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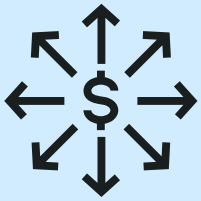
HASHDEX RESEARCH

DeFi Primer



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Introduction

In recent decades, the world has witnessed one of the greatest periods of economic growth in human history, and it is no exaggeration to say that capital markets played a fundamental role in that development. It is through a well-developed financial market that economic resources can be efficiently allocated, reaching the people, projects and companies that can bring the greatest value to society.

A key role of financial organization in this context is that of a trusted intermediary, an institution people trust to deposit their capital with the expectation that it will be deployed in a safe and prudent way. The progress this model has brought to society is undeniable, but it is not without drawbacks. Until recently, some degree of centralization was inevitable in an environment where trust is an essential attribute. After all, the largest and strongest institutions are likely to be the most in demand, attracting even more capital.

There are pitfalls in such concentration, however. As institutions grow larger, some relevant issues arise: operational complexity increases, reducing speed and flexibility; smaller clients may no longer be economically interesting, overlooked in comparison to larger and more profitable ones; and fees usually get higher, as market power increases. Additionally, there are no clear incentives for one institution to cooperate with their competitors, making the sector fragmented. In other words, the system becomes more costly and inefficient.

Now imagine that instead of having to rely on trusted intermediaries, we could establish a global, transparent, interoperable and—most of all—trustless network, in which we could transact, invest and manage our money in a completely decentralized way? That's the innovation that Decentralized Finance (DeFi) brings to the global financial markets landscape.

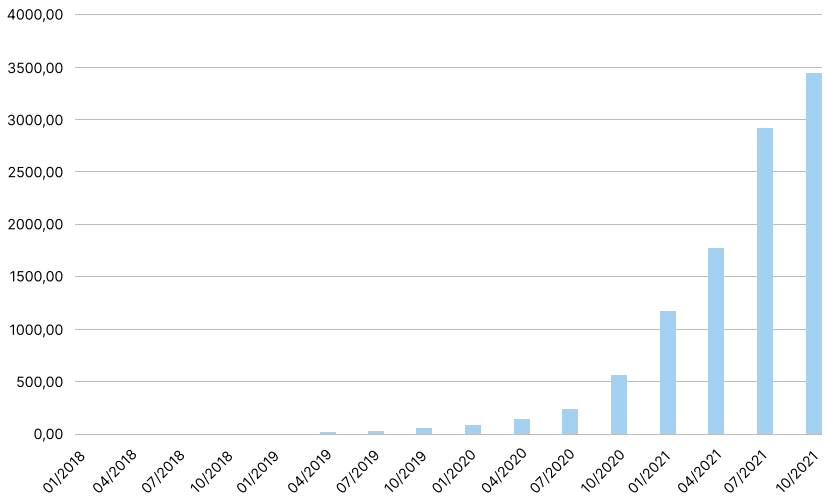
The goal of DeFi is to reimagine and improve upon traditional financial service models by using distributed ledger technology (blockchains), crypto assets, and the innovative concept of programmable money. While Bitcoin paved the way with the paradigm shift of distributed consensus—allowing for peer-to-peer transfer of value—the idea that really unlocked the full potential of DeFi came to fruition with Ethereum[1] and its smart contracts[2] platform: the ability to store and run software on blockchains.

[1] The Ethereum blockchain is a decentralized, open source, and distributed computing platform that enables the creation of smart contracts and decentralized applications (Dapps).
[2] Smart Contracts are automated (smart) sets of instructions (a contract) written in software, which executes automatically according to the instructions.

This new technology laid the ground for a new way to reach “agreements” in the digital world, replacing traditional financial intermediaries with software: self-executing smart contracts secured by blockchain technology. This allows innovators to reimagine everything from lending to trading and much more. As a natural consequence, it is now possible to envision a new financial architecture, where no geographical boundaries exist, everyone can access the same investment products, and capital is deployed much more efficiently.

DeFi dates back to 2017, but it wasn´t until early 2020 that these protocols gained traction. According to The Block and DeBank, the Total Value Locked (TVL) into DeFi protocols grew from less than $1 billion in June 2020 to over $100 billion in November 2021. The number of DeFi users has also skyrocketed in the same period, growing from 20,000 users in early 2020 to close to 3.5 million in October 2021. The increase in the number of users and TVL, which is an important measure of protocol liquidity and activity, indicates a potential inflection point in terms of adoption.

Figure 1: Evolution of the number of Decentralized Finance users *(thousands)*



Fonte: Messari

The goal of this report is to help investors better understand this emerging concept, by describing the main attributes of DeFi services and their infrastructure, while providing an overview of how to think of DeFi as an investment class.

Content Summary

New Ecosysyem DeFi is a new ecosystem of financial applications built on smart contract platforms, which can perform pre-established functions in a transparent and secure way without the need for intermediaries.

Incredibily Diverse The DeFi industry is incredibly diverse, offering a variety of opportunities to both users and developers. The broad range of applications is a direct result of blockchain platforms being an open ecosystem, in which accessibility, composability and interoperability are at their core.

Decentralized Technologies The value of decentralized technologies is directly related to their adoption rate and demand. DeFi protocols translate the utility they provide into economic value for holders of its native tokens.

Developing Rapidly While the DeFi space is developing rapidly, there are some challenges that will need to be addressed as DeFi solutions start to gain more adoption. These include scalability and energy usage issues, as well as relevant operational and regulatory risks.

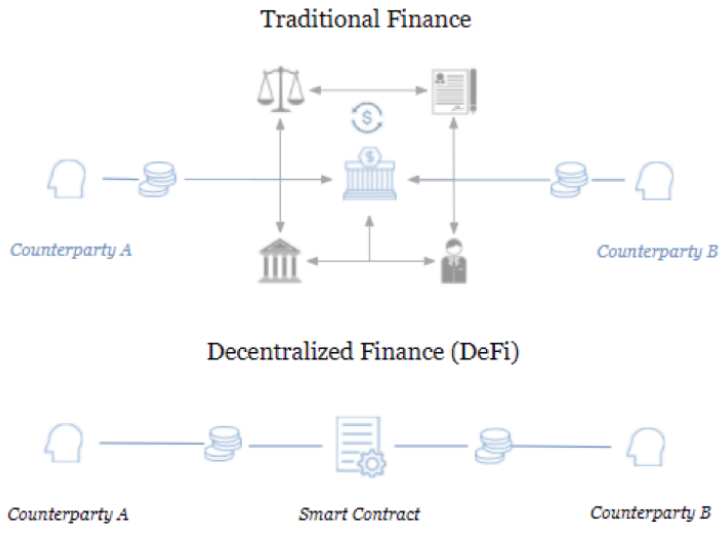
Proven Resilient Despite challenges and risks, the DeFi industry has proven resilient, attracting a strong and committed community of users, developers, and investors. Ultimately, DeFi has the potential to open up financial markets to millions of financially underserved individuals and institutions.

