CAPCO

DEFI EXPLAINED

DECENTRALIZED LENDING AND BORROWING

IN COOPERATION WITH

ABC RESEARCH

Austrian Blockchain Center

a **wipro** company

EXECUTIVE SUMMARY

Decentralized finance (DeFi) remains the subject of considerable interest and debate in the financial services industry. At its core, it is characterized by decentralized applications (DApps) replicating financial services in the form of programmable code.

DeFi lending and borrowing is a rapidly growing sector within the DeFi domain that offers an alternative to traditional lending. DeFi lending relies on smart contracts to automate the lending process, removing the need for intermediaries like banks or rating agencies. The DeFi lending market size has grown rapidly in recent years. According to DefiLlama, the total value locked in DeFi lending protocols was almost $55 billion as of May 2023.[1]

DeFi lending applications can be categorized into two main types based on the workings of their smart contracts and user intentions: lending pools (LPs) and collateralized debt positions (CDPs). Lending pools are made up of funds from lenders that are deposited into a smart contract. Borrowers can then borrow funds from the pool by pledging collateral and paying interest on their loans. Loans offered via lending pools are usually overcollateralized. Loans from CDPs need to be secured via collateral as well, typically in the form of cryptocurrencies. However, CDPs issue new tokens, mostly stablecoins (e.g., DAI in MakerDAO), that are freshly minted and lent to the borrower by the protocol.

In this paper, written in close collaboration with the Vienna-based research institution – Austrian Blockchain Center (ABC), we describe the design and specifics of widely used lending pool solutions. Together with our scientific partner ABC, we also look at important differences between DeFi and traditional lending, such as indefinite loan maturity, the liquidation process in the event of a default and the determination of interest rates based on the utilization of the pool. These differences should be thoroughly understood to ensure the mitigation of the inherent risks of DeFi lending solutions in practice.

Tapping into global liquidity sources and the promise of additional interest income are just two benefits for banks looking to explore DeFi lending. First real-world examples already demonstrate the opportunities that DeFi lending offers for banks. Partnerships with DeFi lending platforms may be a viable option for financial institutions to test the waters and provide an opportunity for learning in terms of know-how and experience. Close dialogue with regulators and supervisors in the design phase of use cases is advisable, since most jurisdications still lack clear regulations for DeFi.

1. Data obtained from defillama.com on May 11th, 2023

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1. DECENTRALIZED FINANCE: A NEW AREA OF FINANCIAL SERVICES?

1.1 The idea of decentralized finance

Decentralized finance (DeFi) is a new approach to providing financial products and services without traditional financial services providers. In DeFi, financial institutions are replaced by automated business logic residing on blockchains. The term DeFi is used rather broadly to describe the decentralized applications (DApps) providing the necessary business logic for transactions as well as the underlying blockchain networks and digital assets. The combination of decentralized, smart-contract-based business solutions with a blockchain-based settlement layer facilitates the creation of financial services in a decentralized way.

The automated software solutions at the core of DeFi are so-called smart contracts. In contrast to what their name implies, smart contracts are neither smart, nor are they contracts in a legal sense. Rather, smart contracts are simply executable code stored on Layer-1 blockchain protocols like Ethereum (see section 1.2 for more details on Layer-1 blockchains). These small software applications are used to automatically execute business logic or rules written in the code. If the conditions of the smart contract are fulfilled, the code will self-execute its set of instructions without the need for a centralized institution (such as a bank) to act as an intermediary. Functional roles of trusted third parties such as brokerage firms, banks, and others are replaced. In this sense, DeFi (similar to other use cases based on distributed ledger technology or DLT) seeks to disintermediate and decentralize the traditional financial services industry.

As such DeFi can be distinguished not only from traditional financial solutions (TradFi), but also from so-called centralized finance (CeFi) which comprises blockchain-based financial services provided by central intermediaries.

There is already a broad range of financial services or products available in the DeFi space including trading, lending, investing, deposits, and payments services (see Figure 1). Furthermore, decentralized applications are highly modular and interoperable. This means that they can usually be combined to create new applications.

	Traditional Finance (TradFi)	Centralized Finance (CeFi)	Decentralized Finance (DeFi)
TRADING	Exchanges / Brokers (e. g. Xetra)	Crypto Exchanges (e. g. Binance)	Decentralized Exchange (e. g. UNISWAP)
LENDING	Secured and Unsecured (e. g. Term Loans)	Lending Platforms (e. g. Nexo)	Lending Protocols (e. g. AAVE)
INVESTING	Investment Funds (e. g. ETFs)	Crypto Funds (e. g. Grayscale)	Decentralized Asset Mgmt. (e. g. Set)
DEPOSITS	Savings Account (e. g. Commercial Banks)	Staking Pool (e. g. Coinbase)	dStaking Services (e. g. COSMOS)
PAYMENTS	Payment Platforms (e. g. SEPA, T2)	Centralized Stablecoins (e. g. USDC)	DeFi Stablecoins (e. g. DAI)

Figure 1: Main financial services categories in traditional finance, centralized finance and decentralized finance.

Since their conception around 2017, DeFi solutions have rapidly gained traction. Money actively used in DeFi solutions rose from slightly more than $600 million as measured by total value locked (TVL)[2] at the end of 2019 to almost $55 billion as of May 2023, registering peak values of more than $213 billion in December 2021. As can be seen from these numbers, the value deposited in DeFi solutions has come down significantly over the past few months. This development is in line with falling prices of cryptocurrencies such as Bitcoin and reduced interest in the DeFi space, due to high profile public scandals like the collapse of Terra/Luna and the FTX fraud. However, despite the recent fall, a longer-term perspective shows the massive increase in interest that DeFi solutions have attracted.

