

DeFi and the Future of Finance:

1. The Origins of Modern Decentralized Finance

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Duke University and NBER

Outline

- The history of decentralized finance
- Infrastructure
- DeFi primitives
- Problems that DeFi solves
- Applications
- Risks
- The future landscape

Evolution of finance

Barter was one of the early methods of market exchange:

- Barter is peer-to-peer and, as such, the first DeFi
- However, barter very inefficient. If I have a cow and want two sheep, I need to find an exact match (someone with two sheep that wants a cow).
- Money solved the matching problem

Evolution of finance

Purposes of money:

Primary

- Unit of Account: A way to compare the value of various goods and services
- Medium of Exchange: Allows for non-barter transactions.

Secondary

- Store of Value: Allows value to be retained – even if partially – rather than complete decay (e.g., storing food).
- Transfer of Value: Ease of transfer of value and to defer value.

Characteristics

Traditional characteristics:

- Durability: Withstand repeated use (coins, paper, gold)
- Portability: You can carry around
- Divisibility: Fractional units
- Uniformity: Versions of the same currency have identical value
- Limited Supply: Unlimited supply would mean zero value
- Acceptability: “This is legal tender for all debts, public and private”
- Stability: If unstable, people will look for alternatives

A brief history

9000 BCE Barter

- Market in Egypt exchanging goods, e.g., cows for sheep



A brief history

600 BCE Coins

- In Lydia



<https://lunaticg.blogspot.com/2008/10/worlds-first-coin-lydian-lion.html>

A brief history

1290 Banknotes

- Marco Polo introduces the idea to Europe (originates in China)



A brief history

1871 e-Money

- First Western Union money transfer

[Form B.]

WESTERN UNION TEL. CO.

TELEGRAPH TRANSFER. No. _____

RECEIVED of *C. C. Antoine*

Three Hundred

to be paid to *Jas H Ingraham*

at *New York*

Dated at *New Orleans Aug 25 1873*

J. G. Alley Cashier for MANAGER.

Amount of Transfer, \$ *300 00*

* Premium 1 per cent. *3.00*

Cost of Telegram, *6.34* TOTAL, \$ *309 34*

WESTERN UNION
Telegraph Office
AUG 25 1873
37 CENTS
100

*No Premium will be less than 25 Cents.

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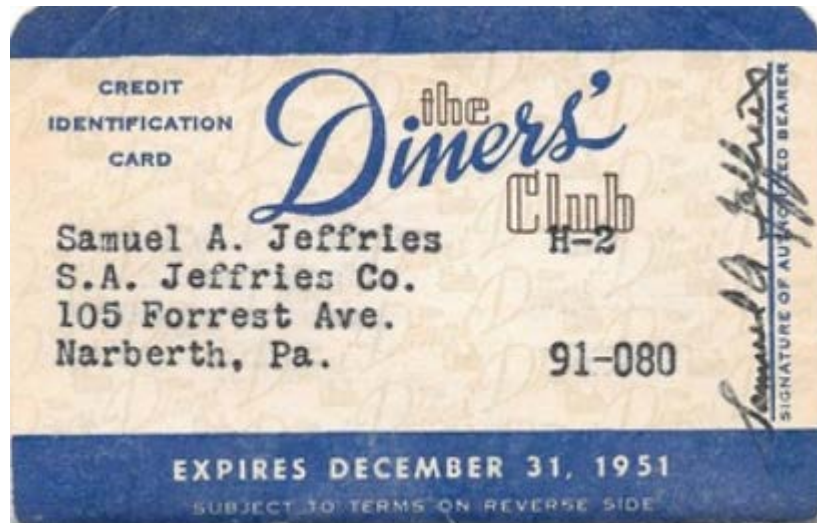
*No Premium will be less than 25 Cents.

3% fee – nothing changed in 150 years!

A brief history

1950 Credit Cards

- First credit card is Diners Club



A brief history

1967 ATM

- First ATM introduced in north London by Barclays Bank



A brief history

1983 Telephone Banking

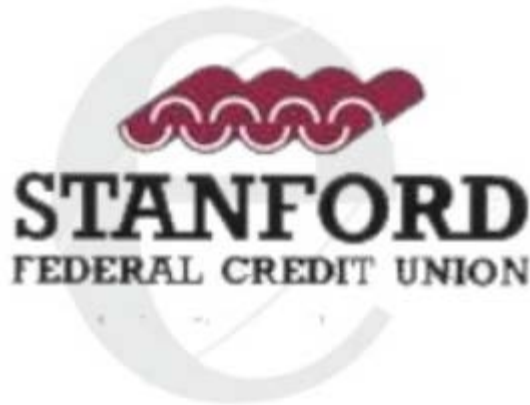
- Bank of Scotland introduced Homelink which is the first application of Internet banking