Part 1: What is Decentralized Finance (DeFi)?

DeFi is a new ecosystem of financial applications, developed using one of the major innovations of the crypto space: smart contract platforms. These are blockchains that introduce programmability: the ability to develop self-executing software which performs pre-established functions in a transparent and secure way, without the need of intermediaries.

By using open protocols[3] and decentralized[4] applications (DApps), all agreements are mediated and enforced by code (smart contracts); all transactions are executed in a secure, transparent, and verifiable way; and all operational changes occur on a public blockchain. This architecture creates an immutable and highly interoperable financial system with transparency, equal access rights, and little need for custodians, central clearing houses, or escrow services because most of these roles can be accomplished by smart contracts.

Figure 2: Diagram comparing Traditional Finance and Decentralized Finance



[3] Open protocol (or nonproprietary) is one that is not owned by any particular company and not limited to a particular company's products. (Investopedia)
[4] Decentralized applications are digital applications that run on a blockchain network of computers instead of relying on a single computer.

This industry gained a lot of traction in 2021 for a number of reasons: (i) it is incredibly accessible, as the distributed network overcomes barriers such as distance or location, (ii) transaction costs are minimized, with custodians or trusted third parties being no longer needed, and (iii) the constant pace of innovation allowed investors and users to allocate capital in new ways, having access to a diverse range of financial services.

The applications in DeFi range from traditional ones, such as sending money to a friend in another country, to innovative solutions for a variety of other use cases. Anyone in the world with an internet connection, a smartphone and a digital wallet can also lend and borrow funds, trade tokens, buy insurance, and manage and invest in digital assets. And it is just the beginning.

DeFi Characteristics

DeFi protocols are built with design properties that have led to an explosion of innovations in the use of money in the digital economy, unbundling financial services into "banking as an API[5]", much like the Internet and YouTube unbundled traditional cable TV packages. DeFi's design properties include:

Disintermediation Assets are locked into smart contracts on the blockchain where only the user can control the movement of funds unless certain conditions are met.

Permissionless and Borderless Consumers and developers can use the protocols regardless of ethnicity, gender, age, wealth or geographical location. All you need is an internet connection.

Composability and Modularity One of the most attractive features of DeFi is that protocols can be built on top of one another. Also, protocols can be disassembled and reassembled to form new products. This means that a multitude of DeFi applications ("Money Legos") can be connected in tandem to create unimaginable use cases and financial products.

[5] API stands for application programming interface and it is a feature in software development that enables companies to open up their application's data and functionality to external third-party developers, business partners and internal departments within their companies.

Autonomous	All functionality of DeFi protocols are codified on smart contracts which are validated and executed on public blockchains, leading to protocols that have the ability to deliver their services fully autonomously.
Open Source & Transparent	The software is always open source, the code is perpetually available for review, and everything is open for audit. All transactions are recorded on the blockchain and can be reviewed anytime.
Non-custodial	Assets are always held by the user or by smart contracts. Users are the only ones who hold the keys to their wallets and control their funds.
Uninterrupted Interoperability	Any user can move capital seamlessly and almost instantly between protocols, 24 hours per day, 7 days a week, usually with low fees.

A Brief History

DeFi Phase 1 (2008-2013)

The history of DeFi goes back to the creation of Bitcoin in 2008. At the time, this novel concept gave birth to the blockchain—a technology that allows for a decentralized, borderless and transnational transfer of value—enabling the development of the cryptocurrency ecosystem that is flourishing today.

DeFi Phase 2 (2013-2017)

It wasn´t until a few years later that new applications (other than peer-to-peer payments) started being developed. Building on Bitcoin´s innovation, Ethereum was launched in 2015, taking a crucial step forward: it was programmable. Ethereum allowed basically anyone, anywhere, to program logic into payments.

Payments are certainly one important piece of the financial system, but for a new system to be robust it demands much more: lending, borrowing, trading, investing, and many other alternatives. Ethereum's launch provided new possibilities: it gave birth to DeFi, and a flood of new applications started being developed around the world.

DeFi Phase 3 (2017-2020)

2017 marked the beginning of a boom in Initial Coin Offerings (ICO´s)[6]. Late in that year, Maker protocol was born, bringing the powerful concept of an algorithmic stablecoin—a crypto asset pegged to a less volatile asset, usually a fiat currency like the US Dollar or the Euro that uses an algorithmic approach to control the stablecoin supply. It was one of the pioneer projects in algorithmic stablecoin and proved to be one of the biggest catalysts for the DeFi ecosystem growth.

In the following years, several other DeFi projects were launched, bringing a diverse set of applications aimed at providing decentralized alternatives for financial services such as borrowing, lending, trading, and derivatives. Many of the current leading DeFi protocols, such as Uniswap and Aave, were launched in this period.

In early 2020, on what became known as Black Thursday, the price of Ethereum collapsed more than 30% in a single day due to widespread fear of the impact of the COVID-19 pandemic in the economy and markets. Surprisingly to some, this event, while severe, did not create any major disruptions for these protocols. The platform all transactions, liquidated all leveraged positions, and continued working around the clock. This shakeout strengthened the ecosystem and kicked off a new growth cycle ahead.

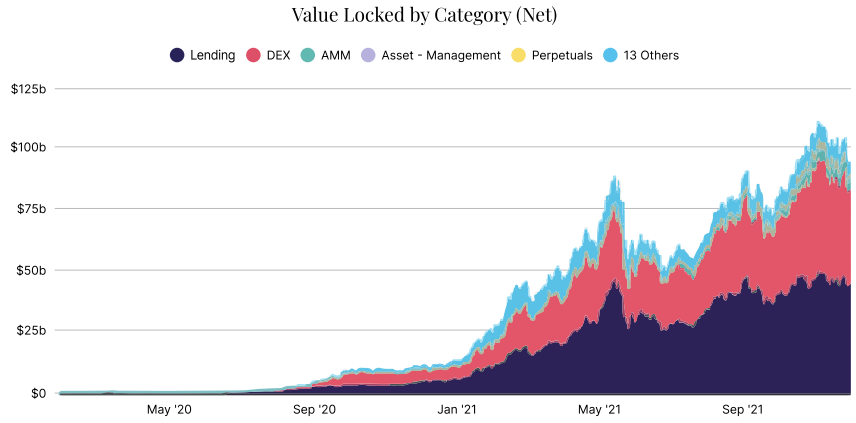
DeFi Phase 4 (2020 - today)

After the successful stress test at the beginning of the COVID-19 crisis, DeFi entered a new period of enthusiasm and continued the surge of new applications—the “DeFi summer”. Whether it was propelled by the change in habits caused by the lockdowns, which pushed people into the digital world, or the excess capital introduced into the economy to alleviate the impact of the crisis, DeFi went through exponential adoption growth.

