)



Source: Bitwise Asset Management. Data from The Block, CoinGecko and DeBank as of October 31, 2021.

Data includes both decentralized exchanges (e.g., Uniswap, SushiSwap) and aggregators (e.g., 0x, 1inch), and excludes volume associated with synthetic assets like perpetual swaps.

¹⁴ Gary Gensler, prepared remarks, American Bar Association Derivatives and Futures Law Committee Virtual Mid-Year Program, July 21, 2021, <https://www.sec.gov/news/speech/gensler-remarks-aba-derivatives-futures-law-committee-virtual-mid-year-program-072121>; Dawn D. Stump, "Digital Assets: Clarifying CFTC Regulatory Authority & the Fallacy of the Question, 'Is it a Commodity or a Security?'," August 23, 2021, <https://www.cftc.gov/PressRoom/SpeechesTestimony/stumpstatement082321>.

¹⁵ Token Terminal, a leading data crypto analytics platform, reports dYdX has grown from \$1.5 billion of monthly trading volume in January 2021 to \$99.0 billion of monthly trading volume in October 2021 (includes synthetic assets like perpetual swaps).

ASSET MANAGEMENT

The asset management space is one of the fastest-growing subsectors of DeFi. Typical asset management services, such as yield optimization and portfolio management, can be automated and executed in an open and decentralized fashion.

Yearn Finance leads this DeFi sector with close to \$6 billion in assets deployed on its platform.¹⁶ Yearn utilizes automated strategies and smart contracts to deploy the assets deposited on its platform across the DeFi ecosystem. These strategies are designed to seek out the most favorable DeFi yields, within encoded risk parameters. Yearn's assets under management and the strategies deployed are publicly auditable and verifiable, thanks to the open-source nature of DeFi.

Yearn is the DeFi equivalent of a robo-advisor in legacy finance. The most popular robo-advisor, Wealthfront, launched in 2008 and has taken thirteen years to reach \$27 billion in assets under management.¹⁷ In comparison, Yearn launched in 2020 and as stated above has already amassed \$6 billion in assets under management.

Other protocols, such as Enzyme Finance and Set Protocol, allow anyone to easily create and manage baskets of tokens in which others can invest. These applications manage the portfolios according to predetermined rules, automate the back-end processes of fund management and accounting, and collect and distribute management fees.

Even a decentralized crypto index fund manager, a DeFi equivalent of Bitwise Asset Management, has recently launched. Index Coop uses infrastructure such as the above-mentioned Set Protocol to create crypto index products, which are advised by DeFi industry experts. As of October 31, 2021, their six index products had \$461 million in assets under management.

