



Expertise
and insight
for the future

Don Q.Dang

Macroeconomics and Blockchain

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| <p>The purpose of the Bachelor's thesis was to present the advantages of blockchain technology and how it would fit in the macroeconomic context.</p> <p>The modern macroeconomics theories used by many countries, which were a mixture of some major theories such as Keynesian, Monetarism and Austrian school of thoughts. The thesis hypothesized that blockchain-base fiat money could fill in some blank spot of the old theories.</p> <p>Therefore, the thesis compared the three major theories to each other, along with the development of money and history, using qualitative research method, in order to see that these theories had proved to be working at a period of time in history, however they had become outdated quickly as the development of technology and historical events.</p> <p>The revolution of the internet changed everything, included the monetary policies and banking systems, many services and products have been digitalized and so as money. Therefore, they should be ready to adapt to the new revolution of technology which blockchain started.</p> | |
| Keywords | |

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Glossary

ICO Initial Coin Offering

DAOs Decentralized Autonomous Organizations

1 Introduction

Money, financial institutions and governments' policies are among the most essentials of all economies, yet the understandings of what money is, what the banks do and what monetary policies are, are still very controversial. Especially, in the last two decades, together with a series of events that shake the world's economics, the discussions about money, banks, and governments have drawn a lot more attention. Not so long after the dot-com bubble had burst in the early 2000s, from the same market, the U.S, another bubble was burst and because the US was such a big player in the world, all of the major economies in the world were affected, eventually led to the Financial Crisis in 2008. In the same year marked the emergence of so-call "a new money", Bitcoin and the technology powering it - Blockchain. Was it a coincident or not, Blockchain and Bitcoin appeared in the right moment when the trust of the people in financial institutions was about to fell off the cliff.

And explained in the first paragraph of the released paper on Bitcoin, the mysterious Satoshi Nakamoto said:

"Commerce on the Internet has come to rely almost exclusively on financial institutions serving as trusted third parties to process electronic payments. While the system works well enough for most transactions, it still suffers from the inherent weaknesses of the trust based model. Completely non-reversible transactions are not really possible, since financial institutions cannot avoid mediating disputes. The cost of mediation increases transaction costs, limiting the minimum practical transaction size and cutting off the possibility for small casual transactions, and there is a broader cost in the loss of ability to make non-reversible payments for nonreversible services. With the possibility of reversal, the need for trust spreads. Merchants must be wary of their customers, hassling them for more information than they would otherwise need. A certain percentage of fraud is accepted as unavoidable. These costs and payment uncertainties can be avoided in person by using physical currency, but no mechanism exists to make payments over a communications channel without a trusted party.

What is needed is an electronic payment system based on cryptographic proof instead of trust, allowing any two willing parties to transact directly with each other without the need for a trusted third party.” (Satoshi Nakamoto, 2009)

As a result, Bitcoin and Blockchain technology started to gain more support from the people, especially those who were suffered by the financial crisis. The first Bitcoin transaction was made in 2009 with 10.000 BTC in exchange for two pizzas, then 9 years later, in late 2018 it went up to almost \$20.000 per 1 BTC.

However, this paper will not discuss Bitcoin but the technology that is powering Bitcoin and later on powering more than a thousand other cryptocurrencies, the Blockchain technology. Follow along with the historical development of money, from the barter system to Gold Standard, to Fiat Currency, will the next one be the Blockchain-based Currency? By that, I do not mean the controversial cryptocurrencies, but more like the Blockchain-based Dollars or Euros or Yen and so on. Also by looking at the developments of macro-economic theories such as Keynesian Theories, Monetarism Theories, Austrian School of thoughts and so on, hopefully, we can see the fit of Blockchain-based currency in the future.

2 The Development of Money

2.1 Representative money

Money is defined by its 4 functions (Milnes, Alfred, 1919), which are a Medium of exchange, a value measure, a deferral payment standard and a value store.

Medium of exchange

It is a widely accepted token which can be exchanged for goods and services, and because of that, it acts as an intermediary instrument.

Measure of value

Or in other words, Unit of account. The value of something is measured in a specific currency unit, thus, it allows different things to compare again each other.