DeFi protocols finally took off, growing more than 100X in terms of TVL from US$ 1 billion in June 2020, to US$ 15 billion in December 2020 and to more than US$100 billion in November 2021, as per the graph below. TVL’s increase over time represents growing confidence among users to place money in smart contracts and interact with new financial tools, a strong sign of adoption.

[6] An initial coin offering (ICO) is the cryptocurrency industry’s equivalent to an initial public offering (IPO). A company looking to raise money to create a new coin, app, or service launches an ICO as a way to raise funds. (Investopedia)

Figure 3: Gross Value Locked (TVL) in US Dollars - LTM for major DeFi Protocols



Source: The Block and DeBank

How does DeFi improve upon traditional finance?

Traditional finance has lagged other industries in the technology revolution. Several aspects of our daily lives have been tremendously impacted by technology improvements, but in finance this has not been the case. Although some countries have more innovative financial infrastructure (Brazil and India, for example), many developed countries still operate under systems and rules built for a different era.

Traditional banks, aiming to maintain market share in a mature industry, have been notoriously anti-competitive and reluctant to allow customers to share their information or integrate with other financial services providers. These practices have led to siloed banking systems and inefficient sharing of consumer financial data leading to limited credit access. This environment has held financial innovation back.

DeFi addresses some of these issues by recreating common financial services and instruments on a decentralized infrastructure. Below is a comparison of the main aspects involved in traditional finance and decentralized finance.

Figure 4: Comparison between Traditional Finance and Decentralized Finance

	Traditional Finance	Decentralized Finance
Custody of Assets	Held by a regulated service provider or custodian	Held directly by users in non-custodial wallets or via smart contracts
Units of Account	Denominated in fiat currencies	Denominated in digital assets or stablecoins (which can be also denominated in fiat currencies)
Execution	Via intermediaries	Via smart contracts
Clearing and Settlement	Via centralized service providers or clearing houses	Via writing transactions to the blockchain
Market Hours	5 days a week - 9am to 5pm	24 / 7 / 365
Governance	Specified by the rules of the service provider, marketplace, regulator and/or self-regulatory organization	Managed by protocol developers or determined by users holding tokens granting voting rights
Auditability	Authorized third-party audits of proprietary code	Open-source code and public ledger

	Traditional Finance	Decentralized Finance
Cross-service Interaction	Limited	Any protocol can integrate with other protocols on the same blockchain, and potentially across chains
Access and Privacy	Identity checks conducted by service providers	Identity verification requirements under discussion by anti-money laundering regulators
Security	Vulnerable to hacks and data breaches in software systems controlling the assets	Vulnerable to hacks and other technical and operational risks of smart contracts

Source: Inspired by Ethereum.org & DeFi Beyond the Hype - The Emerging World of Decentralized Finance

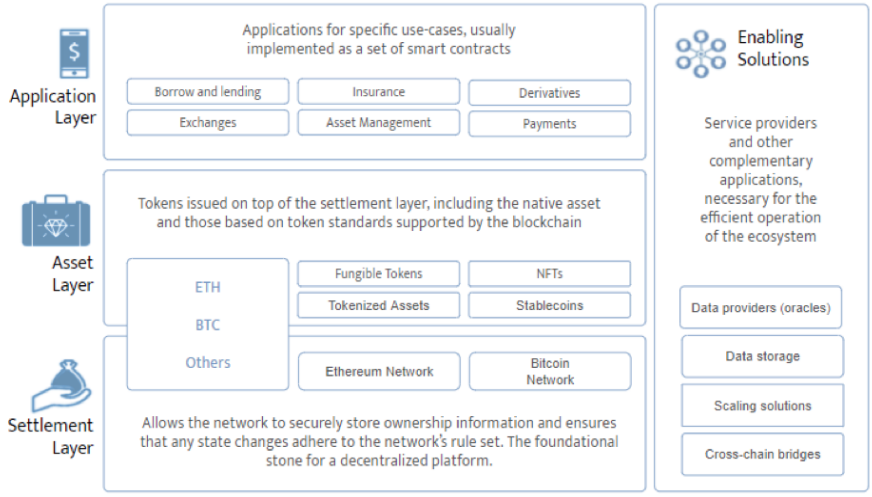
While these characteristics help broadly differentiate DeFi and traditional finance, it is important to understand DeFi's inner workings and how this new technology is built. The structure behind DeFi is an important investment consideration and also leads to a variety of opportunities and risks.

DeFi Architecture

DeFi operates on a multi-layered architecture, where every layer serves a distinct purpose. There are usually three main layers on programmable blockchains, such as Ethereum, with each one providing the basic infrastructure for the others to operate. This allows for an open and interoperable platform that anyone can build on, reuse, and adapt for their own needs.

Another key component is the set of service providers that work as facilitators for the DeFi applications. They can interact with most of the layers providing complementary functionalities, such as data storage or multi-chain integrations.

The diagram below illustrates the basic components of this architecture.



Source: Hashdex and BCG Platinion (https://www.linkedin.com/pulse/sudden-rise-defi-opportunities-risks-financial-igor-mikhalev)

Settlement layer

The original blockchain and its native digital asset where the DeFi protocol is built upon (BTC on the Bitcoin blockchain and ETH on the Ethereum blockchain, for example). This network stores all ownership information securely and ensures all operations are adherent to the defined set of rules of the protocol. It is the foundation for trustless and programmable execution and serves as a settlement and dispute resolution layer.

Application layer

Implements the rules and standards that provide functionality for specific use cases such as decentralized exchanges, debt markets, derivatives, and on-chain asset management. These standards are usually implemented as a set of smart contracts and can be accessed by any user (or DeFi application). The open nature of these protocols means they can work well together.

Asset layer

Consists of all the assets that are transacted on top of the settlement layer. This includes the native protocol asset as well as any additional assets that are transacted on the blockchain (e.g., ERC-20 tokens, tokenized assets or non-fungible tokens, among others).

Enabling solutions

Blockchain protocols that work as service providers, necessary for the efficient functioning of the ecosystem. It includes services of data storage, data transmission, interoperability facilitators, cross-chain bridges and scaling solutions. These are essential to the improvement of service levels and increasing the adoption of DeFi protocols.

