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INVESTING IN CRYPTOCURRENCIES AND DIGITAL ASSETS

A Guide to Understanding Technologies, Business Models, Due Diligence, and Valuation

KEITH BLACK

WILEY

Investing in Cryptocurrencies and Digital Assets

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For Melissa, Trish, and Parker.

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Preface

Cryptocurrencies and digital assets are exciting, innovative, and potentially lucrative investments. Similar to the internet of the late 1990s, blockchain technology may fundamentally transform the ways many industries conduct business. Much of the conversation to date has focused on speculative investments that have provided rags-to-riches and riches-to-rags stories, as well as the potential of crypto-based protocols to upset the current world order of financial markets and sovereign borders.

However, many investors in cryptocurrencies and digital assets may not have explored the characteristics of assets that may rise or decline in value. This book offers a balanced view, embracing the potential to profit and democratize markets while tempering the unbridled optimism that has tempted some to invest their entire net worth in a single, highly speculative crypto asset. While the market capitalization of some crypto protocols may one day exceed the valuation of today's largest tech stocks, most crypto assets today are likely to lose value in the coming years.

This book provides an in-depth exploration of cryptocurrencies and digital assets from the point of view of experienced investors in traditional financial markets. While the technology backing blockchains and digital assets has developed rapidly since 2008, venture capital and stock market investing can provide important historical precedents on the outlook for digital asset investments. The venture capital model shows us that, while most startup companies never reach critical mass, disciplined investing in a portfolio of companies or digital assets can provide strong long-term profits. That is, a small number of massive winners can more than offset the losses from many unprofitable investments.

This book is designed to benefit readers with various goals. First, undergraduate and graduate students in business and computer science wishing to enter an exciting industry can study this volume to get up to speed quickly, demonstrating a breadth of knowledge derived from a full semester course. Second, this book can assist investors and financial advisors in understanding the investment implications of this new technology, including the asset allocation and portfolio construction implications of adding crypto assets to a

traditional portfolio of stock and bond investments. Finally, corporate leaders seeking to future proof their business can search for applications of blockchain technology to their current operations.

Part 1 defines cryptocurrencies and digital assets. Chapters 1 to 15 provide a comprehensive introduction to proof-of-work blockchains, such as Bitcoin, and proof-of-stake blockchains, such as Ethereum. The discussion also delves into the characteristics of centralized finance, making a compelling case for adopting distributed ledgers, which can facilitate more transparent and global transactions.

This book also explores the revolutionary potential of smart contracts, paving the way for groundbreaking applications like decentralized finance and non-fungible tokens. Moreover, it highlights how stablecoins and central bank digital currencies could serve as catalysts for the widespread adoption of digital assets on a global scale, opening up new horizons for investors.

Part 2 provides considerations for investing in cryptocurrencies and digital assets. Chapters 16 to 25 describe ways to access digital asset investments, including holding crypto assets on centralized exchanges or in self-custody wallets, crypto-related stocks, venture capital, hedge funds, and derivative products, including futures, options, and perpetual swaps. The fundamental valuation models and due diligence processes that are discussed can be used to evaluate investment decisions carefully. Lessons learned from previous risk events can help investors keep their holdings safe and avoid losses due to overleverage, custody events, and counterparty and credit risk.

The long-term potential of blockchain technology may be most beneficial in tokenizing assets, using the transparency and security of distributed ledgers to provide ownership records for real-world assets, including automobiles, real estate, and event tickets. Distributed ledger and blockchain technology promise to make the world smaller and more equitable, allowing global peer-to-peer transactions while bringing property rights and financial services to the world's 1.4 billion unbanked citizens.

DISCLAIMER

This book is for educational purposes only and does not provide legal, tax, regulatory, or investment advice. The author may have an economic interest in the stocks, cryptocurrencies, and digital assets discussed in this book. Efforts were made to ensure this book's accuracy when the manuscript was drafted. However, taxes, regulations, and the specifics of crypto protocols can and will change over time.

PART

One

Defining Cryptocurrencies and Digital Assets

The first 15 chapters define the landscape of cryptocurrencies and digital assets, including the differing technologies and asset types.

Chapter 1 discusses money, banking, and inflation. The rationale for creating the digital assets industry arose from dissatisfaction with current institutions, especially regarding bank failures and the debasement of the value of fiat currencies through inflation.

Chapter 2 explains the institutions involved in the centralized finance (CeFi) and traditional finance (TradFi) markets. The crypto universe seeks to recreate, replace, or disintermediate many traditional institutions, including central banks, securities exchanges, and commercial banks.

Chapter 3 introduces the concepts of blockchains and distributed ledgers. As investors move away from reliance on centralized counterparties, information is securely stored by thousands of global recordkeepers.

Chapter 4 discusses the revolutionary concept of Bitcoin, including the process of mining in a proof-of-work protocol. Miners earn block rewards for approving transactions and securing the Bitcoin blockchain.