Standard of deferred payment

It is a widely accepted way to value a debt, and thereby allowing goods and services to be acquired now and paid for in the future

Store of value

It means people can keep wealth in the form of money. It can be saved, retrieved and exchanged at a later time, and be predictably useful when retrieved. In other words, storing money means holding of purchasing power.

Thus, money can exist in various forms such as commodity money (such as Gold, Silver), representative money (a representative of a commodity), and most commonly used nowadays - Fiat money. In this part of the paper, we will not go back too far in the past, instead, we will only discuss the development of money in the form of representative money and fiat money.

Representative money is a piece of paper that represent or be a claim on the commodity such as Gold. Gold is natural material which is rare, very difficult to be mined and is limited, but it is also why Gold is so valuable throughout the history of many different and distance cultures, and it's even more valuable nowadays when it gets rarer. However, using a piece of gold for micropayment as well as carrying it around was never safe. Under the gold standard, the US Dollar was in the form of representative money.



Figure 1: a \$20 US Dollar bill in Gold Standard

The \$20 note in the figure above, stated that it was a Gold Certificated and it could be exchanged for an equally valued piece of Gold anytime when the bearer demand. Thus, in this systems, banks and governments had to make sure that the amount of Gold in their safe had to be equal or greater than the total value of all certificates that were circulating in the market.

In the early and mid 20th century, the World War I and II broke out, as the result, all of the world most powerful economies at the time spent their gold reserves trying to win the war.

“The war of 1914 provided telling proof of the fact that state-guaranteed paper money, unlike gold and silver coins, doe not represent any substantial value. Marshal Trivulzio said that three things are necessary to make war: money, money and yet again money. Ludwig XII asked him what armaments and stores would be required to conquer Milan, and Trivulzio was quite right to assume that he would be able to purchase the necessary arms and provisions with the money then in circulation. With our paper money, this is not possible. It does not consist of gold and silver”
(Hjalmar Schacht, The Magic of Money, 1967)

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Figure 2: Hjalmar Schacht, The Magic of Money, 1967

The 20th century has various features: it is called a century of war, technological advancement, atomic energy, ideology, economic growth, the explosion of population, and so forth. But here it is also a century of gold. (Toyoyuki Samedá, 1999)

The three charts below would somehow describe the flow of the Gold reserves across some of the most powerful economies at the time.

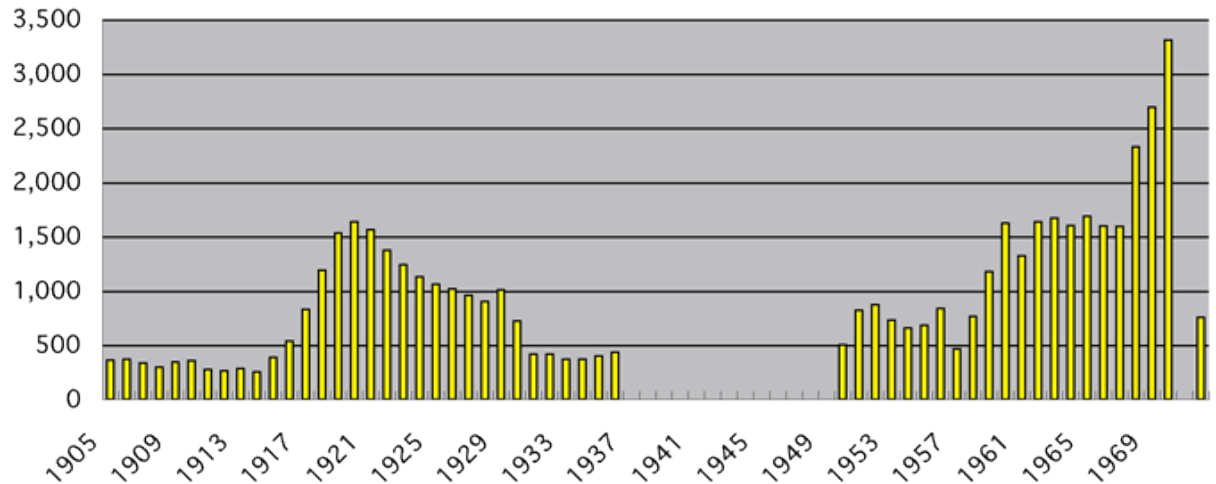


Figure 3: Gold Reserve of Japanese Government & Bank of Japan (1905-36, 1950-70, and 1998) Unit: Au. ton

During World War I, Japan was among the winning countries, however, World War II marked the end of the Japanese Empire as they also spent or lost everything in their gold reserves.