Part 2: Main Verticals in DeFi

The DeFi industry is incredibly diverse, offering a variety of opportunities to both users and developers. Such a broad range of applications is a direct result of blockchain platforms as an open ecosystem, in which accessibility, composability, and interoperability are some of the major primitives.

Composability allows these protocols to work as “Money Legos”, being combined just like Lego blocks to create a whole new set of protocols that improve on their predecessors. Interoperability also allows developers to focus exclusively on the things that make their products special, without the need to “reinvent the wheel”. They do this by building upon common & open frameworks, where each existing protocol can be readily used and integrated.

As Chris Dixon (a general partner at the venture capital firm a16z and one of the most influential voices in the crypto space) once said: “Composability is to software as compounding interest is to finance”.

Given the paradigm shift that the DeFi infrastructure enables in terms of interoperability, programmability and composability, it is not surprising to see such a strong pace of innovations in the industry. These innovations are emerging in all the different sectors of the capital markets, bringing novel and more efficient solutions to how financial services operate.

Exchanges

Exchanges are one of the more well known DeFi services, allowing customers to trade one digital asset for another. There are two types of exchanges that interact with DeFi applications: centralized and decentralized.

Centralized exchanges (CEX) play a key role in the DeFi ecosystem, working as the on-ramp and off-ramp interface between traditional finance and decentralized finance. Centralized exchanges allow users to trade their fiat currencies for digital assets. But in contrast to decentralized exchanges, centralized venues take custody of traded assets and are responsible for brokering both the buy and sell side of the trade. This requires users to trust the operating authority to protect assets, provide accurate price information, match buyers and sellers, finalize and verify all transactions. Examples of centralized exchanges include: Binance, Coinbase, FTX, Gemini, Huobi Global and KuCoin.

Decentralized exchanges (DEX), on the other hand, replace trust-based functions with smart contracts, offering trustless, programmable and automated services. These self-executing contracts allow DeFi exchanges to automatically process transactions, either by connecting different parties or by allowing them to trade against a pool of liquid capital. Examples of decentralized exchanges include: Uniswap, Sushiswap, PancakeSwap and Balancer.

Although some DeFi exchanges still operate order books, the most popular model is a financial innovation known as Automated Market Maker (AMM). In this model, digital assets can be traded without permission and automatically by using liquidity pools instead of a traditional order books or market of buyers and sellers. Liquidity can be provided by any user in exchange for a portion of the transaction fees.

DeFi exchanges are not limited to spot markets. Futures and other types of derivatives contracts, such as options, are also traded on separate exchanges. They can also be coded and performed by smart contracts in decentralized exchanges such as Synthetix, dYdX and others.

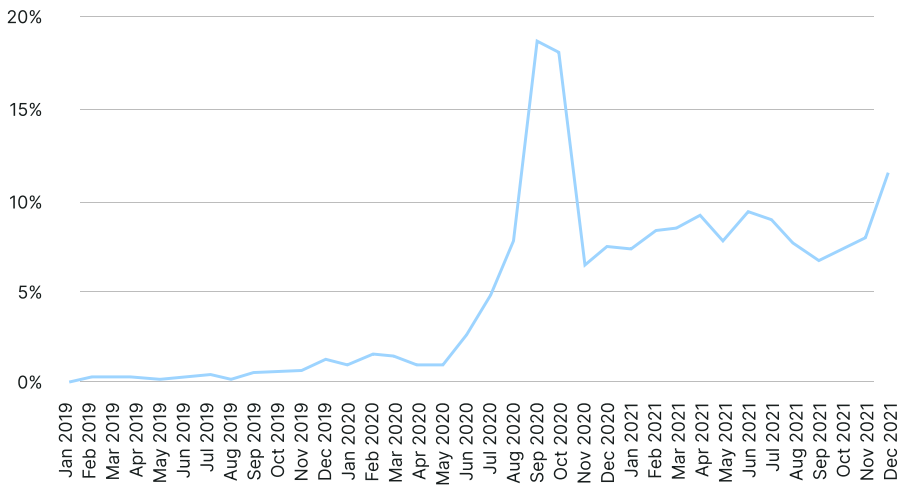
According to CoinMarketCap, there are currently about 440 spot exchanges (more than 300 centralized and more than 135 decentralized) and 30+ derivatives exchanges in crypto worldwide. Although regulation differs from country to country, this has not prevented an explosion of cryptocurrencies trading venues available to the public.

Figure 5: Comparison between Centralized and Decentralized Exchanges in Crypto

	Centralized Exchanges (CEX)	Decentralized Exchanges (DEX)
Privacy	Users share personal data with the exchange	Users only share their wallet address
Control of Assets / Funds	The exchange platform controls the funds and wallets with the asset/cryptocurrency	Users manage their own assets and cryptocurrency in their own wallet
Trade Execution	Through an intermediary exchange or related organization that clears the transaction	Through smart contracts without an intermediary
Market Making	Traditional Order Book	Automated Market Making (AMM) protocol
Regulation	Clearly defined regulation. A license is normally required	Limited regulations as trades are anonymous
Trading Hours	24 / 7 / 365	24 / 7 / 365

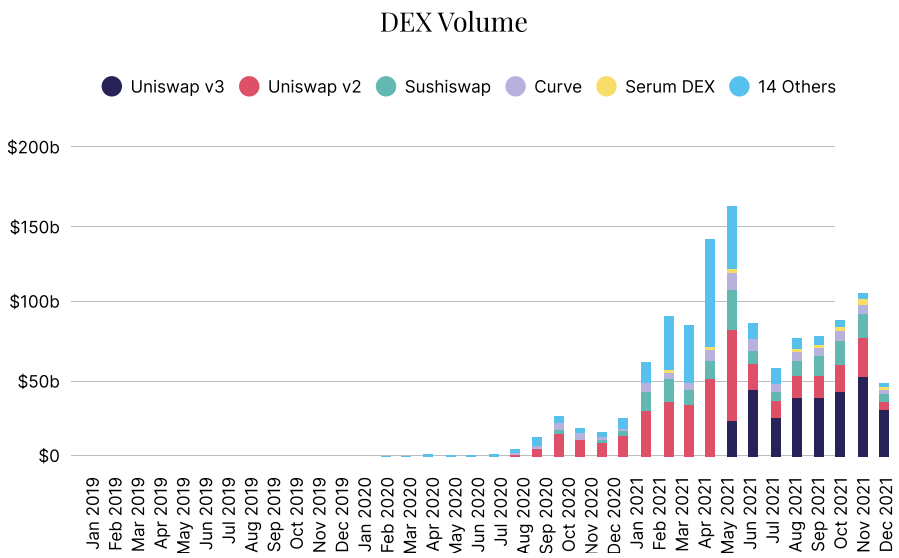
Centralized exchanges still dominate most of the volume traded in crypto but decentralized exchanges volumes have been increasing steadily and now account for roughly 10% of the total volume traded. As per the graph below, DEX volumes are on the rise and on track to move more than US$1 trillion on an annualized basis.