DeFi's rise in popularity can be partly explained by real and perceived structural issues with the financial services industry. DeFi arose out of a desire to free financial services from the control of centralized institutions and governments, thereby providing financial inclusion for more people. Proponents of DeFi argue that traditional financial services are dominated by large institutions and often characterized by tightly controlled access, leading to organically grown inefficiencies, high and opaque fees as well as financial exclusion. In addition, they point to the high level of regulation fostering an environment that is generally hostile to disruptive technologies or innovative business models.

While some industry commentators have cast doubt on the sustainability of fully decentralized financial services, others believe that DeFi has real potential as a disruptor of traditional financial services markets.

2. Total Value Locked (TVL) is a metric commonly used to estimate the size of the DeFi market. It represents the value of assets being deposited in the smart contract of a DeFi solution. Similar to, for example, market capitalization in traditional equity markets, TVL can be used to gauge the size of and public interest in a DeFi solution.

1.2 Technical foundation of decentralized finance

As outlined in our previous paper on decentralized exchanges[3], understanding the different layers of technology used for DeFi applications helps establish a mental map that is useful for analyzing and evaluating specific DeFi implementations (Figure 2).

Protocol, asset, and settlement layers form the core of the DeFi technology stack. The protocol layer consists of DeFi applications that offer some sort of financial services functionality such as trading or lending. The asset layer defines which digital assets can be processed by a DeFi application. It is important to keep in mind that normally a specific DeFi application is offering its services for only a few specific digital assets such as one fungible token or a pair of fungible tokens. Finally, the settlement layer forms the underlying infrastructure. Simply put, DeFi applications as well as digital assets normally reside on Layer-1 protocols (e.g., Ethereum). This Layer-1 protocol is of crucial importance, as it represents the execution and settlement layer for any transactions.

In addition to these core layers, three additional layers can play a role. First, at the bottom of the stack, the interoperability layer allows different settlement layers to directly communicate with each other. It can be used to allow DeFi applications to incorporate different Layer-1 protocols into their functionality. At the top of the stack, an application layer normally provides user interfaces. Finally, an aggregation layer allows to aggregate the functionality of multiple DeFi applications.

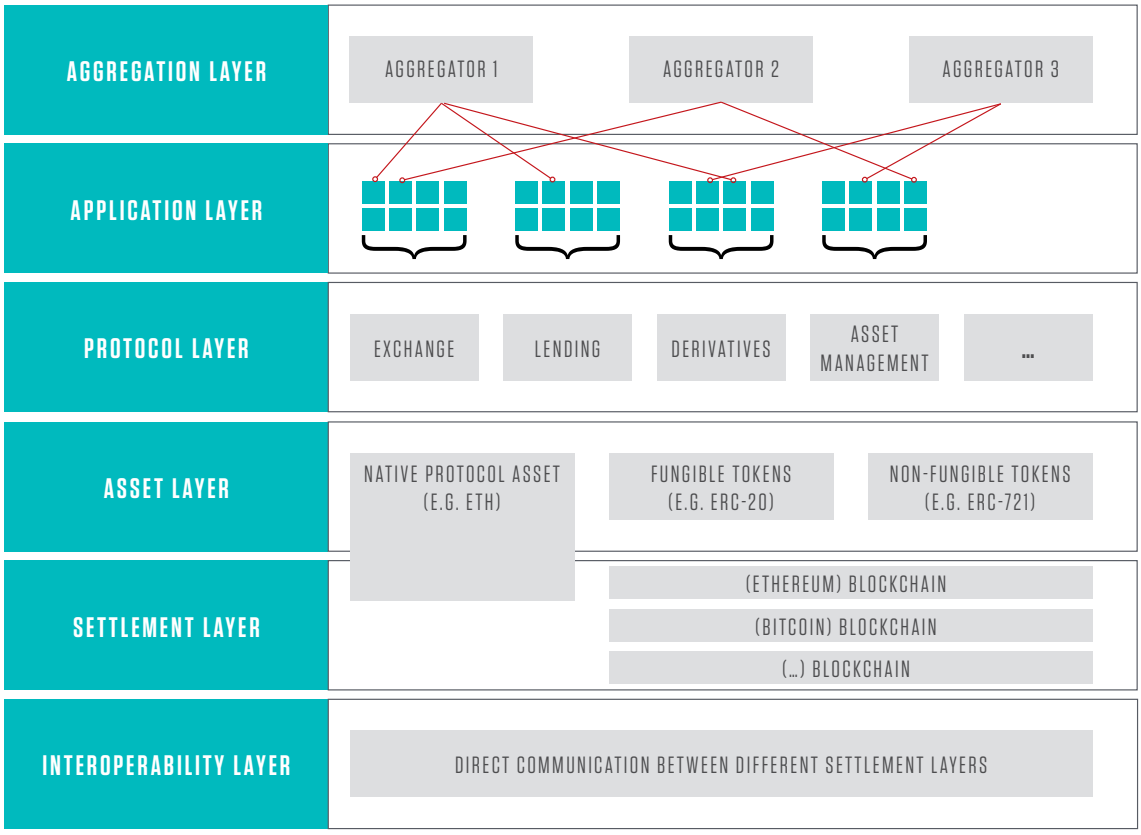

Figure 2: The DeFi Stack (based on IOSCO 2022 and Schär 2021)

3. Treytl, V., Steiner, J.-M., Bhaumik, A., & Hessenberger, G. (2022). DEFI Explained: The Case of Decentralized Exchanges (DEFI Explained) [White Paper]. Capco - The Capital Markets Company.

2. DECENTRALIZED LENDING AND BORROWING

The DeFi ecosystem is a fast-growing industry deploying new solutions on a continuous basis. One of the most promising areas is decentralized lending and borrowing. On the one hand, DeFi lending and borrowing solutions enable lenders to earn interest on otherwise non-interest-bearing digital assets. On the other hand, these solutions enable investors to borrow digital assets against some collateral for various purposes. Like in other DeFi sectors, blockchain-based smart contracts replace traditional financial services providers (see Figure 3).

