Thomas K. Birrer · Dennis Amstutz · Patrick Wenger

Decentralized Finance

From Core Concepts to DeFi Protocols for Financial Transactions

Springer

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Preface

Some introductory thoughts from Thomas K. Birrer

It was in 2016 when I got involved with the crypto space when I was asked by an open minded and inevitably forward thinking colleague whether I would be willing to support a young start-up to get its financial management up to date. Having finished my Ph.D.Thesis on the currency risk management in Swiss corporations, this proved to be a good opportunities to complement my work at the university. The start-up in question was an interesting crypto exchange whose founder envisioned the many opportunities and possibilities that arose from the new technological developments. The following years as Chief Financial Officer were sometimes chaotic, but very instructive and led to many incredibly interesting and enriching encounters. This activity also proved to be the nucleus for transferring the knowledge acquired in my economics studies into practice and for combining the fascination for cryptography, which was awakened by Neal Stephenson's book Cryptonomicon. This book, which is still handy on my bookshelf, combined technology and adventure. Since then, my fascination and my adventurous spirit did not diminish. The idea that transactions from A to B can be carried out on the basis of code without a trusted intermediary is simple. Hence, with the advent of DApps and the colorful world of DeFi protocols, my fascination grew even more.

Some introductory thoughts from Dennis Amstutz

It was prime time in a run-down student bar amidst an Eastern European capital city in early fall of 2015 when I started my DeFi journey. Next to the inflationary local currency, the welcoming establishment accepted Bitcoin as a means of payment for the local brew with an odd German name. With a puzzled expression on my face, I learned about a digital version of gold from a mid-30s, turtle-neck-wearing barman. Inspired by curiosity and his well-groomed mustache, I followed the barman's (financial) advice, and researched the Internet for Bitcoin. In 2016, I added Bitcoin to my portfolio. Intrigued by the significance and implications of a scarce, permissionless digital money, I met fellow cryptonites at business school. Rather than participating in lectures, we took theory to practice during the Initial Coin Offering (ICO) boom of 2017. During adrenaline fuelled days and nights, we researched, discussed, and traded tokens of crypto projects with unlimited access, large promise but sometimes little product. While working for Credit Suisse at day, I researched crypto projects again at night during DeFi summer 2020. In this environment, I was allowed to learn that the crypto industry offers more opportunity for young, motivated talent rather than boring, hierarchical banking. Regardless of age or name, the crypto industry is an open playing field where anyone can make a name for himself with performance rather than hiding behind a legacy institution and academic titles. This is also what drives the founders in the space to create products accessible for anyone with an Internet connection. These experiences have led me to build Bitcoin-mining operations in green-energy-rich Paraguay with fellow author and business partner, Patrick Wenger.

Some introductory thoughts from Patrick Wenger
As much as I have read in the news about cryptocurrencies in their early stages, it never caught my attention until 2014 when I downloaded a binary options demo app where I could trade with different assets. One of those assets stood out as the most profitable in my portfolio, a digital currency called Bitcoin. As I never dared to put real money in this asset class, my skepticism prevailed. However, after seeing the exponential growth in the bull market of 2017 I was encouraged to make my first purchase of Bitcoin, which was an extremely difficult task at the time. My enthusiasm grew along with my interest to educate myself more and more about this industry discovering a passion that was dormant in me and ready to change my way of seeing the finance realm. Over the years, I experimented with mining altcoins in my backyard, investing in different coins and ended up working for an ICO project. All these different experiences helped me strengthen my passion and my determination to dedicate my entire career focus on the crypto sphere.

With this book we would like to share the fascination for the vibrant realm of decentralized finance. We hope that the book provides valuable insights and examples. Although fascination exists only in the imagination of the fascinated, in the best case our fascination spreads even further and encourages others to try something new.

Rotkreuz, Switzerland

Thomas K. Birrer
Dennis Amstutz
Patrick Wenger

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Gratitude is not only the greatest of virtues, but the parent of all the others.