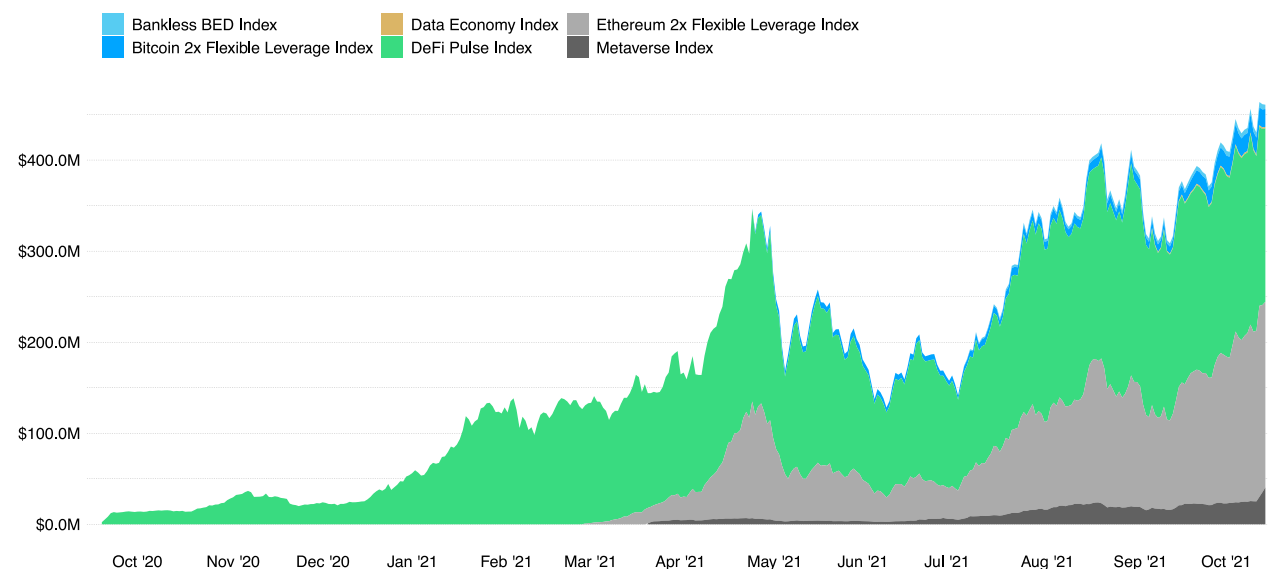
INSURANCE

DeFi is new and still faces considerable risks, including software bugs and exploits of imperfectly designed smart contracts. As such, decentralized insurance applications have launched to provide coverage against the myriad DeFi risks.

Surprisingly, this is an underdeveloped DeFi sector, in particular when compared to the traditional system. For example, the leading DeFi insurance application, Nexus Mutual, currently covers less than 1% of the TVL in DeFi. This vertical has strong potential to gain more traction when the user experience improves. While today users have to obtain insurance through a separate transaction, in the future users may see simple add-on insurance services that can be purchased with a single click before finalizing a transaction.

THE LARGEST CRYPTO-NATIVE INDEX FUND MANAGER HAS \$461 MILLION IN AUM

Index Coop's assets under management, by index product, since launching in September 2020 (USD millions)



Source: Bitwise Asset Management. Analysis by @josephdcook. Data from Dune Analytics as of October 31, 2021.

¹⁶ Data from DeFi Llama as of October 31, 2021.

¹⁷ Wealthfront AUM based on data from the company's website (<https://www.wealthfront.com/>). Wealthfront is a privately held, centralized financial institution and the ability to independently audit and verify their assets under management is limited to the information they publicly disclose.