Figure 6: DEX to CEX Spot Trade Volume (%)



Source: The Block and ConGecko

Figure 7: Monthly Trading Volume - Main Decentralized Exchanges



Source: The Block and ConGecko

Uniswap is an Automated Market Maker on the Ethereum blockchain where trades are executed using liquidity pools (instead of order books) in which users deposit funds in exchange for interest. Currently, Uniswap is the largest decentralized exchange in the world, with a daily trading volume of around US$ 1.7 billion (US$ 600 billion annualized).

Lending and Borrowing

Lending and borrowing are essential parts of any financial ecosystem, as they provide a way to deploy capital in interest bearing instruments that can be used to finance many different endeavors, from new companies to leveraged trades.

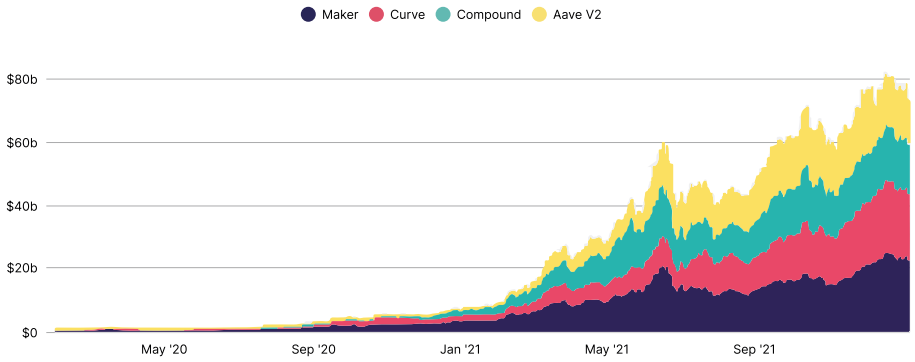
In traditional finance, banking institutions are primarily responsible for lending. Banks pay a small interest rate to depositors, whose assets form a pool of liquid capital the bank can then lend out in exchange for a higher interest rate from borrowers. In this system, they must carefully select borrowers and interest rates to account for defaults.

DeFi credit protocols operate with a different model. Pools of liquid capital are created and interest rates are paid directly from borrowers to lenders, with no need for banks as intermediaries.

Borrowers are typically required to collateralize their loans over 100%, ensuring against default. Additionally, due to price volatility of crypto assets, borrowers must monitor their collateralized assets to ensure they never drop below 100% of the borrowed value, or they will be automatically liquidated to repay the loan. Liquidity protocols like AAVE continuously monitor the health factor on the funds of their active users, the numeric representation of the safety of the deposited assets against the borrowed assets and its underlying value.

This allows all parties to maintain full custody of their assets and to liquidate the loan at any time. Overcollateralization also allows these platforms to offer loans without performing costly screening processes.

FIGURE 8: Top Lending Protocols by Total Value Locked



Source: The Block and DeBank

Compound is one of the leading decentralized lending & borrowing protocols on the Ethereum blockchain. It allows users to borrow and lend assets at algorithmically defined rates without any centralized third party. As of nov/2021, Compound has a market capitalization of US$ 1.75 billion, TVL of US$ 12.5 billion and has generated US$ 360 million in annualized revenues.

Stablecoins

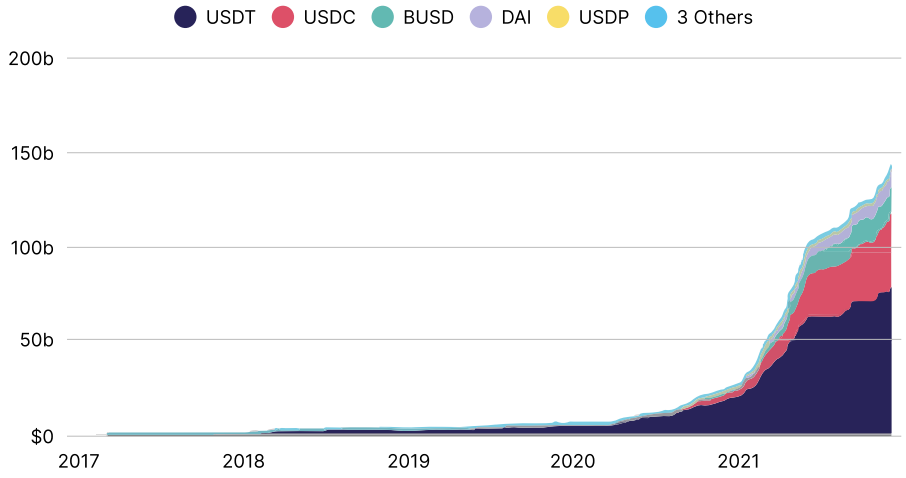
Stablecoins are digital assets that maintain a constant value relative to a more stable asset, usually fiat currencies. Their goal is to provide a cryptocurrency with all the benefits of programmable money, but without the high volatility that usually accompanies most crypto assets. There are two types of stablecoins: “custodial stablecoins” and “non-custodial stablecoins”.

Custodial stablecoins are backed by holding the pegged asset in reserve and are often used in DeFi platforms due to their lack of volatility. Non-custodial stablecoins don’t have that backing. Instead, they use smart contracts to assemble collateral via other cryptocurrencies or use algorithms to maintain a pegged rate by altering monetary supply. These two-types stablecoins are also described as “asset-backed” and “algorithmic,” respectively, and can be considered DeFi services themselves because they use an automated, trustless system. Both custodial and non-custodial stablecoins are incredibly important to the industry, since they provide additional asset volume without the associated volatility and risk.

Stablecoins, especially those pegged to fiat currencies such as the US Dollar or the Euro, are an essential component of DeFi protocols. In particular, USD Tether has gained substantial scale as a “vehicle currency” for investors who seek to trade in and out of crypto assets without having to exit crypto exchanges. This is a very important aspect of it. On the other hand, its growth has raised the attention of regulators across the world, as some see similarities between stablecoins and banks (i.e., they take deposits and promise immediate redemption). As a result, significant scrutiny is expected from regulators on stablecoins.

There is a strong and direct relationship between stablecoin supply and total value locked in DeFi protocols. As of late 2021, the major stablecoins (USDT by Tether, USDC by Circle and Coinbase, Binance USD, TerraUSD and Dai) reached almost US$150 billion in circulation.