Marcus Tullus Cicero

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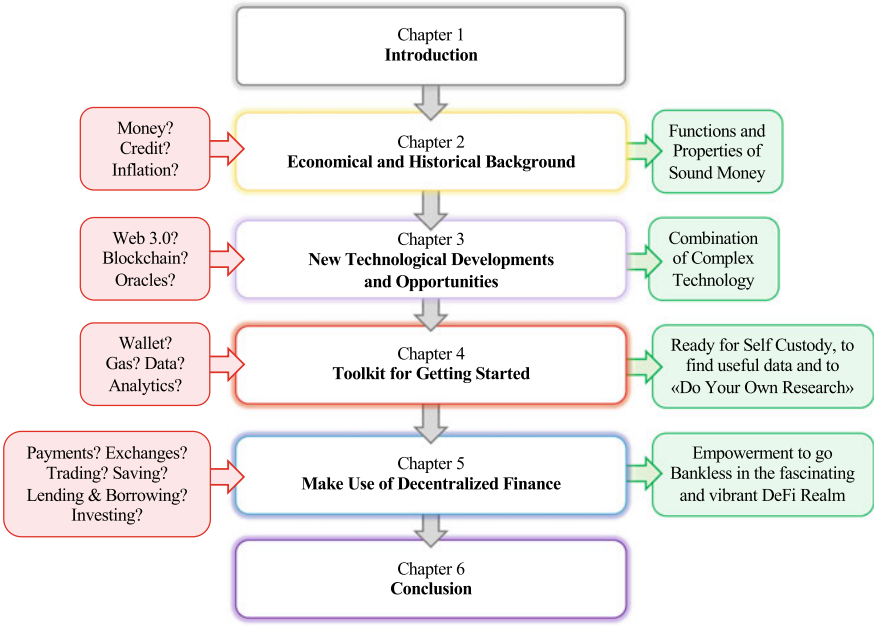
Remark: The views and results presented in this book do solely reflect the personal opinions of the authors (even if we do not completely agree on all points ourselves...).

Overview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Introduction

1

It is well enough that people of the nation do not understand our banking and monetary system, for if they did, I believe there would be a revolution before tomorrow morning.

Henry Ford, founder of Ford Motor Company, in 1922

Regardless of race, gender, or occupation, every human requires goods and services to not only survive but also satisfy the needs and wants of themselves and their families. In economic parlance, the amount of goods and services produced by an individual, or an economy, is known as the standard of living, also referred to as *wealth*. Starting as primitive hunters and gatherers, who relied on self-sufficiency to survive in the harsh climate and wilderness, humans and their communities have started over centuries to specialize in areas and skills. This allowed each community or economy to develop its own resources and trade the excess production with others for theirs, increasing the living standards of all involved. The emergence of money was an important development for mankind.[1]

But the history of money is not that clear as it might seem to be. At the very least, it is agreed upon that money typically fulfills the three functions as a medium of exchange, a store of value, and a unit of account.[2] Economists assume that the bartering of goods and services inspired money's invention. But anthropologists and archeologists contend that early states invented currency as a means of debt payment. This led to the credit theories of money, also called debt theories of money.

[1] See Rothbard (1994) and White (1999).
[2] See Surowiecki (2012) and Bower (2018).

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Let's first have a look at the view of anthropologists and archeologists. As the anthropologist David Graeber puts it in his book "Debt: The First 5000 Years," money was a way "to arrange marriages, establish the paternity of children, head off feuds, console mourners at funerals, seek forgiveness in the case of crimes, negotiate treaties, acquire followers."[3] Money, then had not the prime function to act as a medium of exchange but to define the structure of social relations. Money makes its first appearance in written records already in Mesopotamia during the third millennium BCE. The respective society already had a sophisticated financial structure in place, and merchants were using silver as a standard of value to balance their accounts. But interestingly, cash was not widely used in transactions. The world's first standardized metal coins were introduced in the small kingdom of Lydia in the seventh century BCE (what is now in Turkey). As this kingdom according to its geographical location had a flourishing commerce with foreign travelers, money in the form of coins was useful.[4]