Chapter 5 continues with the evolution of digital assets by discussing the 2014 launch of smart contract technology. The Ethereum blockchain remains a leader in smart contract distributed applications to this day.

Chapter 6 provides a list of alternatives to Ethereum-based smart contracts. Proof-of-stake protocols such as Binance, Avalanche, and Solana seek to provide faster and cheaper access to smart contract-based distributed applications.

Chapter 7 discusses the need to increase the scalability of blockchains, especially Ethereum, which relies on layer 2 solutions such as Polygon, Optimism, and Arbitrum to speed transactions and reduce gas fees.

Chapter 8 introduces stablecoins, which seek to provide a store of value linked to the value of gold, euros, or US dollars. Stablecoins issued by governments are termed central bank digital currencies (CBDCs).

Chapter 9 expands on the use cases of digital assets by explaining oracles and insurance. Oracles provide the price and data feeds required for the smooth operation of smart contracts. Smart contract–enabled insurance policies may revolutionize the cost and speed of insurance operations.

Chapter 10 explains that while the Bitcoin and Ethereum blockchains are designed to be transparent, privacy tokens seek to keep transactions private. The regulatory risks of obscuring transactions are also discussed.

Chapter 11 introduces what could be the most important innovation in the digital assets universe: the creation of a parallel financial system in which decentralized finance (DeFi) seeks to replace the role of banks and securities exchanges.

Chapter 12 explains how smart contract ecosystems can be combined using the concepts of composability and the stacking of distributed applications (DApps) to work together like "money Legos" to accomplish DeFi's goals.

Chapter 13 lists various uses of blockchain applications beyond financial markets, where blockchain technology may revolutionize supply chain management and ticketing for concerts and sporting events.

Chapter 14 explores the exciting impact that blockchain technology may have on popular culture. While initially focused on art, music, and gaming, non-fungible tokens may provide the entry point for consumers to access the metaverse and Web 3.0 using a single wallet as their portable digital identity.

Finally, Chapter 15 explains how the corporate governance structure may be replaced by distributed autonomous organizations (DAOs) that can manage businesses remotely in a much flatter hierarchy than traditional corporations.

CHAPTER 1

Money, Banking, and Inflation

Cryptocurrencies are one portion of the digital asset universe. Digital assets include cryptocurrencies and tokenized assets, including real estate, tickets, art, music, equities, and others that can be viewed as money. Let's discuss some very traditional money and banking economics that describe the current banking system. Later, we will see how cryptocurrencies and digital assets have the potential to improve today's global banking system.

Our discussion starts with fiat currencies and the history of money.

Thousands of years ago, trade relied on the barter system, which did not build the most efficient economy. Those who worked as farmers produced meat, milk, eggs, or grains as their contribution to the economy. Under the barter system, farmers needing clothing must find another participant in the economy willing to trade clothing for the farmer's produce. This barter system has a significant search cost, as participants couldn't always find someone who wanted to take the goods or services they were offering in exchange for the goods or services that they needed.

These high search costs caused many farmers to also chop wood and make clothing, and perhaps some clothing makers to grow their own food. People who weren't able to trade for everything they needed would produce those needed goods or services on their own. This was a relatively inefficient way to trade.

Eventually, market participants agreed on a definition of money, as it was easier to sell the food for money and use the money to purchase the clothing. This reduced the time it took to search for the person willing to trade for whatever goods or services you had to offer. Marketplaces grew with each merchant selling their goods or services for money in a common location, dramatically increasing economic efficiency and allowing market participants to specialize in the good or service where they exhibited the most skill or enjoyment.

The first form of money was based on commodities such as seashells, gold, silver, corn, or tobacco. Of course, once the form of money was defined in an economy, some market participants stopped making food or clothing and set out in search of gold or seashells. Ideally, the commodity money was relatively scarce, but not too scarce that there was not enough money supply to support the desired level of economic activity.

Money is defined as whatever is generally accepted in exchange for goods, services, and debts. Today, fiat money is currencies defined and produced by governments, such as US dollars, Japanese yen, or Euros. While gold or corn may have some intrinsic value, or use beyond exchanging for the goods and services consumers need, fiat currencies have no intrinsic value. The banknotes and coins only have value because the government says they have value.

Efficiencies increase as an economy moves from the barter system into a commodity money system, and increase again as the economy moves from commodity money to fiat money. Consumers don't spend time searching for barter partners, and workers can specialize in the goods they produce most efficiently. As specialization increases, productivity increases, and the economy has a greater quantity and quality of all goods and services available.

There are three characteristics of money. Money is a medium of exchange, a store of value, and a unit of account. A medium of exchange is the characteristic of being able to use money to buy goods and services. When consumers arrive at the market, prices are denominated and listed in money: gold, silver, seashells, or US dollars. Consumers with sufficient money can trade it for whatever goods and services can be procured within their budget. Transactions become more straightforward, and the economy benefits from the division of labor.