Total Stablecoin Supply



Source: The Block and CoinMetrics

Stablecoins such as USD Tether and USD Coin (USDC) are normally backed by dollar reserves. **MakerDAO**, instead, accepts ETH as collateral to mint DAI, a stablecoin that is one of the most used stablecoins in DeFi. As of nov/21, there was approximately US$ 9.0 billion of DAI outstanding.

Asset Management

In traditional finance, asset managers assemble products such as hedge funds, mutual funds, private equity funds, and many other investment vehicles. These products usually have a variety of underlying assets including stocks, commodities, derivatives and bonds, all consolidated into a single portfolio that is distributed to clients.

In DeFi, these underlying assets consist of digital assets such as cryptocurrencies, tokenized real-world assets, stablecoins and interest-bearing crypto assets. DeFi asset management protocols combine them into “vaults” or “pools”, which function as a diversified portfolio of digital assets managed by predetermined rules programmed on smart contracts. Similar to traditional finance, clients can buy into these asset vaults through a variety of protocols or brokers. The boundaries between asset classes and package types, as well as typical business models for these services, are still under development.

Yearn Finance is an asset management protocol built on the Ethereum blockchain which is an aggregator service for DeFi investors, using automation to allow them to maximize profits from different liquidity pools. As of nov/21, Yearn Finance had a market cap of US$ 1.1 billion, total value locked of $6.0 billion and generated annualized total revenues of US$ 260 million.

Derivatives

Synthetic assets are instruments whose value is based on the performance of underlying assets or bundles. Examples include futures and options. A derivative could be based on the value of a stock, a digital asset, a commodity, a real world event, or cash flow of a venture. In DeFi, derivative services operate similarly to traditional finance, with the exception of a trustless system (no intermediaries) and a diverse basket of digital and traditional assets. DeFi derivative protocols connect traders directly and are backed by large liquidity pools provided by users (similar to the lending & borrowing model). These protocols allow users to buy and sell exposure to digital assets, without actually holding them.

Synthetix is a DeFi application on the Ethereum network that provides on-chain exposure to a wide variety of crypto and non-crypto assets via a derivatives liquidity protocol. As of nov/21, Synthetix had a market capitalization of US$ 880 million, total value locked of US$ 1.7 billion and generated US$ 16.4 million in total revenues.

Part 3: DeFi as an investment

Why do DeFi and other crypto assets have value?

Blockchains and crypto assets are the cornerstones of a new digital economy that can deeply change the way we transact and do business. Drawing a parallel with the traditional economy, we can think of each blockchain ecosystem as a "digital nation": For someone to buy goods and services in that nation, they must use the nation's native currency. For example, just as we must use dollars in the USA, we must use ETH in the Ethereum ecosystem. The success of this economy is directly tied to the success of everything that is built inside its borders.

In this new digital economy, the most diverse applications can be built. The possibilities have proven to be numerous, including the development of a peer-to-peer digital monetary system (e.g., Bitcoin), a decentralized financial system (DeFi), a number of decentralized marketplaces (for digital or tokenized assets[7]), and the infrastructure for a more equitable creative economy (art, games and NFTs[8]).

Each of these areas creates value in different ways, and the value of their respective crypto assets (tokens) is directly associated with the services they provide, the problem they solve, the value they generate for their users, and the network effects[9] they accrue to the network.

In practice, the value of decentralized technologies is directly related to the adoption and demand for their use—the more a given application is used, the greater the value of the underlying platform (settlement/asset layers) and the greater the value of its token (application layer), which enables its operation and may have several other specific functions, some of which are described below:

[7] More on tokenized assets in the next chapter
[8] NFT stands for non-fungible token. It is a unique and non-interchangeable unit of data stored on a blockchain. For example, a bitcoin is fungible - trade one for another bitcoin and you have exactly the same thing. A piece of art, in turn, cannot be traded for another piece of art - you would have something completely different.
[9] The network effect is a phenomenon whereby increased numbers of participants improve the value of a good or service. The Internet is an example of the network effect. Initially, there were few users on the Internet since it was of little value to anyone outside of the military and some research scientists. (Investopedia)

Utility Tokens are often used as the "fuel" needed to run any service on a given protocol. The greater the use of the protocol, the greater the demand for the token.

Governance Protocols may require tokens for governance voting (the crypto equivalent to a voting share), used to determine a project's strategic direction.

Income Some protocols have revenue generation and distribution mechanisms, some inspired by traditional equities. For instance, they may charge user fees, potentially distributed to token holders (cash dividends) or to "burn" token supply (token buyback).

Security In protocols with the Proof-of-Stake[10] consensus mechanism[11], the security of transactions is guaranteed by validators who are compensated in proportion to the share of tokens they own.

As a result of the expanding adoption and demand for DeFi protocols, they are able to translate the utility they provide to users into economic value for token holders.

[10] The Proof-of-Stake concept states that a person can mine or validate block transactions according to how many coins they hold. This means that the more coins owned by a miner, the more mining power they have. (Investopedia)
[11] A consensus mechanism is a fault-tolerant mechanism that is used in computer and blockchain systems to achieve the necessary agreement on a single data value or a single state of the network among distributed processes or multi-agent systems, such as with cryptocurrencies. It is useful in record-keeping, among other things. (Investopedia)

Size of the Opportunity

Nowadays, financial services are an essential part of our everyday lives. We use them to send money to relatives or friends, to take a loan to pay for an unforeseen event, or to move money between investments in the pursuit of higher yields. With the foundations of crypto maturing and becoming ready to absorb the growing demand for on-chain financial services, DeFi will probably act as one of the most important drivers for crypto adoption.

DeFi will also greatly benefit from the growth of the overall crypto space, as different use cases, such as Web 3.0[12], gaming and digital art flourish. More crypto activity means more liquidity, more asset turnover, and more demand for financial products. Therefore, the more crypto gets adopted in general, the better it is for DeFi applications.

Although the sector has gained a lot of traction in the past few years, with exponential TVL and user base growth, this is still DeFi's early stages. With its paradigm shifting infrastructure, DeFi tries to address the inefficiencies of one of the largest addressable markets in the world, one that is known for not being very efficient and client-centric. It may not be an exaggeration to say that DeFi is one of the largest opportunities in the crypto space.

As DeFi continues to envolve, with innovative protocols being continuously developed and a growing number of use cases, the DeFi ecosystem is positioned for sustainable growth in the coming years. The purpose of this section is to illustrate some of the most promising avenues for the expansion of this vibrant ecosystem.