While other DeFi sectors such as exchange and trading services try to mimic the solutions from traditional finance rather closely, DeFi lending and borrowing comes with important differences when compared to traditional loan solutions or credit markets. It is crucial to keep these differences, described below, in mind when analyzing DeFi solutions.

Loan maturity: While in traditional loans, the length of time until which a loan must be fully repaid is usually set in advance, decentralized loans ususally have unlimited maturities. In almost all cases, there is no maximum or minimum length to the loan term, and funds can be borrowed for an indefinite duration of time, as long as there is sufficient collateral. Additionally, funds can be repaid fully or partially at any time, allowing borrowers to rebalance their positions. This is especially important during times of high volatility.

Interest rates: While traditional credit products have either fixed or variable interest rates, in decentralized finance interest rates are based on algorithms that are meant to stimulate borrowers to repay the loan in times of high utilization of the DeFi solution (find more details on DeFi interest rates in 2.4.3).

Credit risk and risk assessments: Financial intermediaries, such as banks, usually check credit risks before lending funds, and conduct stringent risk assessments before granting a loan. In DeFi solutions, the role of the bank is performed by a smart contract that conceptually only serves as an agent without actually taking credit risk. Furthermore, DeFi lending solutions do not conduct credit risk evaluations, but rather use collateral as a risk management tool.

Defaults and liquidation: When a borrower fails to repay a loan according to the initial agreement, the loan is considered defaulted. After this, the lender will start the procedure to recover the remaining amount. Like loan provisioning processes, these recovery steps are also automated.

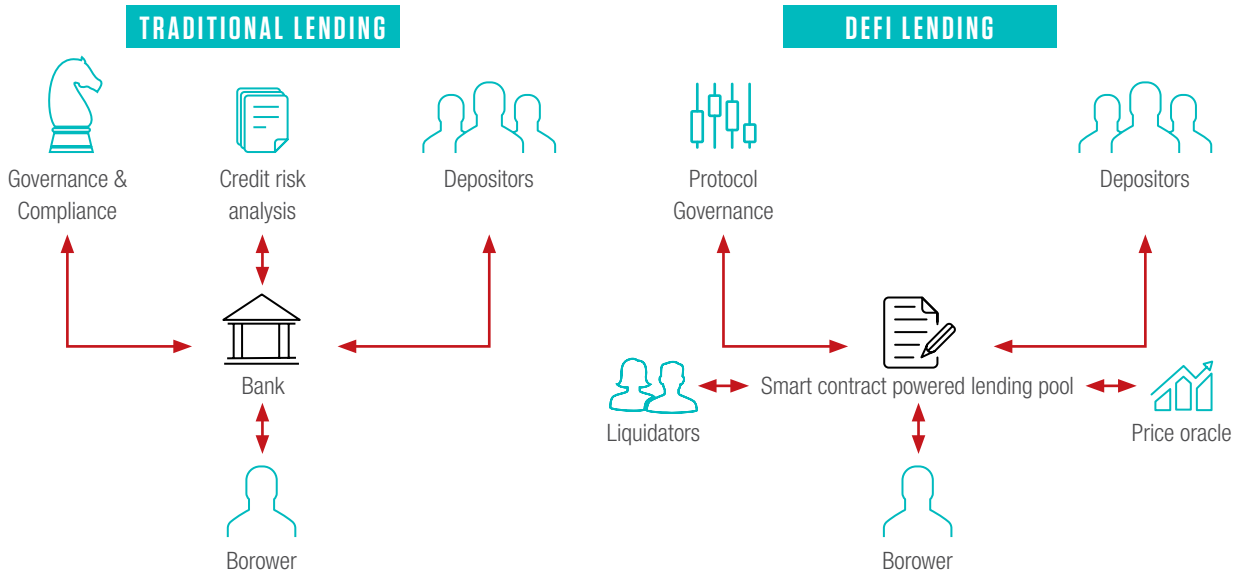

Figure 3: High-level comparison between traditional lending and DeFi lending (based on https://appinventiv.com/blog/how-defi-lending-works/)

2.1 Common types of DeFi lending and borrowing solutions

DeFi Lending solutions come in a variety of forms. Depending on the design of the smart contracts and users' intentions, two main types of DeFi lending applications can be distinguished:

- Lending pools
- Collateralized debt positions

The basic difference between those two forms is that in the lending pool two digital assets, one from the lender, one from the borrower, are "exchanged" against each other, while in the CDP one asset is locked in the protocol and a new token is generated. Both models are discussed in more detail below.

Lending pools (LP) are decentralized applications that allow users to lend and borrow different assets using smart contracts. To allow the borrowing of a particular asset, the asset is first pooled together from lenders into a lending pool. To allow trustless and decentralized borrowing and prevent borrowers from defaulting on their debt obligations, lending solutions have two important characteristics.

The first one is that borrowers are only allowed to borrow assets after sufficient collateral has been deposited into the smart contract. Due to the decentralized nature of blockchains and the absence of a risk assessment of the borrowers, loans are normally over-collateralized. This over-collateralization not only minimizes the counterparty risk but also allows to provide a buffer to the pool, especially with highly volatile assets.

The second characteristic is the introduction of a native token ("I owe you" (IOU) token). These IOU tokens act like market-specific derivatives that reflect the amount of collateral deposited to the lending pool and provide the ability to distribute the accrued interest.

From an economic perspective, lending pools enable borrowers to access liquidity in one asset, while keeping exposure in another asset that is deposited as collateral. The additional liquidity a borrower can raise in this way can be used to build up leverage.

An example for a leveraged long and leveraged short position using a lending pool with ether (ETH) as collateral is shown in the figure below.