In order to understand, why money is so useful under such circumstances, we look at the view of economists. Economists argue that without money, there could be no real specialization, no efficient trade, and thus, no advancement of the economy above a bare, primitive level. In a moneyless society, people would still rely on barter. This would also have been the case in ancient Lydia. Functioning as a barter society, the prevalent problems are indivisibility and "coincidence of wants." The latter is an economic phenomenon where two parties each hold an item the other wants, exchanging these items (e.g., fish for shoes) directly without any monetary medium. With money as a means of exchange, those problems that plagued the barter society vanish due to a simplified price system as prices are now expressed in the commodity money terms.[5] This demonstrates that trade is not only essential to increase one's standard of living but is most efficient when coordinated through money. Next to functioning as a means of exchange, sound money[6] serves as a *store of value* for the ability to save and postpone consumption, and as a *unit of account*, allowing a meaningful interpretation of prices, costs, and profits. Money is an essential component of everyone's life, and its soundness contributes directly to the human ability to maintain and increase the standard of living.

Many different goods have been used as money: For instance, cattle in ancient Greece, or copper in ancient Egypt. Historically, the commodities gold and silver have emerged as money in the free-market competition, displacing other commodities.[7] This commodity money's value of the representative paper is derived from the underlying precious metal such as gold or silver at a fixed exchange rate. Commonly

[3] See Bower (2018) based on Graeber (2012).
[4] See Bower (2018).
[5] See Rothbard (1983).
[6] According to renowned economist Ludwig von Mises, "The sound-money principle has two aspects. It is affirmative in approving the market's choice of a commonly used medium of exchange. It is negative in obstructing the government's propensity to meddle with the currency system." In essence, it is free market, non-centrally-governed money. Source: Mises (1911).
[7] See Rothbard (1983).

referred to as a gold or silver standard, the corresponding money supply is inherently limited in the short run since gold or silver are scarce resources. Thus, to inflate the money supply of an economy, goods and services need to be produced and traded for the commodity, or the commodity must be extracted from the ground or sourced from elsewhere. Therefore, no centralized entity could arbitrarily pursue an inflationary policy under a commodity standard.[8]

Commodity standards were largely prevalent throughout recent human history[9] and not tied to a central entity but a result of the free market. Today's fiat money, such as the US Dollar, do no longer have an intrinsic value beyond the value of the paper. This means that fiat money is not backed by a commodity. Furthermore, fiat money is accepted in exchange not for any value the paper tickets have per se but because everyone expects that everyone else will accept these tickets in exchange. Thus, their value is based on public faith in the monopoly issuer—which typically is the respective central bank, such as the Federal Reserve. In the Western World, most central banks are entrusted with maintaining the currency's stability. The defined objective is often an (arbitrary) two-percent annual consumer price increase[10] (e.g., European Central Bank or Swiss National Bank). Despite having notoriously failed to achieve this target, the currency's purchasing power would theoretically halve within 35 years at this target rate.

Like any good or service, the value of money is subject to the market forces of supply and demand. The value of a currency, expressed in terms of the amount of goods or services that one unit of money can buy, is called *purchasing power*. The purchasing power is thus directly linked to the quantity of money. *Inflation* is defined as the increase of quantity of money not consisting of an equal increase in the stock of a money metal. Inflation decreases the number of goods or services one can purchase with one unit of money, corresponding to a decreasing purchasing power for the money holder, and thus, has a deterring effect on wealth.[11] A household on fixed incomes (e.g., salary of social security rents) will be able to buy increasingly fewer goods and services with its stable amount of income in an inflationary environment with rising prices. Conversely, *deflation* increases the number of goods or services one can purchase with the same unit of money. Deflation results in an increasing purchasing power. This constitutes a desired state for savers, consumers but also producers, who are forced to increase their efficiency and productivity to compete for their client's goodwill. Without the quantity limitations of a commodity standard,

[8] See Bernholz (2006, pp. 21–36) and Sennholz (1975).