Product-market fit

Several DeFi protocols have developed use cases that satisfy real user demand and are getting strong adoption by the market. For example, lending and borrowing protocols such as Aave and Compound, and decentralized exchanges, such as Uniswap, are gaining tremendous adoption with innovative solutions, which have amassed more than US$100 billion in TVL and more than 3 million users.

[12] What Is Web 3.0 & Why It Matters

DeFi market share across the entire crypto space

DeFi protocols are only a small fraction of the market capitalization attributed to all digital assets: US$85 billion of $2.1 trillion, or around 4% of total market capitalization. As a reference, depending on the level of financial development of each country, financial services can represent from 10% to 20% of a country's total equities market size.

Potential to gain share over traditional finance

While Bitcoin initiated an era of an internet-native financial system infrastructure, DeFi is building on top of this infrastructure for most of the traditional financial services. A few relevant metrics to compare:

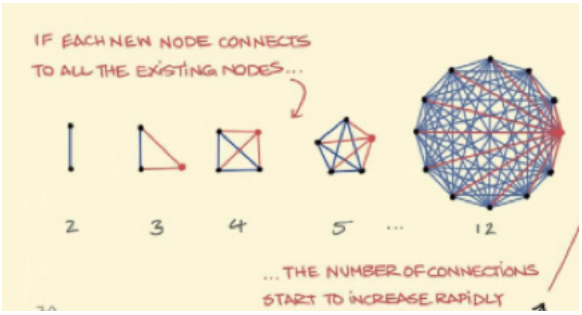
- DeFi compared to Traditional Finance Market Cap[13]: US$ 85 billion in DeFi Protocols versus US$ 8.5 trillion in Global Financial Sector Companies.
- Exchanges Global Daily Trading Volume[14]: DEXes ~US$ 3 billion versus CEXes ~US$ 40 billion and Equities Exchanges ~US$ 570 billion.
- Debt Markets[15]: Total Value Locked in Lending Protocols of ~US$ 50 billion versus Total Value of Global Debt Securities Markets of ~US$ 138 trillion.

Network effects

The theory shows that networks benefit from scale, with their value usually growing exponentially with the number of its members. MetCalfe's Law[16], for instance, states that the value of a network grows in proportion to the square of the number of participants. As crypto assets are starting to be seen as the global network of money, market participants are increasingly considering network effects on their analysis.

[13] Source: Coinmarketcap.com for crypto and Statista.com - Market capitalization of the banking market worldwide from 1st quarter 2016 to 3rd quarter 2021 for traditional finance.
[14] Source: The Block and Coingecko for crypto statistics and Statista.com - Value of global equity trading worldwide from 1st quarter 2017 to 2nd quarter 2021
[15] Source: The Block for crypto statistics and Bank for International Settlements - Debt securities statistics - Table B1-S.
[16] Metcalfe's Law is basically a theory used in computer and telecommunication networks to represent the value of a network and it states that the value of a telecommunications network is proportional to the square of the number of connected users of the system. It is worth noting that Metcalfe's Law is merely a simple statistical & theoretical interpretation for thinking about the value of a network.

Figure 9: MetCalfe's Law graphic representation



To get a sense of adoption, the crypto user base reached 220 million worldwide in July 21 versus roughly 75 million users just one year earlier, while DeFi the user base reached close to 3 million users in July 2021 versus roughly 100 thousand in July 2020.

Revenue generation

Unlike Bitcoin and other commodity-like crypto assets — which have no expected future cash flows — most DeFi protocols generate revenue by charging a fee for the activity on their platforms. In most cases, a portion of these fees accrue to the token holders directly in the form of dividends or through token "burns" (similar to buybacks).

Major DeFi protocols are currently generating more than US$ 3.8 billion in annualized revenues, with a growth trajectory also worth noting: monthly revenues as of November 2021 were approaching US$ 320 million, an increase of 6.4x if compared to a year prior, when it was close to US$ 50 million (US$ 600 million annualized).

Also, as some DeFi protocols are revenue generating entities, they may be analyzed through the lens of traditional financial metrics, such as price-to-sales or price-to-earnings ratios. They also allow for the more traditional valuation toolkit, such as the discounted cash flow model or dividend discount model.

17 Source: Crypto.com - Measuring Global Crypto Users - July 2021

Figure 10: Example of financial analysis of a DeFi protocol using multiples

Uniswap Quick Valuation

UNI Price (US$) - Nov/21	21,00
Current Circulating Supply	627.936.759
Max Supply	1.000.000.000
Current Market Cap	13.186.671.936
Fully Diluted Market Cap	21.000.000.000
Total Value Locked (TVL) - Nov/21	8.810.000.000
Nov/21 Revenues - US$	184.000.000
Annualized Revenues - US$	2.208.000.000

	Current Supply	Max Supply
Market Cap / TVL	1,5x	2,4x
Market Cap / Revenue (Annualized)	6,0x	9,5x

Source: The Block and CoinMarket.com

Asset Tokenization

Asset tokenization is another novel concept that has the power to reshape the way the financial industry thinks about financial transactions. Tokenization is the process of turning an asset—either real or virtual—into a digital token, enabling the digital transfer, ownership and storage of the asset without a central third party or intermediary. Technically, it is the process of converting ownership rights into purely digital representations that can be subdivided, traded, and stored on a blockchain.

The spectrum of assets that can be tokenized is ample. Because tokenization is a digital representation, not the asset itself, in theory anything can be tokenized: fungible and non-fungible assets; fine art and collectibles; precious metals like gold, silver and diamonds; or real assets such as residential or commercial real estate. More traditional intangible financial assets such as stocks, bonds, and funds can also be tokenized. The addressable market is vast.

The benefits of tokenization are clearly very appealing. They include: (i) fractional ownership — a real asset with a high price per unit (e.g., fine art or real estate) could have its value fractionalized, making it more accessible; (ii) added market liquidity — as value is fractionalized, the expected liquidity of these assets should improve considerably, with the added potential of fine-tuning asset price discovery; (iii) programmability — smart contracts built into tokens that can help automate the execution of complex transactions and can even help with compliance processes such as Anti-Money Laundering (AML), Know Your Customer (KYC) and Counter Terrorism Financing (CTF); and (iv) the more common but not less important aspects of crypto assets such as enhanced trust and accessibility.

As a nascent technology, there are still several areas of development needed for DeFi to gain mainstream adoption. Specifically, in the case of real world assets such as real estate or fine art, a solid infrastructure (authentication procedures, storage, transportation, legal validation) is necessary to bridge the gap between the physical and the digital world. Legal, regulatory, and compliance requirements must also be addressed to establish global standards across different jurisdictions.