Figure 4: Lending pools and leveraged positions

Lending pools are typically used to earn interest on both deposited and borrowed assets. In addition, borrowed assets can be used in investment strategies without bearing the consequences of price volatility of the borrowed assets. Lending pools like AAVE support a wide range of digital assets. Other prominent examples of lending pools include Compound, Venus and Morpho.[4]

Collateralized debt positions (CDP) are DeFi solutions that issue new tokens, mostly stablecoins (e.g., DAI in MakerDAO), that are secured by the deposited collateral. In contrast to lending pools, the CDP application creates completely new tokens. To issue these new tokens, a borrower first needs to deposit digital assets into the smart contract of the application. The number of tokens that can be created or "minted" depends on several factors, such as the price of the created asset, the value of the assets locked as collateral, and the target collateralization ratio.

From an economic perspective, CDPs – like lending pools – allow users to access liquidity without selling their crypto assets. This can be useful in situations where a market participant believes the value of their cryptocurrency will increase over time and they do not want to miss out on potential gains. However, CDPs allow only for the borrowing of stablecoins, therefore limiting the opportunity to leverage positions to long positions only (see example in Figure 5 below). As an advantage, CDPs generally offer higher liquidity than lending pools.

CDPs like MakerDAO are typically used to borrow stablecoins like DAI, pegged 1:1 to USD. Other prominent examples of CDPs include Liquity and Abracadabra.[5]

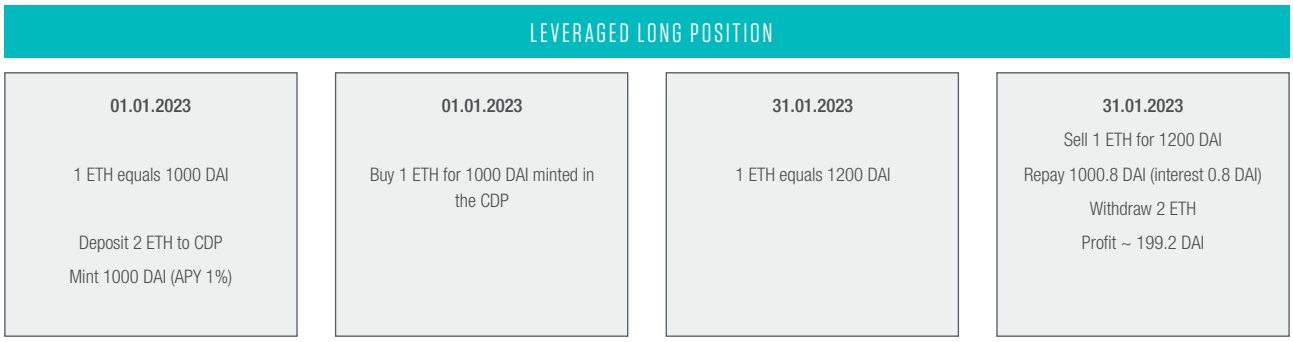

Figure 5: CDP and leveraged positions with ETH as collateral to borrow DAI

4. https://app.aave.com/ , https://app.compound.finance/ , https://app.venus.io/ , https://app.morpho.xyz/
5. https://makerdao.com , https://www.liquity.org/ , https://app.abracadabra.money/

2.2 Market size and major players

One benefit of the transparency of public blockchains is that decentralized lending applications can be observed with the help of blockchain data. Unlike traditional finance where lenders can be analyzed only via their reporting, various types of data are publicly available for DeFi lending solutions. The type of blockchain a DeFi solution is deployed on, its number of depositors and borrowers, the amount of assets supplied to and borrowed from the application, as well as the interest rate developments over time are all publicly available information.

One key metric to analyze DeFi lending applications as well as other DeFi solutions, is total value locked (TVL). TVL is a measure for the size of the DeFi market or application. It represents the value of assets being deposited in the smart contract of a DeFi solution. Similar to, for example, market capitalization in traditional equity markets, it can be used to gauge the size of and public interest in a DeFi solution.

Lending Pools (LPs):

Overall TVL of all lending pools across all blockchains was $15.2 billion as of May 12th, 2023.

APPLICATION	TVL, m USD	AVAILABLE CHAINS
AAVE	5,200	Ethereum, Polygon, Avalanche, Optimism, Arbitrum, Fantom and Harmony
JustLend	3,660	Tron
Compound Finance	1,790	Ethereum and Polygon
Venus	779	Binance Smart Chain

Table 1: Leding pools TVL / market size[6]

6. Data obtained from defillama.com on May 12th, 2023

Collateralized Debt Positions (CDPs):

Overall TVL of all CDPs across all blockchains was $9.7 billion as of May 12th, 2023.

APPLICATION	TVL, m USD	AVAILABLE CHAINS
MakerDAO (issuer of DAI stablecoin)	6,910	Ethereum
JustStables (issuer of USDJ stablecoin)	1,180	Tron
Liquity (issuer of LUST stablecoin)	710	Ethereum
Abracadabra (issuer of MIM stablecoin)	253	Ethereum, Arbitrum, Avalanche, Fantom

Table 2: CDPs TVL market size[7]

While the overall market size as measured by TVL is miniscule when compared to other, more established markets, in the past few years DeFi lending has been able to develop from an experimental proof-of-concept stage to a well-established application within the DeFi solution space.