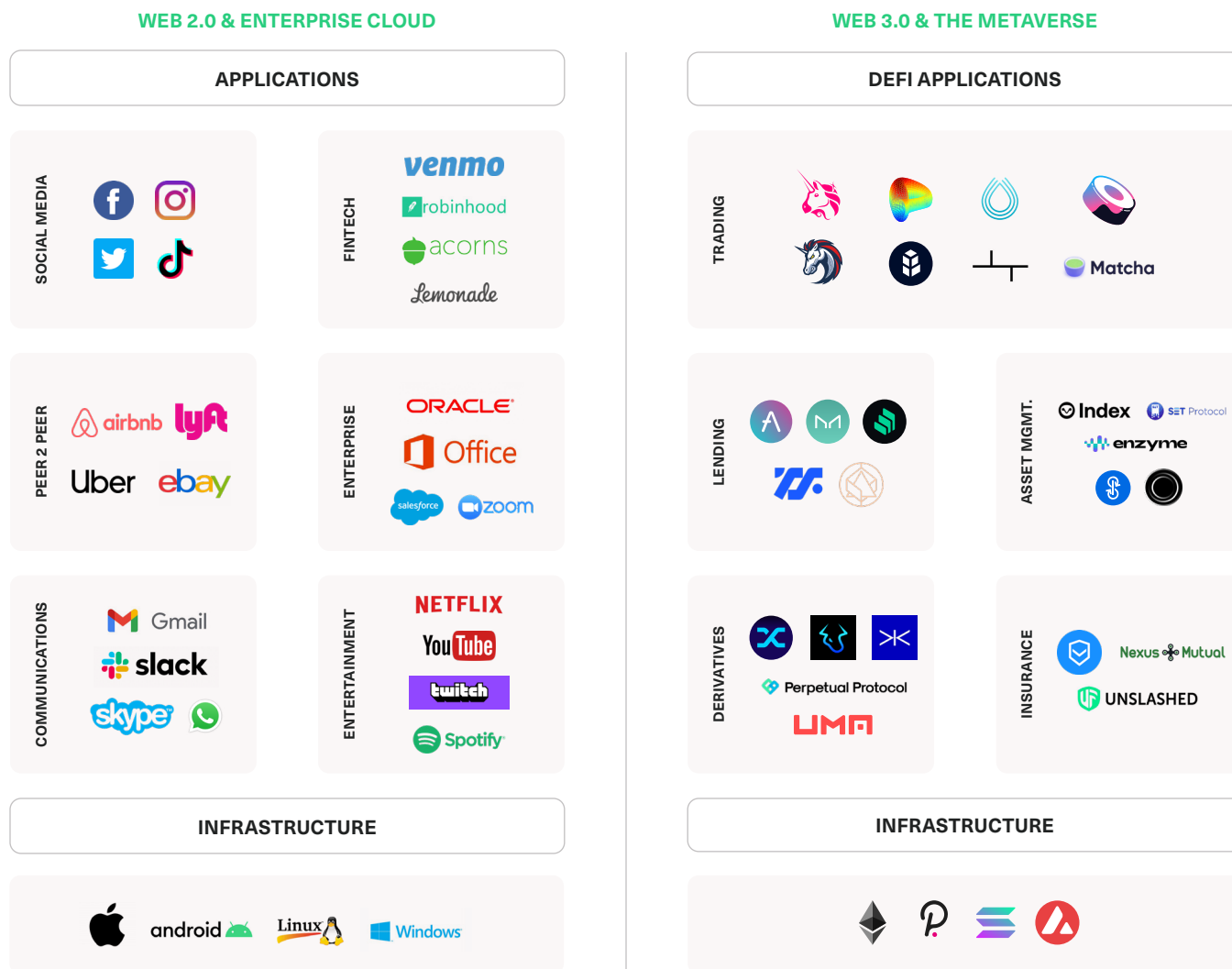
A GLANCE AT THE PLATFORMS THAT POWER DEFI APPLICATIONS

While “Web 2.0” apps, such as fintech, are powered by centrally maintained operating systems like Android or Apple’s iOS, “Web 3” applications, including DeFi, are powered by decentralized, permissionless blockchain networks like Ethereum or Solana.

Thus, the DeFi ecosystem comprises not only the above-mentioned financial applications but also their underlying infrastructure.

This report is mostly focused on the application layer of DeFi, but a brief overview of the infrastructure that powers these applications will help develop a fuller understanding of the thriving ecosystem.

DEFI IS AN ECOSYSTEM OF CRYPTO-NATIVE FINANCIAL APPLICATIONS



Source: Bitwise Asset Management

The above data focuses on the DeFi sector of the larger Web 3 ecosystem, which includes infrastructure and applications beyond those relevant to DeFi. DeFi icons refer to (left to right, top to bottom):

Trading: Uniswap, Curve, Serum, SushiSwap, 1inch, Bancor, Tokemak, and Matcha; Lending: Aave, Maker, Compound, TrueFi, and Alchemix; Asset Management: Index Coop, Set Protocol, Enzyme Finance, Yearn Finance, and Rari Capital; Derivatives: Synthetix, Tracer, Dopex, Perpetual Protocol, and UMA; Insurance: Armor Finance, Nexus Mutual, and Unslashed; Infrastructure: Ethereum, Polkadot, Solana, and Avalanche.

The first generation of DeFi applications was primarily built on the Ethereum blockchain. However, a surge in DeFi adoption led to the Ethereum network becoming overcrowded, pushing the excess DeFi economic activity to alternative networks. As a result, competing platforms such as Solana, Avalanche, and Terra have arisen and are starting to see significant traction across their DeFi ecosystems.

The relative size of these networks and the DeFi ecosystems built on top of them is provided in the below matrix.

The table shows the dominance Ethereum enjoys. It is the platform of choice for an astounding 52% of DeFi applications, which represent 65% of TVL in DeFi. This is part of why Ethereum has a market capitalization of nearly \$500 billion.