A brief history

1994 Internet Banking

- Began to become widespread in the US. Stanford Federal Credit Union offers Internet banking to customers



A brief history

1997 Contactless Payment

- Mobil introduces Speedpass at gasoline stations (RFID device)



A brief history

2005 Chip and Pin

- Introduced with credit cards



A brief history

2008 Bitcoin

- Programmable money introduced by “Satoshi Nakamoto”



Bitcoin: A Peer-to-Peer Electronic Cash System

Satoshi Nakamoto
satoshin@gmx.com
www.bitcoin.org

Abstract. A purely peer-to-peer version of electronic cash would allow online payments to be sent directly from one party to another without going through a financial institution. Digital signatures provide part of the solution, but the main benefits are lost if a trusted third party is still required to prevent double-spending. We propose a solution to the double-spending problem using a peer-to-peer network. The network timestamps transactions by hashing them into an ongoing chain of hash-based proof-of-work, forming a record that cannot be changed without redoing the proof-of-work. The longest chain not only serves as proof of the sequence of events witnessed, but proof that it came from the largest pool of CPU power. As long as a majority of CPU power is controlled by nodes that are not cooperating to attack the network, they'll generate the longest chain and outpace attackers. The network itself requires minimal structure. Messages are broadcast on a best effort basis, and nodes can leave and rejoin the network at will, accepting the longest proof-of-work chain as proof of what happened while they were gone.

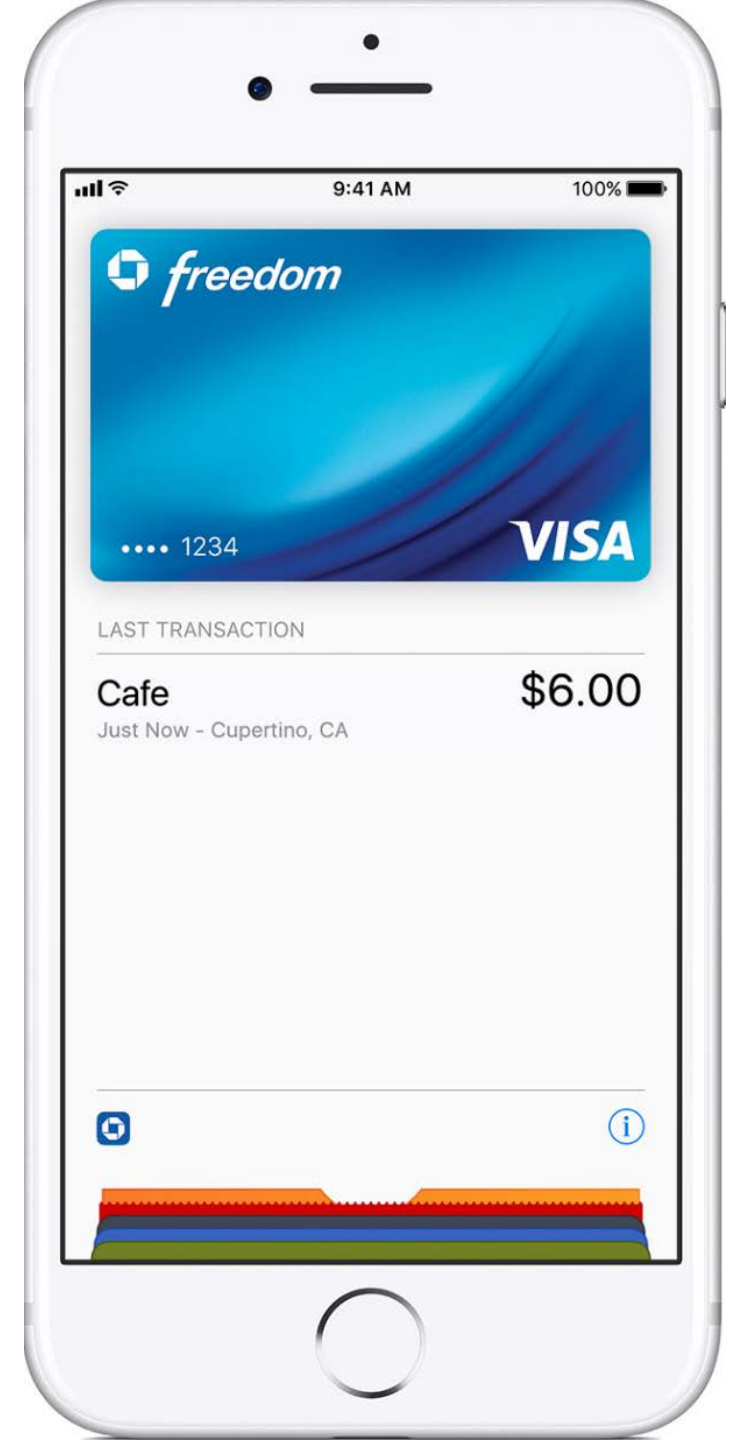
White paper October 31, 2008.