7. Data obtained from defillama.com on May 12th, 2023

2.3 DeFi lending and financial services incumbents

Financial institutions are increasingly exploring the potential of DeFi lending to transform the traditional lending process. An example of this is the cooperation between Société Générale, one of Europe's largest banks, and MakerDAO. MakerDAO is a CDP solution that allows users to access credit in DAI-stablecoins. The partnership allows Société Générale to access additional liquidity quickly and cost-effectively without sacrificing the stability and liquidity of traditional currencies.[8]

In 2022, Société Générale applied to MakerDAO for a $30 million loan, depositing a self-issued bond token with a face value of $100 million as collateral. The tokenized bond was deposited in a smart contract on the Ethereum blockchain. MakerDAO approved the loan request and issued the $30 million in DAI stablecoins, which are pegged to the US dollar.[9] Subsequently, Société Générale could use the DAI stablecoins received to make payments within the Ethereum network as well as exchange the DAI for fiat currencies with an exchange partner. At the end of the loan period, Société Générale will repay the loan plus interest in DAI to release the bond tokens deposited as collateral. The bond tokens represent a corporate bond from Société Générale, which the company introduced on the Ethereum Blockchain back in 2019. The bond has a highly stable structure, however, it does not offer any return with a fixed rate at 0%. By collaborating with MakerDAO, the bank can obtain liquidity using an otherwise illiquid bond.[10]

While the explicit purpose of this token refinancing initiative was to serve as an experiment, it is noteworthy that in this deal MakerDAO assumed a role typically associated with central banks. MakerDAO created money through the provision of loans to banks. The second remarkable aspect is that Société's bond tokens were accepted as collateral by MakerDAO. This marks the first instance of a bond from a traditional major bank entering the treasury account of a DeFi solution.

By joining forces, Société Générale and MakerDAO demonstrated the benefits for finanical institutions by integrating DeFi lending solutions into their business operations.

8. https://www.sgforge.com/refinancing-dai-stablecoin-defi-makerdao/
9. https://vote.makerdao.com/polling/QmajCtnG#poll-detail
10. https://forum.makerdao.com/t/security-tokens-refinancing-mip6-application-for-ofh-tokens/10605

2.4 Liquidity pool based lending and borrowing

While both lending pools and collateralized debt positions are important components of the DeFi ecosystem, they serve different purposes and have their unique advantages and disadvantages. In this section of the paper, we will focus on liquidity pool solutions and delve into their fundamental concepts and inner workings. We will explore the key components that make these solutions function as well as the roles that participants can take. Furthermore, we will examine the benefits and potential risks associated with this lending and borrowing model, including factors such as collateralization and price volatility. By understanding the intricacies of liquidity pool based lending and borrowing, we aim to equip readers with the knowledge necessary to navigate in this dynamic ecosystem effectively.

2.4.1 Participants

Lending pools require three key participants: lenders, borrowers, and liquidators.

The **lenders'** main intention is to create additional income on the assets, that they are holding. Lending pools allow lenders to deposit their assets into pools and generate interest income on these assets.

Borrowers, as a second key group, are ready to pay interest for taking out loans. Normally, the main goal of DeFi borrowers is to create additional liquidity for themselves while maintaining the exposure to their collateral holdings. This can be either used to overcome the shortage of liquidity or create leveraged exposure. Borrowers benefit from the flexible terms that are offered by lending pools, as well as the ability to borrow different assets.

Lastly, **liquidators**, as the name suggests, are participants whose main role is to monitor loan positions and liquidate "unhealthy" ones. They are motivated by risk-free profits from the liquidation process, i.e. by obtaining the collateralized assets with a discount from their market value.

2.4.2 Processes

The functioning of lending pools is based on several key processes. The main processes include the lending process, the borrowing process, and the liquidation process.

The **process of lending** via lending pools consists of four basic steps as shown in Figure 6.

In the first step, the lender deposits assets into the lending pool. The type of asset that can be deposited into the pool depends on the lending solutions. Normally, several assets are supported. For example, the biggest platform AAVE supports 17 assets for deposit including ETH, WBTC, SNX, AAVE and USDC.

In return for the deposit, the lender receives so-called IOU tokens from the DeFi solution. These tokens represent the deposit and serve two main purposes. First, they are needed to withdraw the original deposit. When a lender wants to withdraw funds, he / she transfers the IOU tokens to the smart contract of the lending application and, in return, receives back his / her original assets. Second, IOU tokens are the technical basis for the calculation of interest for the deposited assets. Accrued interest is reflected via an exchange rate between deposited assets and IOUs that increases with time.

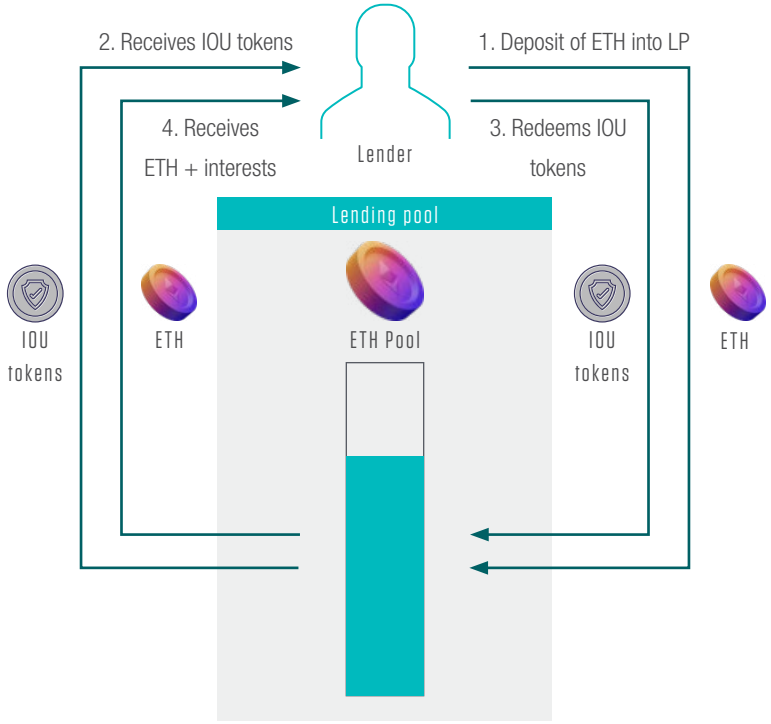

Figure 6: Example of the lending process using ETH as collateral (full loan cycle)

Borrowing via lending pools can be described in six phases (see Figure 7). To initiate the borrowing process, the borrower first deposits collateral into the chosen lending pool to secure the loan (1). After the collateral is successfully deposited, the borrower receives IOU tokens (2) and can borrow cryptocurrencies supported by a DeFi lending solution (e.g. AAVE which supports 17 currencies). The amount of cryptocurrency that can be borrowed depends on the value of the collateral. When the borrower wants to repay the loan, the borrowed cryptocurrency and accrued interest are returned to the lending pool (4). After the loan is fully repaid, the collateral can be redeemed for IOU tokens (5 and 6). As can be seen from this process, a borrower is also always a lender to the liquidity pool.