The primary characteristic that underpins Ethereum's dominant position is its network effects. It was the first to market, became the home of early applications, and now boasts the most developer activity, users and liquidity.

However, Ethereum's lead in the market is anything but guaranteed. The overflow of DeFi activity onto alternative networks is similar to cities that experience such rapid growth that surrounding suburban areas begin to see development and growth in economic activity.

Just as various suburbs have their trade-offs, like proximity to the city center, cost of living, and others, these networks have different trade-offs in core properties such as throughput, security, and centralization.

BLOCKCHAINS OFFER DIFFERENT LEVELS OF SECURITY DECENTRALIZATION AND THROUGHPUT

PROJECT NAME	MARKET CAP (USD BILLIONS)	DEFI TVL (USD BILLIONS)	NUMBER OF DEFI APPS	LAUNCH YEAR	THROUGHPUT (SPEED X COST)
 Ethereum	\$499.3	\$138.7	278	2015	Low
 Cardano	\$62.2	\$0.0	0	2017	Low
 Solana	\$61.2	\$10.7	23	2020	High
 Polkadot	\$45.5	\$0.0	0	2020	High
 Terra	\$16.9	\$6.9	7	2019	Medium
 Avalanche	\$14.0	\$8.4	53	2020	High
 Algorand	\$11.2	\$0.1	2	2019	High

Source: Bitwise Asset Management. Market cap data from CoinGecko as of October 31, 2021. TVL and Number of Apps data from DeFi Llama as of October 31, 2021.

IV. The Opportunity Size in DeFi

The DeFi industry has already gained remarkable traction, but as an early-stage disruptive technology it may still have a lot of room to grow.

In this section, we provide a bottom-up and a top-down gauge of the opportunity size in DeFi, by comparing it to other disruptive technologies that are already further along their respective adoption curves.

From a bottom-up standpoint, DeFi applications provide an attractive combination of decent valuation multiples with massive growth potential. From a top-down approach, the total market capitalization of all DeFi applications is still less than 1% of the market cap of the global financial sector.

BOTTOM-UP ANALYSIS: ATTRACTIVE GROWTH-ADJUSTED MULTIPLES

Unlike the larger crypto assets like bitcoin and ether that behave more like commodities, DeFi applications typically have revenue streams. This makes it possible for investors to evaluate them with some of the same tools that they might use for early-stage equities.

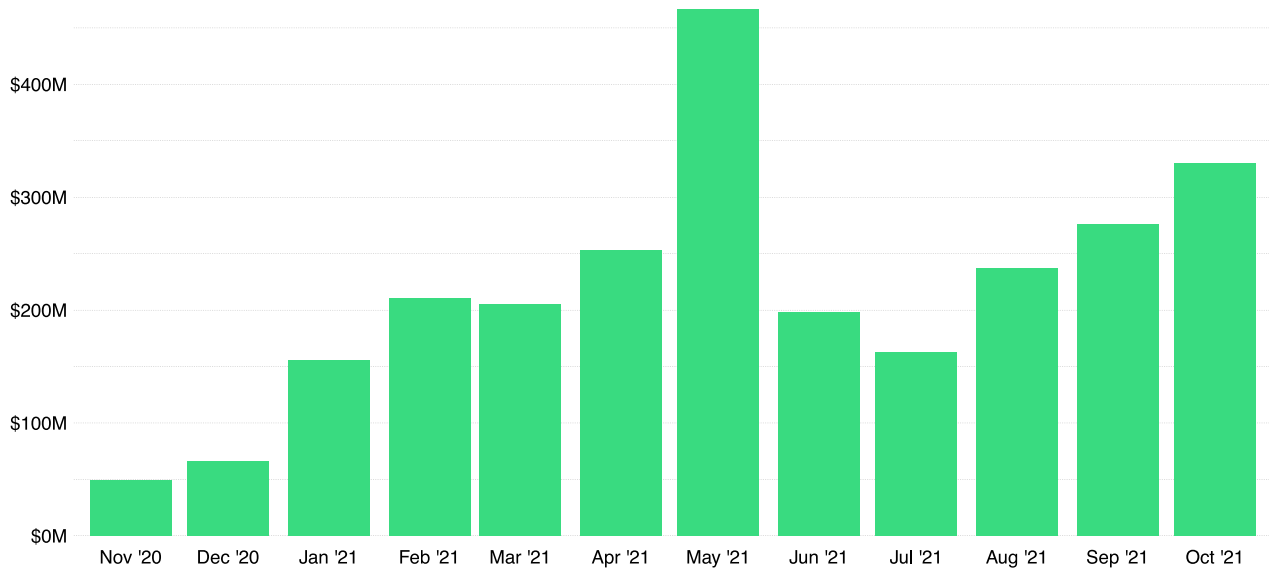
Most DeFi applications generate revenue by charging a fee for the activity on their platform, such as trading or taking out a loan. Currently, the majority of revenue generated by DeFi applications is used to reward participants of the network such as liquidity providers and lenders. A few applications, however, are already channelling part of the revenue to token holders in the form of dividends or buy-backs, and more are expected to do so in the future.