[9] A more in-depth introduction into the monetary history of the Western World can be found in Chap. 4 of Rothbard (2008).

[10] Central banks attempt to measure the level of price increases with an index, the Consumer Price Index (CPI). More information can be found in the theoretical background.

[11] The essence of inflation is not a general rise in prices (e.g., as attempted to be measured by the Consumer Price Index[CPI]) but an increase in the supply of money, which in turns sets in motion a general increase in the prices of goods and services. The CPI has many shortcomings, among others, the omission of assets such as commodities, oil, gold, producer goods, real estate, and stocks. For a reasoned, more in-depth critique, see Thornton (2011).

central banks with a currency-printing monopoly and fractional-reserve banks remain unconstrained in pursuing inflationary policies in today's fiat-money system. The relevant concepts are further explained in Chap. 2.

It is important to recognize that inflation confers no general social benefit but instead redistributes the wealth in favor of the first-comers, people close to the money supply in government and banking, at the expense of the laggard receivers. They will bear the cost of increased prices resulting from an increased demand caused by an expansion in the money supply.[12, 13] In essence, the economic consequences of inflation are a non-democratically instituted tax on the holders of fiat money and used as a subtle means for government acquisition of the public's resources through creating an artificial money supply used to purchase goods and services in the real economy, driving up their prices. According to information of the Federal Reserve themselves, the purchasing power of the US Dollar since its inception in January 1913 has fallen by 96%.[14]

While this constitutes a major decline of purchasing power for holders of the US Dollar, there have been further historical instances of severe inflation. A well-known example is the Weimar Republic of the early 1920s. To pay for their World War I (WWI) efforts, Weimar Germany suspended the gold standard and commenced to print unbacked paper money.[15] Already during the war, the Papiermark significantly depreciated against the at the time gold-backed US Dollar.[16] Having subsequently lost the war and caused severe infrastructural damage to the victorious countries, Germany was burdened with massive war debt to be paid in hard currency, not the depreciating Papiermark. With the debt constituting a significant chunk of the country's Gross Domestic Product (GDP), rather than through increases in production and productivity, German politicians started the money-printing press to attain foreign currencies. This produced the backfiring effect of further devaluing the hard-hit Papiermark. While the victor nations started to demand repairments in commodities (e.g., coal), German consumers paid more than 200 billion Deutschmark for a loaf of bread in November 1923.[17] Other famous examples include Hungary from August 1945 to July 1946, where prices doubled every 15 hours, Zimbabwe from 2007 to 2008, Venezuela in 2016 to 2019, or Argentina from 2017 to 2020.[18] Although the examples vary across time and country, they all have a common denominator. All hyperinflations have been caused by government budget deficits of overeager politicians for war efforts and interventionist policies financed by artificial, unbacked

[12] Source Rothbard (2008).
[13] This is also known as the 'Cantillon Effect', see: Chowdhury (2019).
[14] From January 1913 to September 2021. Source: FRED St. Louis.
[15] In order to finance their war efforts, other countries such as the United States severely increased federal-level income taxes. Source: History.com (2022).
[16] During the WWI years of 1914 to 1918, the exchange rates of the Deutschmark to the US Dollar increased from 4.23 to 7.86 Deutschmark for 1 US Dollar. Source: Measuringworth.com (2022).
[17] In December 1918, a loaf of bread cost 0.5 Deutschmark. Source: Johndclare.net 2022.
[18] For further examples of hyperinflation, consult Hanke & Krus (2012) outlining 56 examples in recent history. See Hanke (2012).

currency creation.[19] While inflation creates an easy exit for indebted governments, it quickly erodes the real value of the local currency, as the prices of all goods increase, leaving the average joe's savings and fixed incomes worthless.