The processes described above show how lending and borrowing works if all participants fulfill their obligations. The **liquidation process** is a safeguard if borrowers do not repay loans or, more commonly, if the collateral of a loan decreases below a certain threshold. The liquidation process in lending pools is characterized by the following three phases.

Triggering liquidation: If the borrower´s collateralization ratio on the loan falls below a certain threshold (also called liquidation ratio) the smart contract will automatically trigger the liquidation process.

The collateralization ratio of a debt position represents the required ratio of the value of deposited tokens to the value of the debt. It indicates how safe a particular debt position is. Different collateralization ratios are normally required for different assets. It is important to manage the collateralization of a position and repay the debt in order to prevent liquidation.

Auctioning the collateral: After the liquidation process has started, the lending pool auctions the borrower´s collateral to recover the outstanding amount of the loan. Often, the collateral is sold at a discount to stimulate the liquidators' interest to bid.

Repaying the loan: After the collateral has been sold, the recovered amount is used to cover the loan. If there are any remaining funds, they will be returned to the borrower.

Overall, the liquidation mechanism helps maintain the solvency of a lending pool.

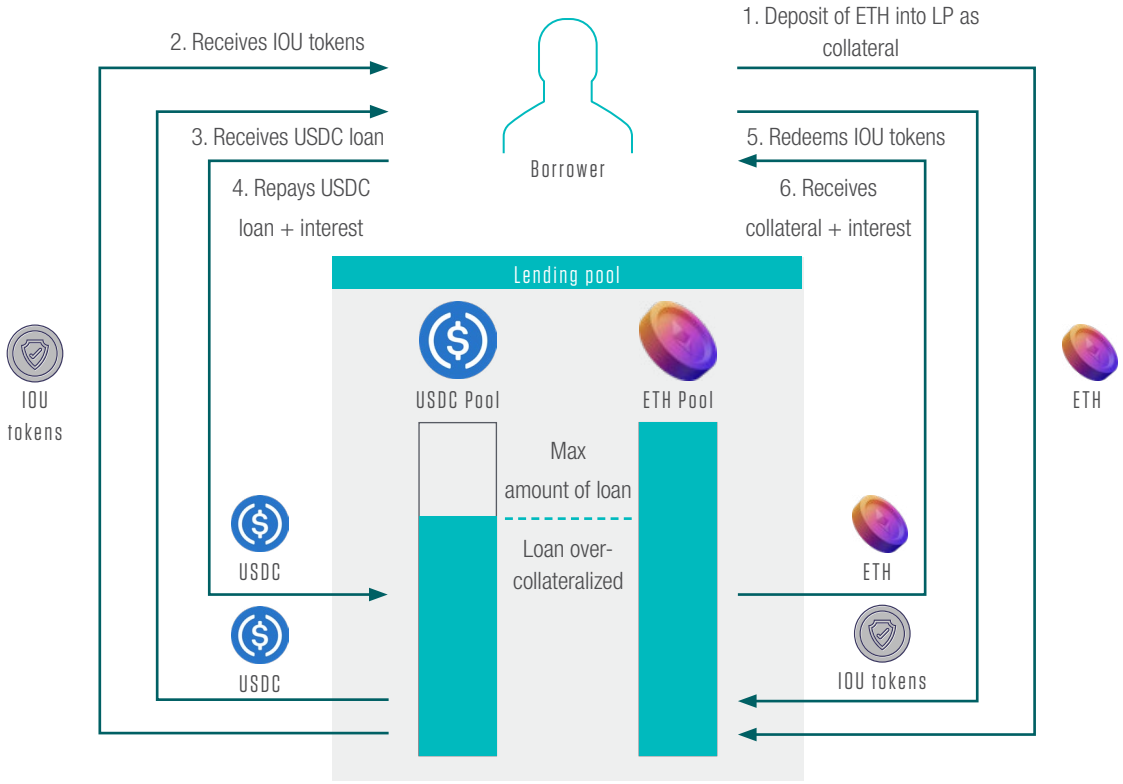

Figure 7: Example of borrowing USDC against a collateral of ETH (full loan cycle)

2.4.3 Interest rates

One functionality through which lending pools facilitate lending and borrowing is the automatic adjustment of interest rates based on the supply and demand for the assets in the pool. The borrowing interest rates are derived from the so-called utilization rate of a pool. Utilization is an indicator of the availability of funds within the pool, whereas the interest rate model supports liquidity of the pool through user incentives.This is shown in Table 3.

Liquidity risk becomes a risk factor when utilization is high (as U gets closer to 100%). To adjust the model to this constraint, applications apply kinked interest rate models (see Figure 8), where interest rate curve changes around the optimal utilization rate. Before utilization reaches its optimal levels, the slope is small, and after reaching optimal utilization it starts to rise sharply. It is important to mention that optimal utilization rates can vary from 45% for volatile assets (e. g. WBTC, ETH, AAVE, etc.) to 90% for stable assets such as DAI.