Program launched January 3, 2009.

A brief history

2014 Apple Pay

- The majority of US retailers have capability for contactless pay



A brief history

2021 Blockchain

- All leading banks have blockchain initiatives

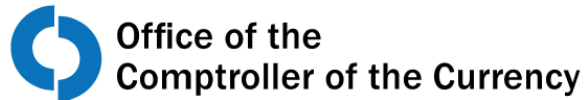
David Solomon, CEO Goldman Sachs.

- *“Assume that all major financial institutions around the world are looking at the potential of tokenization, stablecoins and frictionless payments.”*

A brief history

2021 Blockchain

- OCC grants permission to use stablecoins



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News Release 2021-2 | January 4, 2021

Federally Chartered Banks and Thrifts May Participate in Independent Node Verification Networks and Use Stablecoins for Payment Activities

<https://www.occ.gov/news-issuances/news-releases/2021/nr-occ-2021-2.html>

A brief history

Can money have value with no backing? Iraqi Swiss dinar

- Iraqi Swiss dinar was the currency of Iraq until the first Gulf War in 1990 (plates made in Switzerland, printed in the UK)
- In 1991, Iraq was split in two with Saddam Hussein in the south the Kurds in the north
- Because of sanctions, could not import dinars so Saddam ordered the printing of a new currency

A brief history

Iraqi Swiss dinar

- In May 1993, the Central Bank of Iraq announced that citizens had three weeks to exchange old 25 dinar notes for new ones



A brief history

Iraqi Swiss dinar

- However, old Swiss Dinar continued to be used in the north.
- Saddam cranked the printing press to finance regime and soon the exchange rate was

300 Saddam dinars=1 Swiss dinar

A brief history

Iraqi Swiss dinar

- Key insight is that Iraqi Swiss dinar had no official backing yet it was accepted as money – because people were willing to accept it as money.

<http://www.npr.org/sections/money/2010/10/04/130329523/how-fake-money-saved-brazil>

A brief history

2021 DeFi

- Enables peer to peer transactions without a centralized institution
- It allows for an efficient barter mechanism
- There are many problems with centralized finance

Problems with centralized finance

Five problems

- Centralized control
- Limited access
- Inefficiency
- Lack of interoperability
- Opacity

Problems with centralized finance

Centralized control

- Centralized banking system is highly concentrated
- National central banks control currency
- Non-financial centralization of tech giants, e.g., Amazon-retail, Facebook/Google-digital advertising

Problems with centralized finance

Limited access

- 1.7 billion unbanked
- Billions underbanked
- Many entrepreneurs use credit cards to finance their businesses because banks won't lend to them because they are small (negative impact on growth)

Problems with centralized finance

Inefficiency

- 3% for a credit card swipe
- 5-7% for a wire transfer
- 2 days settlement time for a stock transaction
- Slow transfers of funds
- Fraud, chargebacks, insecurity
- No micro transactions
- Difficult to get paid

Problems with centralized finance

Lack of Interoperability

- Siloed institutions
- Difficult to move money from one banking institution to another
- Difficult to move money from a bank to a non-bank
- Note Visa attempted acquisition of fintech company Plaid

Problems with centralized finance

Opacity

- Very little transparency
- Bank customers do not know the health of the bank
- Must rely on costly regulation and the promise of bailouts

Result of these problems

Missed growth opportunities

- Entrepreneur might have a great project, say with a 25% ROI, but the project is never pursued because the cost of credit card borrowing is 24%
- High ROI project fuel high CAPEX, strong real GDP growth, and robust employment growth



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Journal of Financial Economics 77 (2005) 3–55

www.elsevier.com/locate/econbase



Does financial liberalization spur growth? ☆

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<https://wallethub.com/edu/cc/credit-card-landscape-report/24927#interest-rates>

Result of these problems

Inequality of opportunities

- Projects should be financed based on the quality of the idea and the soundness of the execution plan
- Many have no access to Internet commerce (to buy or sell)
- Given the number of unbanked and underbanked, this creates unequal opportunities and perpetuates or even exacerbates inequality.