SushiSwap, for example, charges a 0.3% fee for every trade made on its decentralized exchange. Of that, 0.25% is passed on to the liquidity providers and the remaining 0.05% is distributed to SUSHI token holders, similar to a dividend. The Aave lending application charges a 0.09% fee on all flash loans, a portion of which is automatically used to buy AAVE tokens on the secondary market and “burn” them (i.e., permanently remove them from circulation), much like a stock buy-back.

The chart below shows the evolution of the revenue generated by DeFi applications over the past twelve months. In October 2021, the revenue generated by these applications reached \$330 million (\$4.0 billion annualized).

DEFI APPLICATIONS GENERATED MORE THAN \$4 BILLION OF ANNUALIZED REVENUE IN OCTOBER 2021

Total monthly revenue in DeFi (USD millions)



Source: Bitwise Asset Management. Data from The Block, Ethereum ETL, and The Graph as of October 31, 2021.

As a result, while DeFi applications don't have a centralized corporate structure, ownership of a DeFi application's native token can carry economic incentives similar to equity ownership in startups. Moreover, token holders often have governance rights that can be used to influence the development of the application and determine how the revenues generated by the application are allocated. If token holders of a certain protocol wish to increase the fee charged by the platform and channel it into a dividend-like payment to token holders, they can use their tokens to vote on a governance proposal that would do so.

With the presence of revenues and, in a few cases, profits, investors can apply standard valuation tools to the valuation of DeFi applications. The preferred valuation ratio currently used by the market is the price-to-sales multiple (P/S), since many DeFi applications are early-stage projects that generate revenue but do not yet accrue profits to their token holders.

The data below shows that the top DeFi applications, defined as the constituents of the Bitwise Decentralized Finance Crypto Index, currently boast a median P/S multiple of 14.5x.¹⁸ For the top five protocols by market capitalization, the P/S multiple varies from 4.6x to 37.6x and the median is 7.9x.

Such multiples are within striking distance of publicly listed disruptive technology companies. As an example, the median P/S ratio for the publicly traded companies in the ARK Fintech Innovation ETF, an ETF run by legendary investor Cathie Wood focused on fintech innovation, currently stands at 13.8x.

The difference, however, is the rate of growth that DeFi applications have been demonstrating.

The top DeFi applications are currently delivering median revenue growth of 632.6%. By comparison, the median 2021 revenue growth projected by analysts for the constituents of the ARK Fintech Innovation ETF is significantly lower, at 37.3%.

As the DeFi industry matures and investors become more confident in its growth going forward, the valuation multiples of DeFi applications have room to re-rate.