Money as a store of value allows producers to save the proceeds of their labor and transfer purchasing power from one time period to another. This is easier with fiat currency and commodities such as gold, but harder with perishable commodity money such as food or tobacco. Those who don't spend their gold or dollars today will be able to buy goods and services at a future date rather than spending all of their income in the current period. Holding commodity money or fiat currency in the form of banknotes does not allow savers to earn interest.

Money is also a unit of account. The listed prices for goods or services are the number of monetary units that the seller will accept for their produce. Consumers have to choose which goods and services to purchase while keeping to their current holdings of money. Producers must determine the price that will be charged for their goods or services in the marketplace. Comparing prices and reducing costs brings economic efficiency into the market.

Once prices are listed in monetary units, economists can track those prices over time. If the price level of goods and services rises over time, there is inflation in the economy and consumers are encouraged to spend their money quickly because rising prices will reduce the future level of goods and services that can be purchased.

Bankers arose to pay interest to savers while lending money to borrowers. Savers were being paid to wait to consume while borrowers were paying more to consume today. Ideally, savers can earn enough interest to offset the decline in purchasing power through inflation, while bankers can earn a positive net interest margin by charging borrowers a higher interest rate and paying depositors a lower interest rate.

Historically, precious stones, gold, silver, seashells, corn, fish, and other foods were used as commodity forms of money. The US was on the gold standard from 1934 to 1971.[1] During this period of time, US dollars were convertible into gold at a fixed price of $35 per ounce. The US did not print dollar bills unless there was sufficient gold in the vaults to guarantee this conversion. From 1934 to 1971, dollars could be exchanged for gold at $35 per ounce, as the dollar was a gold-backed currency. Dollars were inherently worth something because they could be traded for ounces of gold.

This limited ability to print money kept the rate of inflation low but also capped potential economic activity. The gold supply was relatively fixed over time, while the demand for economic activity continued to increase. In 1971, as inflation started to increase, President Richard Nixon ended the gold standard. Without its direct convertibility into gold, the US dollar became a fiat currency unbacked by any store of value. Inflation skyrocketed to more than 11% by 1974 and to more than 13% in 1980. Gold moved away from its fixed price regime and was allowed to trade at a floating price. With gold priced at more than $2,000 per ounce in 2024, the US dollar has lost more than 98% of its value as denominated in gold in just 53 years. The price of most other goods and services in the US also rose sharply over the last 50 years, reducing the purchasing power of a single US dollar. Each dollar now buys less milk, fewer eggs, fewer gallons of gas, and less value in the housing market. Each dollar is worth less as the economy-wide level of prices continues to rise.

The paper dollar bills that consumers have in their wallets or bank accounts are not backed by any physical asset. There's nothing to back those dollars except for the full faith and credit of the US government. The US construct is that dollars are legal tender, meaning that dollars are accepted for US tax payments and for all goods and services sold in the US. Legal tender means that US dollars are required to settle all trades in the US.

Therefore, a vital focus of the cryptocurrency and digital asset community is avoiding inflation or the debasement of fiat currencies. Ideally, this

new type of digital money will not have this type of inflation. Cryptocurrencies and digital assets can potentially serve as a stronger store of value than a fiat currency subject to substantial value debasement through the accumulated effects of price inflation over time.

Fiat currencies, such as dollars, euros, and yen, are exchangeable for valuable goods and services because the respective governments declare them to be valuable. It costs governments very little to print currencies, as printing presses can continually crank out $100 bills or 500 euro notes. The ability of governments to print money without limit is mocked by crypto memes, such as "Money printer go Brrr."

Fortunately for US consumers and investors, the US has a relatively strong financial system. The dollar serves as a hard currency or a safe haven given its history of strong global demand during economic crises. Relatively few currencies serve this role, including dollars, euros, Swiss francs, and British pounds. Even though the dollar has been deemed a strong currency, its value has fallen by more than 97% over the last 50 years due to inflation. Investors need to earn 2% to 3% per year on their savings to maintain the current level of purchasing power over time.

While an average annual inflation rate of 2% or 3% in the US or Europe debases the value of currencies over long periods of time, countries with excess inflation and weak currencies can see purchasing power decline much more quickly. In some emerging markets, governments seek to repay debts or increase spending by increasing the money supply quickly and printing fiat currency without limit. With inflation compounding at more than 600% per year in Zimbabwe or totaling more than 50,000,000% from 2016 to 2019 in Venezuela, people lose trust in the value of the fiat currency. Currency is printed in ever-increasing denominations, such as the 10-trillion-dollar bill issued by Zimbabwe, which is worth less than $1 US dollar. I own one in my personal collection, as it sounds fun to say that I have $10 trillion in cash.

People are paid daily, hopefully at a new wage each day. The pay must be spent immediately because the prices of goods will be even higher next week. When grocery shopping requires wheelbarrows of bolivars or dollar bills, the currency has effectively become worthless. Consumers seek to abandon the use of fiat currencies and search for other stores of value, whether it be dollars, euros, bitcoin, stablecoins, or even move back to commodity money such as gold or precious stones.