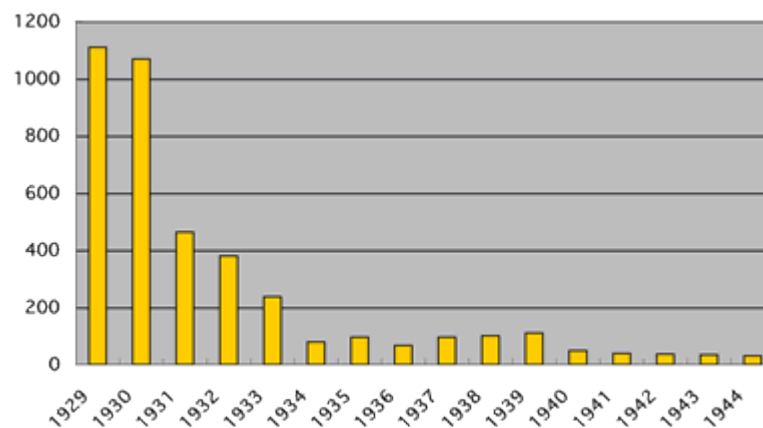


Figure 4: German Reserve of Gold & Foreign Currency held by Reichsbank (1929-44)

Germany's gold reserve during World War II went to the same direction as her ally Japan. By the end of the war, almost everything in Germany's gold reserve was spent.

World War II also marked a significant rise of the U.S gold reserve as shown in the chart below. In 1944, it was estimated that the US possessed three-fourth ($\frac{3}{4}$) of the total amount of gold in the world, whilst the rest of the world had to share the last one quarter ($\frac{1}{4}$). Nowadays, the U.S is still holding the largest amount of gold - 8133.50 tonnes (in March 2019), about 2.5 times higher than the second country which is Germany holding 3369.70 tones (in March 2019). Back in 1944 none of the main economies in the world in 1944 would have enough Gold in reserve to be able to maintain a monetary system based on Gold standard anymore, excepted for the United State of America.