THE TOP DEFI APPLICATIONS BY MARKET CAP HAVE A MEDIAN P/S RATIO OF 14.5X

DeFi applications trade at similar multiples to those of high-growth tech startups

DEFI APPLICATION	DEFI SUBSECTOR	PRICE-TO-SALES MULTIPLE	MARKET CAP (USD BILLION)
Yearn	Asset Management	4.4x	\$1.2
SushiSwap	Trading	4.6x	\$2.1
Aave	Lending and Borrowing	7.1x	\$4.1
Compound	Lending and Borrowing	7.9x	\$2.0
Uniswap	Trading	14.5x	\$12.9
Bancor	Trading	19.9x	\$0.1
MakerDAO	Lending and Borrowing	37.6x	\$2.1
Ren	Trading	69.8x	\$1.0
Curve	Trading	144.0x	\$1.7

Source: Bitwise Asset Management. Data from TokenTerminal as of October 31, 2021.

Top DeFi applications defined as the constituents of the Bitwise Decentralized Finance Crypto Index. See footnote below for additional information.

¹⁸ An additional constituent of the Bitwise Decentralized Finance Crypto Index, 0x, is excluded here due to data anomalies. The Index identifies the largest investable DeFi assets by market capitalization, subject to eligibility requirements. For the full Index methodology, please visit www.bitwiseinvestments.com/indexes/methodology.

TOP-DOWN ANALYSIS: DEFI IS STILL LESS THAN 1% OF GLOBAL FINANCIAL INDUSTRY

From a top-down perspective, the DeFi industry's market capitalization of \$152 billion is still a fraction of the size of the industry that it could potentially disrupt, representing less than 1% of traditional finance's \$24 trillion market value.¹⁹

A more illuminating sense of DeFi's relative size may be a comparison to JPMorgan Chase, the largest bank in the world, which boasts a market capitalization of \$508 billion — more than 3x the combined value of all 534 DeFi applications.

The diagram below shows what the potential DeFi market cap could be if it were to capture the same market capitalization that other successful disruptors captured from their target markets.

The first comparison is to bitcoin, which is a relatively new technology but is almost ten years further down its adoption curve than DeFi. Often referred to as digital gold, in its 13-year history bitcoin has captured 10% of the global gold market. If DeFi were able to achieve similar penetration of the traditional financial market, it would be a \$2 trillion industry.

Of course, bitcoin is still early in its adoption curve. What if DeFi can go further and be as dominant as other, more established disruptors have become in their respective industries?

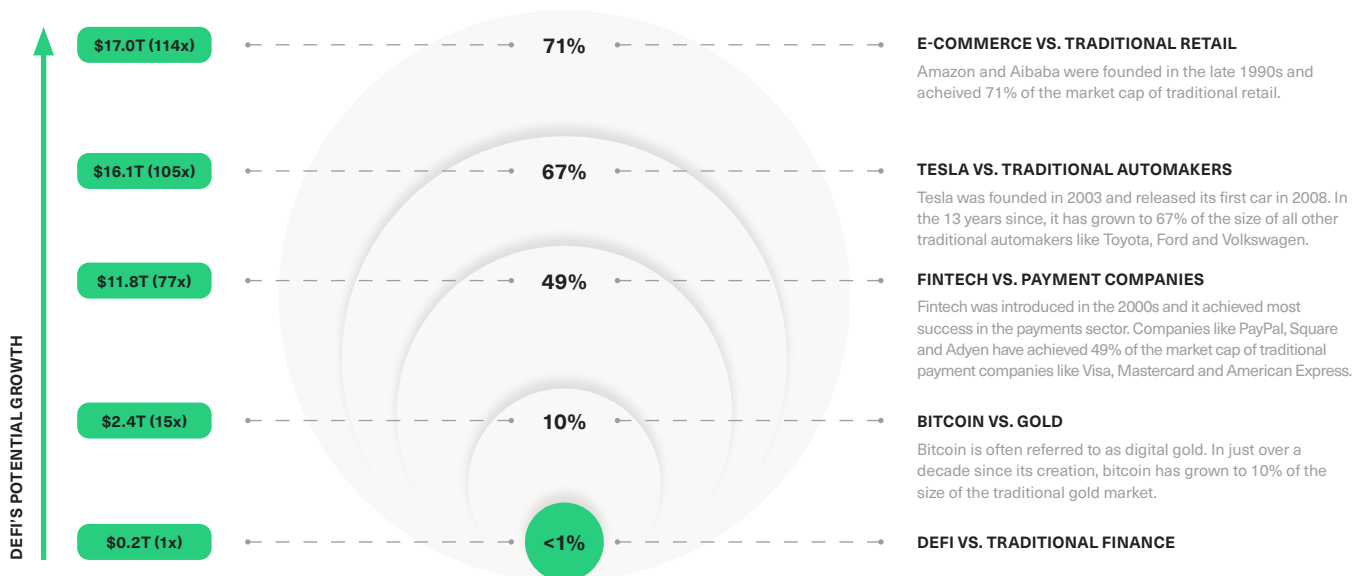
The most successful disruptors captured roughly between 50% and 70% of the market capitalization of incumbents over a period of 10-20 years. The examples below include fintech versus payment processors (49% penetration), Tesla versus other automakers (67% penetration), and Amazon and Alibaba versus traditional retailers (71% penetration).