Origins of DeFi

Fintech

- When costs are high, innovation will arise. However, if there is a strong layer of middle people, innovation may not be fast
- Consider the FX market
- Alice needs to buy €100m with dollars at the end of September to pay for a machine
- Alice goes to her bank and they quote a rate

Origins of DeFi

Fintech

- Carol needs to sell €100m (translate into dollars) at the end of September
- Carol goes to her bank and the bank quotes her a (different) rate
- The difference in the rate – the spread – is the bank's profit (and it can be substantial)

Origins of DeFi

Fintech

- 20 years ago a company is formed with a simple idea
- Suppose Carol and Alice use the same bank. Why not match them together? Indeed, if either Carol or Alice had multiple banking relationships, you could match people from other banks
- Let the banks do the credit quality evaluation and pay them a very small fee for that
- The “spread” – which is a significant cost for Alice and Carol vanishes

Origins of DeFi

OCTOBER 2001 www.euromoney.com

EUROMONEY

Markets on a war footing



Botín emerges victorious at Santander

The bizarre economy of Belarus

Forex exchange model threatens multi-bank sites

ONLINE FOREIGN EXCHANGE

Forex goes into future shock

When forex trading first harnessed the internet, banks tried to attract clients to their individual platforms. They soon faced the problem that some customers were obliged to seek the best price for every transaction. Hence the difficult birth and troubled childhood of multi-bank platforms. End-users seem little more happy with these systems than the rival banks that set them up. And before they have had a chance to digest their implications clients are being offered the prospect of trading directly with each other. Jennifer Morris reports on a market whose innovators may have taken a step too far

Campbell Harvey knew he had a captive audience. Stand up in front of a group of CFOs and suggest that perhaps they're paying over the odds for foreign exchange transactions and you very quickly become the centre of attention.

"They were all nodding and saying yes, the costs are huge," recalls Harvey, whose day job is teaching finance at Duke University business school in North Carolina. "So I pointed at one of them and said 'you have €10 million to sell. Then I turned to another and said 'you need to buy €10 million' - you guys should be talking to each other."

It seemed obvious to Harvey and his then PhD student and now business partner Arman Glodjo that the online forex markets could do better. "The standard spread on a \$1 million euro transaction is \$500 by pips, then there are other costs, such as clearing and settlement, that add on around \$25," says Harvey. That is too high. By slimming down the banks' role to preserving credit lines and providing a clearing mechanism, he estimates that end-users could cut the cost of doing a standard \$1 million transaction in half and stand to save even more on larger deals. Over a year, the potential economies are phenomenal. And as the money of three Bermuda-based hedge

by another client of one of those banks.

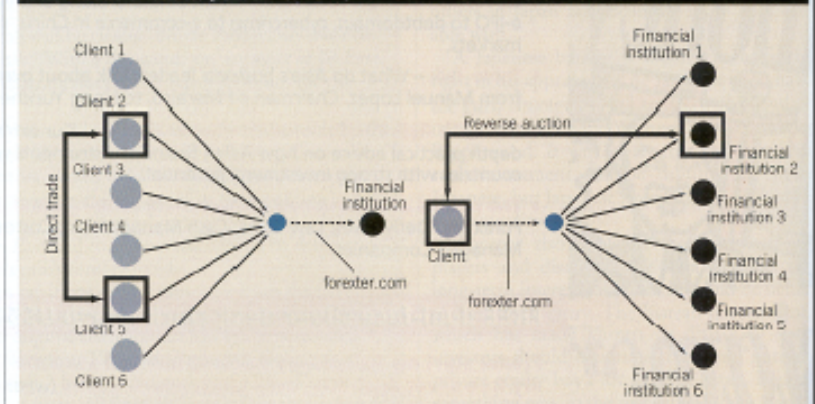
In the first case, the bank processes and clears the trade normally. In the second, the trade happens via the bank, which handles the clearing, even though the trade is taking place client to client. They might be customers of the same bank or one might have a relation-

now entered the mainstream with a deal with BMG. But Glodjo says the technology is actually closer to that of Grutella, a type of software that allows for the decentralized sharing of files. When users look for material, the search engine hops from PC to PC to find the requested file, rather than going to a central server.