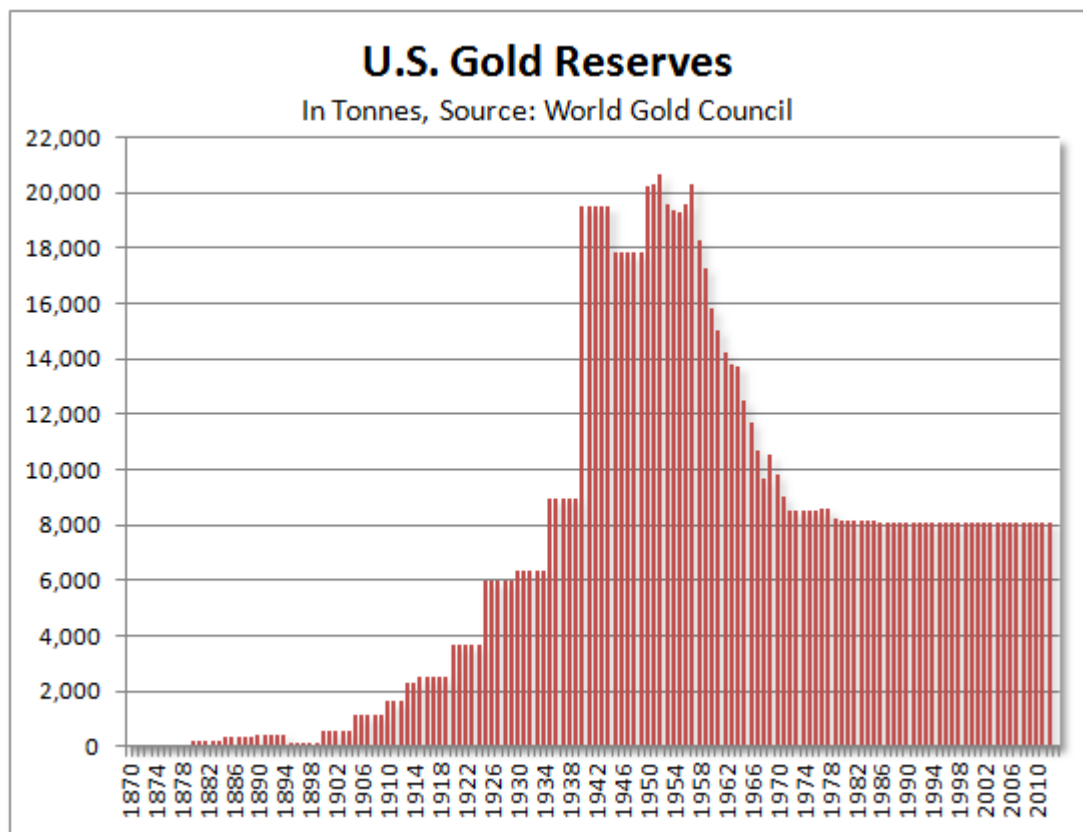


Figure 5: U.S Gold Reserves historical data

In 1944, leaders of the Allied released a "Joint Statement by Experts on the Establishment of an International Monetary Fund" that provided the basis for the negotiations at Bretton Woods. After three weeks of discussion, the delegates signed the Final Act of the United Nations Monetary and Financial Conference, which included charters outlining the aims and mechanisms of both the IMF and IBRD. The IMF was charged with the maintenance of a system of fixed exchange rates centered on the U.S. dollar and gold. In the end, almost all of the main currency then would be backed by the US Dollar. This new framework set up the Dollar as the worldwide currency and

the remainder of the world was taken off the gold standard, and put it in "Dollar standard" instead

The problem with the Bretton Woods system was that there was no reserve-ratio established, means that there was no regulation or law stated about how much of Gold one must keep in reserve. After World War II, most of the world had done with wars, accepted for the U.S. Between 1950 and 1969 when Germany and Japan recuperated, the amount of the world's monetary yield owned by the US dropped to 27% altogether, from 35%. Besides, deficit spendings, developing public debt brought about by the war in Korea and the Vietnam War, and monetary inflation by the Federal Reserve caused the dollar to turn out to be increasingly overvalued (Lowenstein Roger, 2011)

The French called the Bretton Woods system as "America's exorbitant privilege", referred to the benefit of the U.S had due to its own currency being the international reserve currency, as it resulted in an asymmetric financial system where non-US citizens found themselves supporting the living standards of American and subsidizing American multinationals. As American economist Barry Eichengreen summarized: "It costs only a few cents for Bureau of Engraving and Printing to produce a \$100 bill, but other countries had to pony up \$100 of actual goods in order to obtain one" (Barry Eichengreen, 2011). The French president Charles de Gaulle, in 1965, made an announcement to exchange France's U.S dollar reserves for gold at the official exchange rate.(Margaret Garritsen de Vries, 1971)

West Germany was unwilling to revalue its Deutsche Mark and eventually left the Bretton Woods system in May 1971. Switzerland redeemed \$50 million in July and left the Bretton Woods system in August, France acquired \$191 million in gold (Frum David, 2000). As the outcome, in 1971 the US was experiencing enormous stagflation – a destructive blend of recession and high inflation. Accordingly, Richard Nixon deflated the dollar to \$42 per ounce. A run was created on the US gold reserve as individuals redeemed their rapidly debasing dollars for pieces of gold.

In 1973, Richard Nixon declared the value of the dollar to be completely unhooked from gold, which was called later the Nixon Shock, and as the Dollar was the last currency backed by Gold, now the world monetary became the current type of currency as we know of and are using, the Fiat Currencies.

2.2 Fiat Money

Fiat money has been defined as:

A type of money declared and guaranteed by a government to be its legal tender.

Explained by the Bank of England, “Many people are confused about what legal tender means. It’s actually about settling debts rather than how you can pay for things.”

A type of money that is issued by the state and by law it is neither convertible to any other thing nor fixed in value in terms of any objective standard (John Maynard Keynes, 1965)

Money that has no intrinsic value and used as money because of government decree. (N. Gregory Mankiw, 2014)

An intrinsically useless object that serves as a medium of exchange

So how does fiat money fit in the four functions of money? Well, since they are intrinsically valueless and useless, to serve as a medium of exchange, a measure of value, standard of deferred payment and store of value, fiat money only needs to be backed or issued by governments. Bank of England stated on their website that, the banknotes they produce will always be worth their face value and they contain the ‘promise to pay’ inscription.