If DeFi were to reach this level of success it would have a market capitalization of over \$15 trillion.

Of course, this market-sizing exercise should be seen only as a ballpark estimate of the asymmetric long-term potential that DeFi could deliver if it becomes as successful as other disruptive technologies. Reality can be much more complex, partly because disruptors not only capture market share from established players but often have an additive impact on total market size.

WITH THE SAME SUCCESS AS OTHER DISRUPTIVE TECHNOLOGIES, DEFI COULD BECOME A \$15T+ INDUSTRY

DeFi market capitalization penetration versus other disruptive technologies



Source: Bitwise Asset Management with market capitalization data from FactSet, CoinGecko and CompaniesMarketCap.com as of October 31, 2021.

¹⁹ Global financial market data from FactSet. DeFi data from The Block and DeFi Llama as of October 31, 2021.

V. Risk Factors

The DeFi industry uses emerging, complex technology that aims to automate highly regulated financial services. Operating at this intersection carries a number of risk factors which have the potential to significantly affect the long-term outlook for DeFi.

DEPENDENCIES AND INTERCONNECTIONS WITH THE TRADITIONAL SYSTEM

Some DeFi applications currently rely on the traditional financial system for infrastructure and business operations (vendor payments, bank accounts, credit cards, etc.), creating a critical point of dependency. Researchers Nic Carter and Linda Jeng argue that the growing supply of U.S. dollar-denominated stablecoins backed by commercial banks and held by financial institutions creates a vulnerable point of connection between the traditional and decentralized systems.²⁰ As a consequence of such interconnections and dependencies, DeFi is partially exposed to systemic risks of the traditional financial system.

It is not yet clear whether this is a growing pain that DeFi will outpace (for instance, by creating algorithmic stablecoins that are not pegged to fiat currency), or whether some degree of interconnection between the two systems, and hence shared risk, are likely to persist over the long term.

EXECUTION AND TECHNICAL RISKS

The advanced nature of blockchains and DeFi applications creates the possibility of unknown execution and technical risks. For instance, infrastructure risks arise because DeFi protocols depend on public blockchains to validate their transactions. As a result, if the underlying blockchain experiences downtime the DeFi applications themselves could be inaccessible.

Moreover, DeFi applications are open-source, which means bad actors can dissect their inner workings in search of vulnerabilities to exploit. In the event of technical exploits (where the code is bad and the system doesn't work as intended), or economic exploits (where malicious actors extract value from a system even though the system's mechanisms work as intended), the capital deployed to the protocol is at risk of irreversible loss or theft.

For example, in September 2021 an upgrade to the Compound lending application unintentionally introduced a bug in the smart contract responsible for distributing the COMP token as an incentive to users of the protocol. While the bug did not pose a direct risk to any lenders' assets, it sent erroneous amounts of COMP tokens to users. In total, 490,000 COMP tokens, which at the time were worth approximately \$163 million, were placed at risk due to this bug. A software patch fixing the bug was ultimately implemented, and the majority of users who incorrectly received COMP tokens chose to return them to the application.