Access to hard currencies or cryptocurrencies can be an economic lifeline for consumers in countries with weak currencies or failing banking systems. Rather than going back to the barter economy in Venezuela with consumers trying to buy any goods possible to maintain the value of their assets, it can be easier to store value in cryptocurrencies and digital assets.

While bitcoin or Ether tokens have volatile prices, the value of stablecoins is linked to the value of one dollar or one euro. When moving into blockchain-based wallets, the assets of consumers are no longer linked to the value of their home country's currency or subject to the risks of the local banking system.

Money is valuable because demand exceeds supply. If it's hard to find money, then that money is going to be valuable. The faster the government prints money, the faster the value of that money declines. Prices rise when the money supply grows faster than real GDP. When too much money is chasing too few goods, price levels tend to quickly increase. For example, during the COVID-induced supply chain shortages, the US government was distributing $1,400 stimulus checks to US consumers regardless of their financial need or whether their income had declined. As goods were scarce and money was not scarce, prices rose quickly, such as the 40% increase in used car prices in less than two years after the start of the pandemic.[2]

Hopefully, you've learned as a finance or economics student that personal prosperity requires spending less money than is earned as income. Once you get your first job, you should open a 401(k) plan, save 5% to 10% of your salary and receive your employer's matching contribution. If you can live on 80% to 90% of your income today, eventually you'll be able to retire. You invest those retirement account contributions into stocks and bonds. If stocks and bonds have a higher return than inflation over time, the purchasing power of your assets can increase. By saving money today, you can increase the level of your future consumption.

The US national debt rose from $5 trillion in 1996 to $15 trillion in 2012 and to more than $33 trillion as of the third quarter of 2023.[3] This was the equivalent of 65% of GDP in 1996, 100% of GDP in 2012, and more than 132% of GDP at its peak in the second quarter of 2020, with the debt per capita approaching $100,000. As a percentage of GDP, the US national debt more than doubled from 1996 to 2020. This demonstrates continued borrowings as the US regularly engages in deficit spending whether the economy is strong or in recession. This ever-growing national debt increases the portion of the US budget needed to service the debt, which may require future tax increases or spending cuts.

The US money supply is tracked through the M1 and M2 measures. M1 includes currency and the value of checking accounts, while M2 includes M1 and the value of savings accounts, certificates of deposit, and money market funds. M1 balances are available for immediate spending needs, while M2 can quickly be converted to use for immediate spending needs. Consumers may spend most or all of their M1 balances in any given month, while the savings portion of M2 is designed to be a store of value that is not spent in the

current month. Balances held in investment accounts, such as stocks, bonds, or cryptocurrencies are not counted in the US money supply.

Inflation, economic growth, and money supply growth are closely linked. Between 2000 and 2019, US M2 money supply growth averaged 5.8% while inflation averaged 2.2%. In the three years ending September 2022, US M2 money supply growth exploded to an annualized average rate of 12.4% due to COVID-era stimulus policies as well as the continued easy monetary policy of the Federal Reserve. After CPI inflation reached a low of 0.1% in May 2020, inflation exploded to reach a peak of 9.1% by June 2022, a direct result of the increased money supply growth rate on top of supply chain issues that made goods and services less available. When inflation was just 1% in July 2020, theories of money supply growth could be used to forecast future inflation. In "Socially Distant Inflation," CPI inflation was predicted to reach 5% to 15% due to this growth in money supply and scarcity of goods.[4] With the annual inflation rate having been 2.9% or less since 2012, prices increased by 5.4% in the year ending July 2021 and 9.1% in the year ending June 2022.

US short-term interest rates were near zero from 2009 to 2016 before the Fed tightened to reach 2.4% by mid-2019. By April 2020, the Fed again reduced rates to near zero as a result of the COVID-induced slowdown in the economy. In 2022 and 2023, once it was clear that inflation had reached uncomfortably high levels, the Fed quickly increased rates to more than 5.25%. When economic growth is slow, the Fed might reduce interest rates in order to facilitate economic activity, and when interest rates are rising, the Fed is trying to tighten monetary conditions and reduce inflation.

Money can also be created through fractional reserves, which allow banks to loan more money than they have in deposits. The required reserve ratio is the percentage of deposits that banks must hold as reserves. For banks with assets below $47.8 million in checking account deposits, reserve requirements are set at 3%. Larger banks have reserve requirements of 10%. No reserves are required on M2 categories such as savings accounts or certificates of deposit.

Any deposits in excess of the required reserves are excess reserves that can be lent out as new loans. As excess reserves become loans, the money supply increases. The Fed sets and enforces reserve requirements, but they are rarely changed, as this would be extremely disruptive. Increasing the reserve requirement would tighten credit availability and shrink the money supply while reducing reserve requirements can increase the money supply as loans become more plentiful.