“We stand by the ‘promise to pay’, but exchange into gold is no longer possible: today, our notes can instead be exchanged for other Bank of England notes of the same face value.” - Bank of England.

And the same how it works in all other nations and since fiat money is not linked to physical reserves, such as a national stockpile of gold or silver, it may lose value due to inflation or even become worthless in the event of hyperinflation. If people lose belief in the currency of a nation, the money will no longer hold value.

Representative money such as the dollar backed by Gold had a big limitation, it limited the money supply in the economy and thus limited the government power to manage the variables of the economy such as the rate of interest, liquidity, the supply of money,

and velocity of money. Governments now want to have more control in these variable, to avoid being in a crisis or stagflation. However, the 2007 mortgage crisis and subsequent financial meltdown tempered the belief that by regulating money supply, central banks could necessarily prevent depression or severe recessions.

Zimbabwe's provided an example of the worst-case scenario of the early 2000s. In response to serious economic problems, the central bank of the country began printing money at a staggering pace. This resulted in hyperinflation, which in 2008 ran between 230 and 500 billion percent. Prices rose rapidly and consumers were forced to carry money bags just to buy basic staples. At the height of the crisis, about 40 cents worth of 1 trillion Zimbabwean dollars in U.S. currency (Investopedia, 2019).

2.3 The forms of today's fiat money

The main two forms of money that nowadays everyone is using are cash and bank deposits. In the UK, the vast majority of all money is held electronically as deposits with 96%, with just a small proportion held in physical form as cash (banknotes and coins), only 4%. The trend towards the use of non-cash transactions and settlement began in daily life during the 1990s, when electronic banking became common. By the 2010s, digital payment methods were widespread in many countries, with examples including intermediaries such as Paypal, digital wallet systems operated by companies such as Apple, Samsung, contactless and NFC payments by electronic card and/or smartphone, and electronic bills and banking, all in widespread use.

Together with the development of digitalization and technology, digital money can allow for instantaneous and borderless transfer-of-ownership, it also expands into smaller categories.

- *Centralized digital money* is the digital money issued and controlled by governments and central banks.
- *Virtual money* is a type of unregulated, digital money according to the European Central Bank. It is usually issue and controlled by its creators, accepted and used in a certain community.

There are three different types of virtual money: closed virtual currency, unidirectional flow currency, and bidirectional flow currency

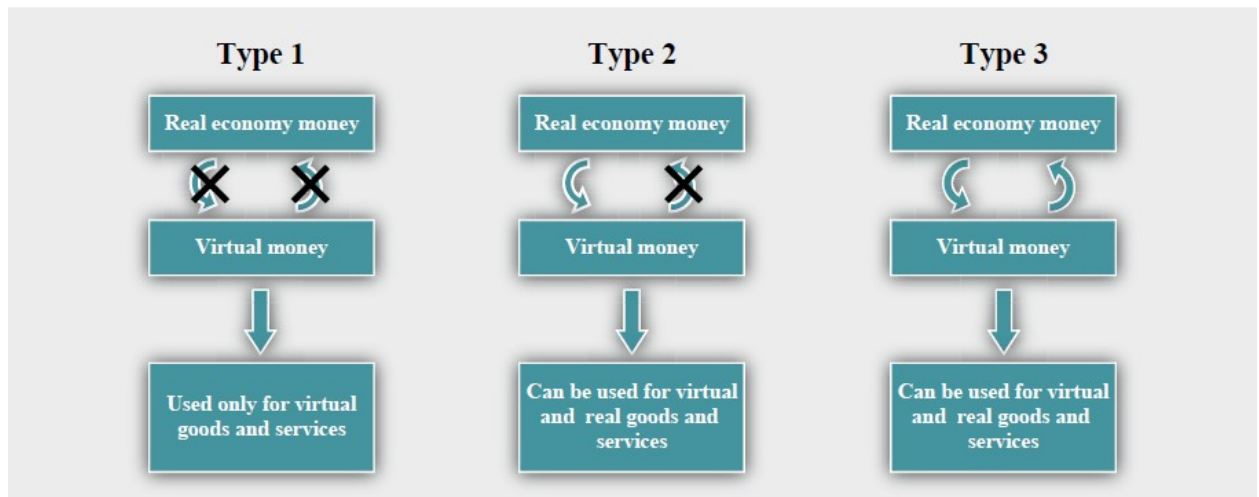


Figure 6: Types of virtual currency. Source: Virtual Currency Schemes - European Central Bank