However, the possibilities with tokenization are endless. One can imagine a hypothetical world where a retail investor trades an illiquid position in a private equity backed company in the US for a piece of commercial real estate in Canada without the use of intermediaries using blockchain technology. It seems distant, but it is a glimpse of what this technology may make possible shortly.

Tokenization is therefore one of the most promising DeFi opportunities. Its target market can encompass the largest asset classes on the planet, such as equities, bonds, and real estate. To get an idea of the size of the opportunity: the global equities market capitalization is close to US$125 trillion, the global bond market capitalization is US$130 trillion, and the Global Real Estate Market (Commercial Real Estate + Residential Real Estate + Agricultural Land) is another US$100+ trillion market. These are massive addressable markets that could be tokenized and traded 24/7 without intermediaries. A modest 1% of these markets being tokenized would already represent a massive upside for the whole DeFi sector.

Part 4: Challanges and Risks

Challenges

Although the pace of innovation is breathtaking and the DeFi space is developing rapidly on several fronts, there are challenges to be addressed as DeFi solutions start to gain more adoption and scale up.

Scale and costs - Scalability, throughput and transaction fees for blockchain settlement platforms are significant limiting factors.

Limited interoperability - DeFi protocols still have limited interoperability across blockchains and with traditional financial services (on-ramps and off-ramps to fiat currencies).

Energy usage - Depending on the consensus mechanism (especially with proof-of-work), energy usage raises concerns about its contribution to climate change.

Privacy concerns - Privacy considerations may be in tension with transaction transparency.

Governance - In some cases, immature governance can be an issue as high-stakes decisions are made by small and sometimes inexperienced teams. Hidden centralization of control and low thresholds for governance rights may give certain actors disproportionate power in certain protocols.

Compliance - Applying national legal requirements such as KYC, AML and CTF to decentralized global networks could prove challenging. Financial intermediaries enforce these rules today and the absence of them in DeFi (by definition) poses a considerable challenge for regulators worldwide.

Infrastructure design - Poor infrastructure design choices and implementations can potentially lead to significant losses.

Risks

This section provides a list of the main risks of DeFi protocols, split into four categories. This section was written with the support of the comprehensive report issued by the World Economic Forum, “Decentralized Finance (DeFi) Policy-Maker Toolkit”.

Financial Risks

Definition: A depletion of funds due to the transactional behavior of fellow digital asset users in the DeFi service.

Market Risk - The possibility that the asset value will decline over time due to market conditions, new information and trading patterns.

Counterparty risk - The possibility that a counterparty will default on its obligations. This can be failing to repay a loan (credit risk) or failing to settle a transaction by providing the specified asset (settlement risk).

Liquidity Risk - The possibility that there will be insufficient funds or assets available to realize the value of a financial asset.

Technical Risks

Definition: Failures of the software systems supporting transaction execution, pricing and integrity.

Transaction risks - Limitations or any type of failures of the underlying blockchain network.

Miner risk - The possibility that transaction processing entities behave maliciously towards certain transactions.

Composability Risk - Although this is one of the most exciting features of DeFi protocols, there is the possibility that risks can cascade down as each subsequent building block of software inherits the risk of the underlying blocks.

Smart contract risks - Code that does not execute as intended, such as a programming flaw that can lead to funds being hacked.

Oracle risk - Involves the potential that data external to the blockchain on which a DeFi contract relies is inaccurate or has been manipulated.

Operational Risks

Definition: Failures of the human systems for key management, protocol development, or governance. Although DeFi protocols are highly automated, human operators still play a crucial role.

Public and private key management - Can be a potential problem for all blockchain-based systems. A mismanagement of public and private keys can cause irreversible problems for the protocol and for token holders.

Governance mechanisms - Token concentration, wrong incentives, lack of transparency among token holders, low participation rates in voting processes, activist investing, centralized exchanges taking advantage of the voting power of tokens in their custody to exert undue influence on protocols and even bribe among token holders can have consequential impacts on any given protocol´s functioning.

Legal, Compliance and Other Risks

Definition: The use of DeFi to engage in illicit activity or to evade regulatory obligations.

Financial crimes- Involve breaches of AML and/or CFT restrictions, financial sanctions and similar legal regimes.

Fraud and market manipulation - Involves deliberate scams, misappropriation and other efforts to take advantage of investors.

Regulatory Risks

- Overall regulatory environment for DeFi is still very uncertain. Financial services are highly regulated activities everywhere. Banks, broker-dealers, exchanges, clearing houses, and custodians are regulated by different regulatory bodies and must comply with complicated regulations. There is the risk of unfair regulation, overregulation, or asymmetric regulation.
- DeFi protocols can be deemed securities. Stablecoins can be considered money market instruments and could be compared to bank deposits. Crypto derivatives exchanges could face harsher regulatory oversight.
- All these options are currently being considered by officials and poorly designed regulation can have lasting consequences for the ecosystem.

Part 5: Conclusion

Decentralized Finance is a diverse and growing sector with a large market potential. The industry is experiencing massive growth, with the total value locked in DeFi protocols reaching more than US$ 100 billion and its user base growth showing consistent signs of adoption. This results from a combination of a powerful technological innovation with a diverse range of services offered.

Additionally, DeFi is an interconnected and interdependent industry that benefits directly from further developments in the crypto ecosystem itself. Although crypto already has a considerable size as an asset class, it is still in its early stages, with institutional investors just starting to gain exposure. As an example, investment vehicles that provide regulated access to crypto, such as ETFs, are yet to be approved in most of the developed world.

Nevertheless, this scenario is gradually changing, and a growing number of corporations, endowments, sovereign wealth funds and pension funds are increasingly considering crypto for their portfolios. Venture capital funding to the industry, for example, has reached US$ 25.1 billion in 2021 alone (8x larger than in 2020), while M&A activity reached its all-time high in 2021 as well. That is a good indication of the flourishing of a new asset class.

Despite the many challenges and risks, the industry has proven to be very resilient. It is standing the test of time and continues to improve and adapt in response to global challenges. Blockchain bottlenecks such as scalability and transaction cost are being addressed by a variety of market participants, while security and regulatory concerns are scrutinized by crypto institutions in collaboration with government organizations. As DeFi builds momentum, government oversight initiatives will increase, but it seems very unlikely that DeFi will be regulated out of existence.

By proving itself as a viable and growing industry, DeFi has attracted a strong and committed core of users, investors, and developers, all eager to take advantage of the opportunities ahead, both to profit and to change the financial landscape for the better. The potential in front of us is tremendous, and DeFi has a chance to disrupt one of the largest markets in the world at the same time that it opens it up for millions of financially underserved people, completely transforming the way societies utilize financial services.

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