In the same way, requests on Forexster are seen by the entire client base of the bank, rather than just a single institution, and all of that group can compete for them. "When a CFO posts a trade, the system performs an arbitrary number of credit hops to find the best price," explains Glodjo. Furthermore, a client trying to sell €200 million is not dependent on finding another counterparty with the exact opposite requirement. "Part of the order might be filled by a natural seller and the rest by a bank." In the worst-case situation that there is no corporate on the other side, a bank or banks would theoretically step up for the whole amount. "If your bank is on Forexster, they should give you the same price as if you had called them up and asked for one," asserts Glodjo.

So far so good. But the devil is in the detail and the flaw in Harvey and Glodjo's plan could prove to be fatal. As they themselves point out, it is hugely profitable for banks to keep clients apart, so they will fight tooth and nail to defend the status quo. "It will eventually be forced on them by clients who really love this idea and will say to the banks 'either

The forexster.com system



Source: Forexster

Origins of DeFi

Fintech

- Can you imagine pitching the Board of Directors of a major bank the following:
 - Spend the money to implement this fintech idea and eliminate one of your major profit center

Origins of DeFi

Fintech

- Can you imagine pitching the Board of Directors of a major bank the following:
 - Spend the money to implement this fintech idea and eliminate one of your major profit center
 - Fortunately, many banks saw the future and wanted to be first in to this peer to peer system

Origins of DeFi

Fintech

- Another early decentralized idea was “dark pool” trading
- 1979 the US SEC instituted Rule 19c3 that allowed stocks listed on one exchange, e.g., NYSE, to be traded on another exchange
- Many institutions moved their large block trading to peer to peer trading in dark pools.
- Currently, almost half of stock trading is done in dark pools

Origins of DeFi

Fintech

- Paypal founded in 2000 as a way to speed up payments
- Banks have followed with initiatives like Zelle
- Importantly, these payment initiatives use the legacy banking infrastructure



Origins of DeFi

Bitcoin and cryptocurrency

- Stuart Haber and Scott Stornetta (1991) invent the blockchain idea to keep track of time stamping of documents
- Adam Back (2002) invents the Proof of Work idea. It is based on a key paper by Cynthia Dwork and Moni Naor (1992) that was aimed at eliminating junk mail (require the sender to do a computational task to send the email to you, while this is easy to do once – it is infeasible to do for millions of recipients)
- Satoshi Nakamoto (2008) put these ideas together to introduce bitcoin

Origins of DeFi

Bitcoin and cryptocurrency

- Bitcoin eliminated the key problem with digital currencies in the past (you can make a perfect digital copy and “double spend”)
- Every transaction would be kept in an immutable ledger (ensorship resistant blockchain) and the ledger would be distributed across many different computers
- Cryptographic scarcity was enforced by a limit of 21 million bitcoin
- User sovereignty (only owner determines how to spend)
- Portability in that you can send or receive anywhere quickly and cheaply

Origins of DeFi

Comparison to fiat

- US dollar since 1971 is a pure fiat currency
- Demand comes from:
 - 1) taxes;
 - 2) purchase of goods denominated in USD; and
 - 3) repayment of debt in USD
- US economic expansions and contractions impact value
- Fed also has the ability to inflate

Origins of DeFi

Bitcoin vs. fiat

- Scarcity and self-sovereignty create the potential for store of value
- While untested, there is no direct link to economic activity or inflation, so there could be some hedging
- Bitcoin was originally intended to be a peer-to-peer currency. However, it deflationary characteristics and flat fees discourage its use in small transaction.
- Bitcoin a flagship for other innovations in the crypto space

Ethereum and DeFi

Ethereum history

- Began in 2015
- Allows for running of computer programs. So Ethereum is a distributed computational platform offering functionality via offering a “smart contract platform”.
- Smart contracts control assets and data and define interactions between assets, data, and network participants

Ethereum and DeFi

dApps

- Decentralized applications allow peers to interact directly and remove the need for a central clearing house for app interactions
- DeFi is fundamentally a competitive marketplace of financial dApps that function as various financial “primitives” such as exchange, lend, tokenize, and so forth.
- These dApps benefit from the network effects of combining and recombining DeFi products and attracting increasingly more market share from the traditional financial ecosystem.

Ethereum and DeFi

Next

- Explore the DeFi infrastructure including blockchain, cryptocurrency, smart contracts, oracles, stablecoins, and decentralized applications

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