Money is created through an interaction between the Federal Reserve and the banks. Banks extend loans based on customer deposits, which are tracked through the M1 and M2 money supply measures. The excess of deposits over reserve requirements can be lent to consumers through mortgages, credit

cards, car loans, and businesses through commercial loans. Money supply growth accelerates as loan growth increases and the proceeds of the loans are spent more quickly. The monetary base is the amount of bank reserves plus circulating currency. Open market operations, the most frequently used tool of the Fed, change the money supply by about twice their size.

When the Fed is easing monetary policy, it creates money by buying bonds from banks and introducing more cash into the system. When the Fed is tightening, it is selling bonds to take cash out of the system. These open market operations are the most frequently used tool of the Fed. The balance sheet of the US Federal Reserve Bank increased from $4.2 trillion in February 2020 to nearly $9 trillion in the second quarter of 2022. Liquidity at US banks increased by nearly $5 trillion in two years as the Fed bought bonds and injected cash into the US banking system, some of which was recently printed. As the Fed tightened interest rates and sold bonds or allowed them to mature from the second quarter of 2022 to the end of 2023, the Fed's balance sheet declined from nearly $9 trillion to around $7.8 trillion, taking $1.2 trillion out of the banking system. The Fed's decade-long stimulus started at the beginning of the GFC in 2008, as the Fed balance sheet moved from less than $1 trillion in September 2008 to nearly $3 trillion at the end of 2011.

The Fed directly controls short-term interest rates, but less directly influences long-term interest rates. While the Federal funds rate rose from 0% to 5.5%, the 10-year Treasury rate has risen from 2% to 4.25%.

According to Milton Friedman and the monetary school of economists, the money supply primarily influences output in the short run. Easy monetary policy and stimulative fiscal policy can temporarily positively influence GDP growth. The COVID-era stimulus was largely spent by the end of 2023, which kept the US economy out of a recession. However, an increase in the money supply increases prices more than economic growth in the long run. That is, an economy can't simply grow GDP by printing money. Empirically, the more money is printed, the greater the increase in the price level. Fluctuations in real GDP and inflation come primarily from volatility in money supply growth.

The equation of exchange is P * Y = M * V = GDP. Price * output = money * velocity. This quantity theory of money implies that only prices are affected by the growth of the money supply. Output growth is impacted by productivity, labor force size, education, and resource availability. Velocity measures how quickly money is spent.

There's a strong log-linear relationship between inflation and money supply growth. Inflation occurs whenever the money supply grows faster than GDP. For example, 5% money supply growth in a country with 2% real GDP growth is likely to lead to an inflation rate of 3%. Slower money

supply growth is less correlated to inflation. Money supply growth of 2% to 3% might not have a direct correlation to GDP growth or inflation.

The fastest GDP growth experienced in emerging markets can be 5% to 10%. Money supply growth in excess of 10% annually, even in emerging markets with the strongest GDP growth, is likely to lead to inflation. The rates of hyperinflation seen in Venezuela and Zimbabwe come from the government printing money and increasing the money supply by more than 100% annually.

From 2002 to 2019, M2 growth in the US averaged 5.8% while inflation averaged 2.1%, very close to the Fed's target inflation rate of 2%.[5] Besides the global financial crisis of 2008 and 2009, US GDP tended to grow steadily during this period. From 2020 to 2022, M2 growth averaged 11.6%, far above US GDP growth. In 2020, monetary policy was easy, interest rates were near zero, homeowners quickly refinanced mortgages to rates under 3%, and credit was widely available. In addition to stimulative monetary policy, fiscal policy was also stimulative with multiple rounds of $1,400 checks provided to the majority of US taxpayers. With M2 growth of 11.6%, inflation averaged 4.8% from 2020 to 2022, reaching a peak of 9.1% in June 2022, an inflation rate not seen in the US since the 1970s. The US dollar lost more than 15% of its purchasing power as inflation compounded at a 4.8% rate over three years. By the third quarter of 2022, the Fed quickly moved to raise rates from zero to more than 5% in just one year to combat inflation.

The decline in the value of fiat currencies gave digital currency adherents ammunition to say fiat currencies are inherently unstable and untrustworthy. Because the central bank can be stimulative and debase the value of a currency so quickly, it can be difficult to find a store of value.

It is difficult for a central bank to know when to ease and tighten monetary policy, as monetary policy and fiscal policy are implemented with a lag. The effect on employment and output may take 12 to 18 months, while the impact on prices may take two years or longer. The record levels of monetary and fiscal policy stimulus in 2020 resulted in the highest inflation rate in more than 40 years in 2022. The stimulus payments received by consumers were fully spent, but it took until the end of 2023 to work off those levels of excess savings.

The goal of monetary and fiscal policy is to be expansionary below full employment in times of slow GDP growth and recessions. If the Fed could know exactly when the economy will experience a period of slow growth, the economy can improve if the Fed is stimulative during that time. Central banks also want to be restrictive in times of excess growth. Once the economy is growing too quickly, the goal is to slow growth and reduce potential inflation.