The first one, which has no relationship with the real money, is called closed-virtual-currency. It is used only in a virtual environment, for example video games, to purchase virtual goods and services there.

The second one is called uni-directional-flow currency. It can be acquired using currencies in real life such as USD and EUR at a set rate of exchange, however, it cannot be converted back to the real fiat currency. For example, Facebook introduced Facebook Credit (FB) in 2009, a virtual money allowed users to buy virtual products in any Facebook's applications. They could be bought by using a credit card, via Pay Pal account and many other payment methods.

The last one is called the currency of bi-directional flow. People can buy virtual money and sell it with their real money based on a rate of exchange. It is similar to any other convertible currency in terms of its interoperability with the real world, allowing users to purchase real and virtual goods and products. The fiat currencies such as USD or EUR, which are being used electronically, does not belong to this group. The figure below shows the differences between Electronic and Virtual currencies.

| | Electronic money schemes | Virtual currency schemes |
|--------------------------------|--|--|
| Money format | Digital | Digital |
| Unit of account | Traditional currency (euro, US dollars, pounds, etc.) with legal tender status | Invented currency (Linden Dollars, Bitcoins, etc.) without legal tender status |
| Acceptance | By undertakings other than the issuer | Usually within a specific virtual community |
| Legal status | Regulated | Unregulated |
| Issuer | Legally established electronic money institution | Non-financial private company |
| Supply of money | Fixed | Not fixed (depends on issuer's decisions) |
| Possibility of redeeming funds | Guaranteed (and at par value) | Not guaranteed |
| Supervision | Yes | No |
| Type(s) of risk | Mainly operational | Legal, credit, liquidity and operational |

Source: ECB.

Figure 7: Differences between Electronic and Virtual Currency. Source - Virtual Currency Schemes, European Central Bank

2.4 Bitcoins and Blockchain

2.4.1 Bitcoin

Satoshi Nakamoto, the known creator of Bitcoin and whose real identity is still unknown, released his work on Bitcoin and the blockchain technology and proved that his idea was able to solve the problems which had made all prior researches failed. He published his work to the internet in 2009 and completely vanished with only one message to one of his friend that he had moved on to another project. He gave additional people, separate from the Bitcoin developers, ownership of the domain, to share responsibilities and to prevent any person or group from gaining control easily over the Bitcoin. The story inspired many journalists to take part in investigating the true ID of Satoshi Nakamoto. Despite a few suspects, all of them turned out to be wrong and so far nobody knows who Satoshi Nakamoto really is.

The system of Bitcoin is a decentralized system designed so that there is no involvement of central monetary authority. Described in the work he published, Nakamoto said:

“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”.

So how it actually works? Here is the simplified version:

- When buyer and seller agreed on a deal, the buyer then sends bitcoin to the seller as payment, and seller then sends his product to the buyer. The transaction is started when both sides has done their parts, and it is irreversible, meaning that the transaction can not be cancelled.
- Then an encrypted digital “message” is sent to the system in which contains the public keys to identify sender and receiver. After that, miners who are parts of the system will be selected randomly into a “competition” of verifying the transaction.
- Miners have to use computer power, following a set of rules of defined by the system, to solve the mathematical algorithms that are used to encrypt the transaction. And here is one of the most disadvantaged of blockchain technology and bitcoin, because it consumes a lot of electricity.
- The data that miners’ computers get from decoding the “message” will be cross-checked with the historical data stored in a digital data block within the system.
- Only the a few miners who have completed the verification of the transaction first get rewarded with a certain amount of Bitcoin by the system, and that is when a amount of Bitcoin is created and introduced into the system. This step is called confirmation, for a transaction to take place, 6 confirmations are usually required. The process of validating and verifying the transaction as described above is called "mining."