AVALIABILITY OF FUNDS	UTILIZATION	INTEREST RATES
Funds are avaliable	U is low	Low interest rates to encourage borrowing
Funds are scarce	U is high	High interest rates to encourage repayments of debt and additional supplying to the pool

Table 3: Interest rates and utilization

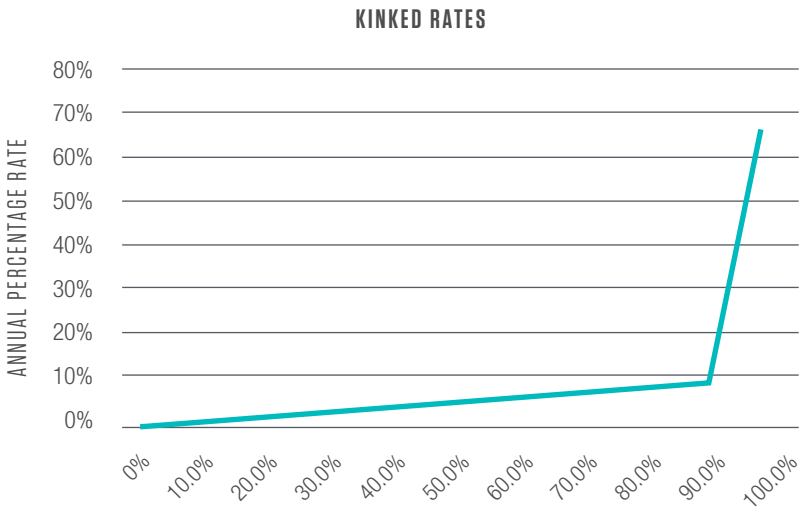

Figure 8: Kinked interest rate models (interest payable in relation to utilization)

2.4.4 Borrowing process example

The following section provides a simplified example of the processes.[11]

Let´s assume a borrower owns 15 ETH and would like to borrow 10,000 USDC for 31 days from a lending pool that offers 3.7% annual percentage yield. The borrower uses ETH as collateral, for which he will get 2% annual percentage yield (APY).

In order to take out a loan, the borrower first needs to provide collateral to the application (e.g., AAVE). To this effect, the borrower deposits the 15 ETH to the AAVE pool with a 2% APY and can then borrow up to 80% of the value of the collateral. Assuming a price of 1 ETH at $1,000, the maximum amount he or she can borrow is $12,000. Naturally, to avoid liquidation in case of price fluctuations, the borrower will take out a loan that is somewhat lower (e.g., 10,000 USDC), for which the APY of 3.7% will apply.

After 31 days, the borrower wants to repay the loan and get the collateral back. To repay the loan, he or she needs to repay the initially borrowed 10,000 USDC as well as the accrued interest of 31.4 USDC (0.314% for 31 days), which equals to 10,031.4 USDC. After the repayment, the initially deposited 15 ETH are available for withdrawal, including the additional interest earned of 0.025 ETH (0.169% for 31 days). In total the borrower receives 15.025 ETH.

Assuming that the price of ETH is $1,200 after 31 days, the total borrowing costs are 31.4 USDC minus 0.025 ETH (approximately 30 USDC) and equal to 1.4 USDC.

Figure 9: Lending and borrowing example

11. The description doesn't take Layer-1 transaction costs into account. Furthermore, lending pools use variable interest rates. Fluctuations of the interest rate can affect results considerably.

2.4.5 Risks and drawbacks

While lending applications can be beneficial for both lenders and borrowers, there are also risks involved.

Collateralization bounds and risks: The main safeguard for lending pools is the securing of each loan by collateral for which an automated liquidation process is in place. However, this liquidation process is not risk-free. The process is only effective if the collateral can be liquidated at a price equal to the value of the outstanding loan. Although DeFi-Loans are normally overcollateralized, large and sudden fluctuations in price may decrease the value of the collateral and thus make loans partially unrecoverable. During volatile market conditions and so-called "flash crashes" many liquidation events may occur at once. While the liquidation mechanism logic is set to operate under normal market conditions, extreme volatility can cause a knock-on cascade of liquidations, adding further momentum to a decline in price. This can cause a situation when the retrieved collateral could be valued less than the loan itself. Thus, lenders risk not getting their deposits back if an application fails to recover the entire amount of the debt, and borrowers risk the liquidation of their collateral during volatile market conditions if they do not manage the collateralization ratio of their position.

Interest rate instability: Certain market conditions can also cause instability in algorithmically calculated interest rates, which will impact investment strategies. Like any algorithm, these systems may not always respond effectively to changing market conditions.

Transaction costs: Normally, lending pools are used as part of more complex trading strategies. Depending on the expected profit margin of a trading strategy, transaction costs can considerably impact the success of a strategy, especially as transaction costs of the blockchain based settlement layer are normally variable and increase with the utilization rate of the settlement layer. When the settlement layer becomes congested due to heavy market activity, transaction costs can become prohibitive. This introduces a risk factor to any trading strategy based on lending pools.

In addition to those lending-pool-specific risks, lending pools also have risks common to all decentralized applications deployed on blockchain:

Smart contracts: Decentralized applications are subject to coding vulnerabilities that can be exploited by malicious actors to steal or manipulate funds, leading to potential financial losses for lenders and borrowers.

Operational security: While DeFi lending aims to be decentralized, certain components, such as user interfaces or blockchain access providers, may still represent centralized points of failure. Developer teams may even have admin keys to the application to maintain and update it.

Data inputs: Lending pools, like many other decentralized solutions, rely on on-chain as well as off-chain data, i.e. data stored outside of the blockchain. Providers of this off-chain data are called "oracles" and present another vulnerability to the system.

Regulatory risks: In most jurisdictions, there is still no clear regulation for decentralized finance. Particularly fiat on- and off-ramps acting as intermediary and gateway between decentralized and traditional financial systems are facing greater attention from regulatory bodies.