The difficulty is that when decisions are made regarding monetary and fiscal policy, the central bank doesn't know what economic conditions will be one to two years from now when those policies will eventually impact the economy. There is a potential for stimulative policies to impact the economy during a time of growth, which can accelerate inflationary pressures. There is also the potential for restrictive policy to impact the economy during a time of slowing growth, perhaps deepening a recession.

In 2022 and 2023, it was probably too late for the Fed to increase interest rates and too late to slow that money supply growth. In 2022, the Fed is starting to implement restrictive monetary policy while fiscal policy is becoming more restrictive as stimulus programs are ending. While both monetary and fiscal policy are simultaneously restrictive, the Fed's balance sheet is also shrinking. Interest rates have risen from zero to more than 5% in an attempt to slow the economy, but the timing of how this will impact the economy is unknown as policy changes impact the economy with a lag.

It is unknown if the interest rate increases implemented in the second half of 2022 will move the US economy into recession in 2024. The interest rate increases implemented in 2022 aren't immediately impacting the economy in 2022, but can impact the economy in 2023 and 2024. The Fed doesn't know exactly how tight monetary policy should be because the impact is going to be felt in the economy with a lag. It makes sense for a pause in any easing or tightening cycle to observe the impact on employment and output.

Unfortunately, a central bank may be stimulative for too long, leading to excess growth and inflation, or restrictive for too long, perhaps pushing the economy into recession. Rather than attempting to time the economy by being stimulative during times of slow growth and restrictive during times of strong growth and inflationary pressures, some economists would prefer that central banks simply implement a stable money supply growth policy.

If the central bank believes that maximum long-term GDP growth is 2% to 3%, inflation can remain under control with a policy of targeting a stable money supply growth rate of 4%. When money supply growth is 4% and GDP growth averages 2%, the central bank may reach a target of an average annual inflation rate of 2%. With stable money supply growth, businesses can plan for relatively stable inflation rates of around 2%.

With a stable money supply growth rate, the central bank isn't trying to predict when to stimulate a weak economy or when to restrict a strong economy. The stable money supply growth rate will automatically be stimulative in a weak economy and automatically restrictive in a strong economy. Whenever GDP growth exceeds 4%, 4% money supply growth is automatically restrictive. The slower the economy becomes, the more stimulative the money supply growth becomes. Another benefit of stable

money supply growth is that business owners and central bankers don't have to predict when monetary policy is going to be stimulative or restrictive, so the economy will automatically react to the stable policy.

It is important to understand real interest rates and nominal interest rates. Fixed-rate bonds and bank deposits earn a nominal interest rate. In early 2024, nominal rates were 5% on short-term Treasury bills and 4% on 10-year Treasury notes. Consumers were able to earn more than 4% on carefully chosen checking accounts or certificates of deposits. Nominal rates equal real rates plus expected inflation.

Expected inflation can be observed as the difference between nominal Treasury notes and Treasury Inflation-Protected Securities (TIPS), which pay a real yield. In early 2024, the five-year Treasury had a nominal yield of 4.0% while the 5-year TIPS had a real yield of 1.6%, making expected inflation 2.4%.[6] Consumers investing at rates of 4% have a positive real yield, meaning that their purchasing power increases over time as the interest earned exceeds the inflation rate. Those holding assets in cash or bank accounts earning yields near zero will experience declines in purchasing power close to the annual inflation rate.

Investors are not encouraged to compare nominal rates across countries, as the main source of the difference in interest rates around the world is inflation rates. Real rates are relatively stable around the world. For example, the US has nominal yields of around 4% and real yields of around 1.6%. Investors may be tempted to buy Brazilian government bonds at 10% yields, but they are likely to lose more than 8% to inflation, leaving real rates near 2%. While the difference in nominal rates between the US and Brazil is 6%, the difference in real rates is less than 1%. Investors seek to invest in countries with the highest real interest rates, not countries with the highest nominal interest rates, as real rates measure the ability to preserve purchasing power over time.

The US inflation rate is based on the annual change in the consumer price index (CPI). Compiled by the US government, the CPI regularly measures the cost of a typical bundle of goods purchased by households. The CPI basket is about 33% housing; about 20% goes into food and energy, including groceries, restaurants, heating bills, electric bills, and gasoline. Housing, food, and energy make up 53% of the CPI basket, with another 15% on education and medical care, 9% on new and used cars, and 23% on all other consumer goods and services.

The government regularly surveys the prices of goods and services to determine the inflation rate and the change in the consumer price index year over year. A 6% inflation rate is experienced when the cost of goods and services in the consumer price index has risen by 6% from last year to this year, meaning that the basket of goods and services consumed by the average

American is 6% more expensive than it was last year. The higher the inflation rate, the weaker the value of the dollar.

Currencies exist in a global market. The dollar is worth whatever basket of goods and services consumers could buy with it. We can also measure the value of the dollar relative to the Brazilian real or the euro. The value of each currency is calculated relative to another.