History seems to repeat itself. In an inflationary environment, there is an incentive to consume rather than save, as current consumption is preferred due to a decreasing purchasing power. This is exactly the case in the prevalent financial system. In addition, the incentive is to borrow and repay later rather than save and lend. Inflation, therefore, lowers the general standard of living by creating a deception of prosperity based on credit. Furthermore, inflation is a convenient means for today's debt-loaded governments to repay their creditors (i.e., debt burden decreasing in relative terms), without having to increase taxation on the population. In essence, the economic consequences of inflation are a non-democratically instituted tax on the holders of fiat money and used as a subtle means for government acquisition of the public's resources through creating an artificial money supply. In this inflationary environment, fiat money is no longer working as a sufficient store of value. Also, the eroding purchasing power makes fiat money increasingly obsolete as a meaningful unit of account, as a means of exchange if public trust is lost, and therefore, could no longer function as money in the economy.

Traditionally, the public was forced to partake in the adverse consequences of this inflationary financial system of central and commercial banks discouraging savings, while encouraging consumption and credit expansion. Regardless of one's occupation, financial functions such as transacting, saving, investing, credit, or leverage are important means for storing and increasing an individual's income and wealth.[20] Thus, the access to financial services for example through a savings or investment account is essential. Nevertheless, around 1.7 billion people in the world are still without access to basic banking services.[21] Not only since the global financial crisis of 2007/2008, the public trust in the current, centralized structure of the financial system has been crumbling, making alternative and innovative concepts for future financial systems become increasingly relevant.[22]

In response to several bank bailouts throughout the world at the taxpayer's expense, Nakamoto introduced *Bitcoin* in 2008 as the first decentralized, global cryptocurrency with a limited supply of 21 million coins.[23] Reinforcing the need for sound, trust-less money in the economy and resembling a digital version of gold, the emergence of Bitcoin has brought widespread attention not only to cryptocurrencies but also to the underlying technology: the *blockchain*, a distributed ledger that records and secures transactions in a peer-to-peer network without the need of

[19] Source Bernholz and Kugler (2009).
[20] Source: Sennholz (1985).
[21] For 2017 see this source: The World Bank
[22] Source: Chen (2019).
[23] See Nakamoto (2008), which can be downloaded here.

a trusted, centralized party.[24] A further milestone in the widespread application of blockchain technology was the introduction of *Ethereum* by Buterin in 2013.[25]

Ethereum, dApps and the vision of DeFi

Ethereum is likewise an open-source platform leveraging the technology to create and run decentralized digital applications, so-called dApps, enabling users to make agreements and execute financial transactions without a trusted intermediary such as a commercial bank.[a] This area of blockchain technology is known as Decentralized Finance (DeFi) and offers users a functioning alternative to the traditional inflationary financial world.[b] Transferring and settling billions of dollars in value each day, nobody is excluded from the network and can execute functions commonly known in the traditional financial world such as payment, saving, investing, lending, and borrowing. Furthermore, no central entity can monopolize the network and implement inflationary policies as is the case in the current financial system.[c] The sphere enables censorship-resistance, and the goal is to prevent anyone, no matter how powerful, from owning, corrupting, or blocking access to the DeFi applications. Thus, this enables anyone to take self-responsibility for their financial actions.

[a] See Wu et al. (2019).
[b] Source: Angeris and Chitra (2020).
[c] See Chen (2019).

This novel functioning financial system offers the unique opportunity to maintain and increase wealth, by providing a return to sound digital money without the adverse externalities of today's financial system of central and commercial banks.

The active reader may ask, if a DeFi user should no longer trust commercial banks, politicians, and central bankers, who is to be trusted but themselves? While humans are inherently flawed—nobody is perfect—and prone to irrational and inconsistent behavior, lines of code execute exactly as programmed. These hardcoded rules provide DeFi users with the ability to execute powerful but predictable financial functions. Ultimately, they provide trust via rational mathematics and proven laws of economics, while the unpredictable influence of the "human factor" is minimized.

Regardless of profession and life situation, it is highly advisable to (at least to a certain extent) store income and assets in solid money to hedge against the vast risk stemming from the prevalent inflationary financial system. Thus, this book provides the following value to the reader:

[24] See Chen (2018) and Klages-Mundt and Minca (2019).
[25] The initial Ethereum Whitepaper can be found here.