Scalability and interoperability: Blockchain-based solutions always face a trade-off between decentralization, security, and scalability. Liquidity in lending pools is fragmented and spread across different protocols. Layer-2 scaling solutions, interoperability protocols, and cross-chain communication mechanisms will be needed to drive DeFi lending adoption in the market.

2.5 Beyond liquidity pools

While collateralized borrowing against liquidity pools is the most common form of DeFi lending, other forms of lending and borrowing can be observed in the DeFi space. The most important one is the so-called flash loan. These loans are a special type of pool-based lending which enables collateral-free loans by building on the technical characteristics of the blockchain-based settlement layer.

From a technical perspective, blockchains process transactions in batches or blocks. Transactions are first pooled and then combined into blocks. These blocks are then added to the existing chain of blocks. Only when a new block is added to the blockchain by the majority of the network, the transactions in the block are executed. The time needed to pool transactions into a block and adding this newly created block to the chain is known as 'block cycle'.

Flash loans build on this property by including the borrowing transaction as well as the loan repayment into one block. In other words, the whole process of a flash loan takes place within one block cycle of the underlying Layer-1 protocol. This is effected by making the two transactions conditional upon each other. This means that, if the borrower is not able to repay the debt before the end of the cycle, the borrowing transaction will be reverted before the end of the cycle (i.e. before execution).

Flash loan transactions have two characteristics that are not found in traditional finance:

No debt default risk: Due to the conditional linking of the involved transactions and blockchain infrastructure, the loan will not be granted if debt is not repaid in the same transaction cycle.

No need for collateral: As borrowing and repayment take place within the same block cycle, there is no need for collateral, as a loan is only extended if it is repaid within the same transaction cycle.

Typically, flash loans are used to profit from arbitrage opportunities or to liquidate insufficiently collateralized positions in lending pools. An example of a flash loan use case is presented below.

LIQUIDATION PROCESS WITH FLASH LOAN
1: Borrow amount X of crypto-asset A
2: Act as liquidator for Lending Pool 1, by delivering amount X of A to Lending Pool 1. Receive amount Y of collateral B in return (closes defaulted position in Lending Pool 1)
3: Swap Y*B for A with Y*B > X*A
4: Return amount X of crypto-asset A
5: Profit = Y*B – X*A

Figure 10: Example of using a flash loan in a liquidation process

As can be seen from the examples above, flash loans are normally components of more complex trading strategies and require customization by borrowers for each strategy.

3. CONCLUSION AND OUTLOOK

To sum up, DeFi lending and borrowing is a promising area of the DeFi ecosystem. Unlike traditional loans, decentralized loans have no fixed repayment period, interest rates are based on algorithms, and credit risk assessment is replaced by collateral management with automated liquidation processes.

Today's DeFi lending solutions come in two forms - lending pools and collateralized debt positions. Both types of solutions provide mechanisms for collateral management, interest rate setting, smart contract execution and governance. Lending pools allow borrowers to borrow one asset by depositing another asset as collateral, while CDPs allow users to access liquidity in the form of stablecoins by pledging an existing asset. Use cases for lending pools and CDPs may differ, as shown in section 2.1.

Financial institutions should consider DeFi lending as an additional source of liquidity, a means of generating interest income on digital assets, and as a way to further improve lending processes. First real-world examples demonstrate that DeFi lending can provide access to a global pool of liquidity. It is likely that financial institutions will also explore lending pools and earn interest by providing liquidity to such applications.

As DeFi lending continues to evolve and digital assets are increasingly gaining a foothold in banks, more financial institutions will be looking to benefit from lending and borrowing those assets in a decentralized manner. It is, however, important to note that financial institutions should carefully assess the regulatory implications of venturing into this territory and ensure the mitigation of potential risks and appropriate compliance.

How to get started?

Financial institutions interested in DeFi lending can get started in several ways, depending on their risk profile and experience with digital assets. One option is to collaborate with existing DeFi lending platforms to leverage their expertise, technology, and user base. This option will allow financial institutions to quickly 'jump' into the DeFi lending space and gain firsthand experiences without the need for extensive development efforts. When considering to engage in DeFi lending, it is important to develop a use case that aligns with the bank's service offering and customer segments. In addition to compliance challenges and build-or-buy decisions, establishing internal know-how and capabilities will be a crucial factor to ensure long-term viability of any potential endeavor.

Capco and ABC Research can support your organization along the innovation and implementation path with comprehensive technical knowledge, capital markets and DLT expertise and extensive experience, from digital asset strategy definition to new business model implementation. Contact us to find out more and discuss.

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Capco, a Wipro company, is a global technology and management consultancy dedicated to the financial services industry. Our professionals combine innovative thinking with unrivalled industry knowledge to offer our clients consulting expertise, complex technology and package integration, transformation delivery, and managed services, to move their organizations forward. Through our collaborative and efficient approach, we help our clients successfully innovate, increase revenue, manage risk and regulatory change, reduce costs, and enhance controls. We specialize primarily in banking, capital markets, wealth and investment management, finance, risk & compliance, and insurance. We also have an energy consulting practice in the US. We serve our clients from offices in leading financial centers across the Americas, Europe, and Asia Pacific.

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The Austrian Blockchain Center (ABC), located in Vienna, is a COMET competence center with the mission to be Austria's first scientific contact point for blockchain and related technologies. Blockchain is a technology for secure cooperation between different participants with a wide range of use cases, not only as a digital currency, but also in industry, finance, energy, logistics, and public administration. ABC is an interdisciplinary and application-oriented research institution dedicated to all aspects of blockchain research. Technological, economic, and legal topics are the focus. Projects with a high practical relevance, which directly lead to innovations in the economy, are made possible by the experts of the ABC and its scientific partners - Austrian and international universities, universities of applied sciences and research institutions.

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