A key determinant of the currency's value is the difference in inflation rates from one country to another. If Brazil has a higher inflation rate than the US, the Brazilian currency is expected to devalue or weaken relative to the dollar. Inflation rates also influence exports and imports. If prices in a country are increasing relative to other countries, that country is likely to purchase more imported goods at lower prices and export fewer goods at higher prices. These dynamics mean there is excess selling of the currency to pay for imports, which drives the currency's price lower. Countries with lower relative inflation rates are likely to experience greater exports and fewer imports. Higher exports create demand for the currency, which leads to higher prices.

Nominal rates are equal to real rates plus expected inflation. Higher real interest rates cause a currency to appreciate over long periods of time, as money from around the world flows into that country's investment markets.

From its low in 2008 until early 2024, the US dollar appreciated 40% relative to a basket of large global currencies. The strong dollar was driven by real interest rates and strong stock prices that attracted capital from around the world.

This has been an overview of the traditional money and banking system. We've defined monetary policy and how the Fed sets interest rates. We've defined fiscal policy as the government's taxing and spending policies. When monetary and fiscal policies are stimulative, the economy may experience rising inflation and faster GDP growth. Restrictive policies are designed to slow inflation and economic growth.

The cryptocurrency community views a number of weaknesses in this TradFi system, as they seek to build a parallel monetary system that can reduce the impact of inflation and excessive money supply growth on the debasement of fiat currencies.

CHAPTER 2

Centralized Finance (CeFi) and Traditional Finance (TradFi) Markets

In Chapter 1, we explored traditional methods of money and banking and the impact of inflation on the long-term purchasing power of fiat currencies. In this chapter, we will discuss how blockchain-based markets seek to improve on the inefficiencies of the centralized finance (CeFi) and traditional finance (TradFi) markets.

The digital asset market facilitated by blockchain will change many of the industries in today's economy. One of the first areas of innovation is moving functions from traditional and centralized financial markets into a parallel financial market facilitated by blockchain technology.

Once we understand these different financial systems, we'll move to the Bitcoin and Ethereum blockchains to see how this new financial technology may one day replace many existing financial systems.

Our financial system has a variety of goals including price discovery, asset liquidity, facilitating payments, and efficiently bringing savers and borrowers together.

Price discovery allows investors to know exactly what an asset is worth at any point in time, while liquidity allows investors to sell an asset quickly for close to the expected price. The insurance industry and derivative products, such as futures and options, are among the largest businesses in the financial sector. Facilitating payments and purchases allows consumers in an economy to efficiently interact without resorting to barter.

Savers have excess capital with a desire to earn a return, ideally a yield that is higher than inflation, so their savings can have greater purchasing power in the future than in the present. There is also a need for individuals and corporations to borrow. In many cases, older individuals are savers and younger individuals are borrowers. Younger companies need to access capital to grow while more mature companies may have excess capital to invest.

Bringing borrowers and savers together allows money to move through the economy, while the capital markets help the economy grow jobs and make investments. An economy can develop a shared prosperity when the

savings of the savers are used to lend to the borrowers, and hopefully, the borrowers will put that money to good use, perhaps starting a business, buying a house, or earning a college degree.

Cryptocurrencies, digital assets, and blockchain technology have the ability to transplant or reinvent many of the areas of the CeFi industry. Centralized means that there is one specific institution that's in charge. It might be a bank, a securities exchange, a governmental regulator, or a central bank. Other centralized counterparties include credit card payment processors, remittance facilitators, and insurance companies. Many of these large financial institutions are now seeing competitors in the blockchain space.

Banks bring together savers and borrowers. Savers deposit their money into the bank to earn a yield to maintain or grow the future purchasing power of their cash. Banks loan those deposits to borrowers who consume or invest today and repay the loans in the future. Ideally, the investments made with the borrowed funds have a higher return than the loan's interest cost, allowing the borrower's wealth to grow. Banks allow borrowers to spend now, and savers to store and increase their assets for future spending.

Many institutions have relatively similar functions, such as banks, credit unions, and savings and loans. In the US, deposits are insured up to $250,000 per individual per institution by Federal government institutions such as the Federal Deposit Insurance Corporation (FDIC) and the National Credit Union Administration (NCUA). While US banks insure a portion of deposits, deposit insurance is not available in every country and certainly not widely available in the cryptocurrency and digital asset industry.

It is important to understand the assets and liabilities of these depository institutions. A bank's assets are the customers' liabilities, and the bank's liabilities are the customers' assets. Banks borrow money from their customers' deposits into checking accounts, savings accounts, and certificates of deposit. Many of those deposits bear interest, which comprises the bank's borrowing costs. In addition to customer deposits, banks may borrow money through short-term credit facilities or by issuing long-term bonds.