CENTRALIZATION RISKS

One major criticism levied against DeFi applications is that they are not truly decentralized and that core developers can control or access the funds deposited in them. If a subset of contributors retain control over the protocol, they could alter the application's underlying code and use the funds in unintended ways. To address this risk, the most decentralized DeFi applications are self-executing and only implement changes when a majority of the application's token holders have reached consensus regarding a proposed change or upgrade.

REGULATORY RISKS

In the near term, DeFi is likely to face regulation around taxes, anti-money laundering, and other key regulatory guardrails. Many of these regulations are needed, both to protect investors and to safeguard society from risks.

That said, there is significant risk in any emerging technology that poorly structured regulations can overreach and constrain innovation. Investors should expect more regulatory scrutiny on DeFi, with the likely result that some DeFi applications will not be able to comply with U.S. or other regulatory structures and may be forced to cease operations.

²⁰ Nic Carter and Linda Jeng, "DeFi Protocol Risks: The Paradox of DeFi," in *Regtech, Suptech and Beyond: Innovation and Technology in Financial Services*, ed. Bill Coen and D.R. Maurice (London: Risk Books, 2021). Preprint available at <http://dx.doi.org/10.2139/ssrn.3866699>

VI. Conclusion

There has been a widespread failure to innovate across the global financial industry over the past 30+ years. A combination of high barriers to entry and high switching costs have given incumbents little reason or motivation to innovate.

Fintech has been a long-promised revolution that has never arrived. Despite massive venture capital investment and a great deal of hype, our core financial infrastructure and day-to-day experience of financial life has changed little over the past few decades.

Decentralized finance fixes this.

The emerging industry of low-cost, highly composable financial applications known as DeFi is threatening the economic moats that traditional financial institutions have enjoyed for so long. These DeFi applications are agile in ways that archaic financial institutions simply can't compete with while simultaneously offering a vast overall improvement to the global financial system.

DeFi enables globally accessible, secure, 24/7 financial markets and services that can be audited and monitored in real time.

By outsourcing infrastructure costs to blockchains and automating the if-then logic of financial transactions, DeFi applications can operate at a lower cost and extract less value from the system than traditional, centralized brick-and-mortar institutions. In turn, DeFi applications pass that value on to their users.

In less than three years, DeFi has grown to an ecosystem of more than 534 crypto applications that provide financial services like lending, borrowing, and asset management. To date, these financial applications have seen more than \$212 billion in capital allocated, as measured by total value locked (TVL).

What was once the domain of crypto enthusiasts is now beginning to attract the attention of some of the largest traditional financial institutions in the world. Consider that Société Générale, the sixth largest bank in Europe, recently proposed a first-of-its-kind \$20 million deal with DeFi application Maker that would open new partnership possibilities between DeFi and traditional financial institutions.²¹

With significant revenue streams and soaring growth rates, many DeFi applications resemble — and compare favorably with — high-growth, early-stage equities. These same characteristics can make DeFi applications more intelligible to investors than commodity-like cryptocurrencies such as bitcoin.

The nascent DeFi industry faces an unclear regulatory future, a trait common among highly disruptive technologies. The pioneers of Web 2.0 like Facebook, Apple, Amazon, Netflix and Google were met with similar challenges and uncertainty from regulators in their early days and are now among the world's most valuable companies. Generally, the near-term impact of regulation is unclear; however, increased regulatory clarity and guidance will ultimately lead to more room for the DeFi industry to expand and more capital flowing into the ecosystem, driving growth.

The \$152 billion market value of the DeFi industry represents only a small portion of the \$24 trillion global financial market.²² Based on the history of disruptive technologies in other markets, we believe that DeFi will expand from this modest start to be a \$15 trillion industry in the next 5-15 years.

While the industry has a long road ahead of it, like the internet and disruptive technologies before it, DeFi is growing at far too fast a rate to ignore.

²¹ Andrew Thurman, "Société Générale Applies for \$20M MakerDAO Loan Using Bond Token Collateral," CoinDesk, September 30, 2021, <https://www.coindesk.com/business/2021/09/30/societe-generale-applies-for-20m-makerdao-loan-using-bond-token-collateral/>

²² Global financial market data from FactSet, DeFi data from The Block and DeFi Llama as of October 31, 2021.

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