Assets (Often Long Term)	**Liabilities (Often Short Term)**
Loans	Checking accounts
Cash	Savings accounts
Central bank reserves	Certificates of deposit
Bonds and investments	Bank borrowings

The liabilities of bank customers, such as loans, are the key assets of a bank. Banks can also keep cash reserves in their vault or on deposit with the central bank. Banks can also purchase bonds and make other investments.

The goal of a bank is to earn a positive net interest margin, which is the income on loans and other assets relative to the costs of the bank's deposit base and borrowings. For example, if the bank offers a corporate loan at 8% and pays a 3% yield on a checking account, the bank's net interest margin is 5%. The bank earns a profit when the net interest margin exceeds the cost of their operations, employees, buildings, and losses on loan defaults and bad investments.

The goal is to borrow at a lower rate and lend at a higher rate. The net interest margin is the difference between a lower borrowing rate and a higher lending rate. Banking is difficult when the duration of the assets differs from the duration of the liabilities. An asset-liability mismatch is created when bank deposits can be withdrawn at any time, while the bank uses the volatile deposit base to lend to homeowners in the form of 30-year fixed-rate mortgages. Banks naturally tend to have short-term liabilities and long-term assets. If not carefully managed and hedged, times of rising rates can be especially challenging for banks.

In centralized finance, investors are concerned about the potential failure of a key institution. In the great financial crisis (GFC) of 2008, a number of significant players in the financial industry failed, including Bear Stearns and Lehman Brothers. When banks fail, depositors are concerned about when, and if, they will receive the return of their assets.

There's a concern that banks exhibit censorship when some types of consumers are denied service. Denials of service may be due to a consumer's income or credit quality, country of citizenship, or even discrimination based on race or other issues. A key goal of the cryptocurrency industry is to provide a level playing field for consumers around the world. Consumers are free to interact with any blockchain-based protocol as long as they meet the financial requirements.

Many countries, especially those in emerging markets, have strict regulations or a lack of access to financial services. If the services are available, they may be expensive or difficult to access.

Finally, centralized counterparties, whether banks or social media providers, tend to operate as walled gardens. While the assets or social media connections are the consumer's property, centralized businesses make it difficult to transfer across platforms. In order to transfer an account from one US bank or brokerage firm to another, it may take several days or even weeks to fully close one account, open another account, and transfer assets to the new account. It is even more difficult to transfer US dollar–denominated assets from a US bank to euro-denominated assets at the European bank.

While transferring assets from one firm to another is time-consuming, it is extraordinarily difficult to transfer liabilities, such as a home mortgage, from one bank to another. That process typically involves refinancing, borrowing a new mortgage at today's current rate, and using the proceeds to

retire the original mortgage. This is beneficial during declining interest rates, but infeasible and expensive during times of rising mortgage rates.

Similarly, there is no portability of a user's followers, friend list, or connections between Twitter/X, Facebook, or LinkedIn platforms.

The goal of the blockchain and cryptocurrency community is to use a decentralized, peer-to-peer system to disintermediate banks, reduce costs, and make it easier for consumers to access financial services worldwide.

Banks fail for a variety of reasons, especially credit losses, investment losses, and asset-liability mismatches. A recipe for bank failure is when the bank's assets are long term and illiquid, and the liabilities are called immediately. A moral hazard is created if the banks receive the profit or reward for taking risks while the losses from taking those risks are insured by the government or the taxpayers. In fact, taking greater risks by lending to more risky borrowers is expected to have a higher net interest margin, but the riskiest borrowers also have the highest probability of defaulting on the loan and not repaying principal and interest as scheduled.

What are the mechanics of a bank failure? Consider the market in 2021, where savers were earning near-zero interest rates while borrowers were able to lock in 30-year mortgages at 3%. Banks expected to earn a net interest margin of 3%. However, after the Fed tightened rates aggressively in 2022 and 2023, savers sought to earn 5% yields on Treasury bills, money markets, and even checking accounts. Banks paying zero interest rates were forced to either increase the interest rates they offered to maintain their deposit base or see their deposits depart for higher-yielding accounts in other institutions. Banks paying 5% on deposits while earning 3% income on 30-year mortgages face a negative net interest margin that can threaten the profitability and stability of the bank.

In March 2023, Silicon Valley Bank (SVB) experienced the largest bank failure in 15 years and second only to the 2008 demise of Washington Mutual as the largest bank failure in US history. As SVB's assets increased from $71 billion in 2019 to $211 billion in 2022, the bank was unable to increase loan growth as quickly as asset growth, so a substantial amount of bonds was purchased.

As short-term interest rates increased rapidly, SVB's portfolio of long-term Treasury bonds was losing value. After mark-to-market losses of more than $15 billion combined with a bank run of rapid customer withdrawals, the bank failed and its operations were sold to First Citizens Bancshares.

SVB noted that its available-for-sale bond portfolio held $21 billion in US Treasury and agency securities, yielding 1.79% with an average duration of 3.6 years.[1] As interest rates rise, bond prices decline at a rate of the duration multiplied by the change in yield.