After being verified, the transaction is saved in a data collection block in the system together with other transactions’ historical data are also stored. This data block is strictly linked to the block before it and used as a reference for the block that will be created after it, that makes a chain of blocks and we call it blockchain. All of the miners keep their own copies of the blockchain data, or in another word a ledger, it will be updated simultaneously and continuously as new transactions are happening and being verified in the system.

Buyers and sellers, in this system, can do trade with each other without a trusted middleman such as banks or bank-like institutions. In the conventional way, one or sometimes more than one trusted third parties participate in the process, that increases transactional costs, which are eventually passed on to consumers, as well as time to the business. In cases that the third party fails to fulfil its duty, it might push business into an unexpected crisis. Although there are a lot of laws and regulations to ensure the trust, it costs businesses so much more to sort it out when a contract breach occurs.

Bitcoin ensures that the trust is not needed as well as third parties since there are sets of rules that have been coded into its system, the system ensures that transactions can only take place when all the rules and conditions are met. How about the intermediaries that are called Exchanges

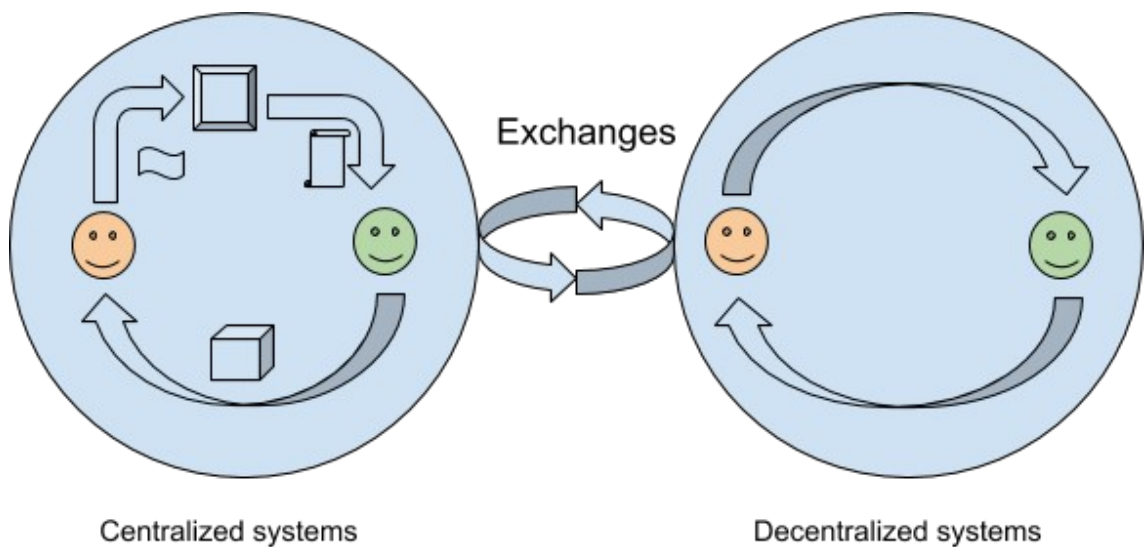


Figure 8: visualization of how money flows from one system to another

The Centralized system is the world of fiat currencies or centralized currencies. Normally, when a buyer wants to buy something from a seller, the buyer must first pay the money to the seller's bank, when the bank confirms that money is in place, the seller then ships the products. The bank will take a small commission fee from the seller for using their services, and that fee then becomes a part of products' costs for the buyer.

In the Decentralized system, buyer and seller after having agreed on the deal can start making a transaction. Immediately buyer and seller can see each other alias and amount of money they have, the seller can be notified that a transaction is on the way once the buyer has made payment. Because the transaction is irreversible, seller can start shipping the products knowing that he/she will get the money. The blockchain technology allows a feature called Smart contract, which we will discuss later, it makes sure that only when the payment and shipment are on the way and both sides have done their responsibility, the transaction is moved to the network, waiting for miners to do their verifying task and return back confirmations that everything is legit, then the transaction is done and miners get their rewards from the system.

In order to get into and buy some cryptocurrencies, people would need a middleman to help them get started. These exchanges show the exchange rate between cryptocurrencies and real money so that the buyer could change their fiat currencies to cryptocurrencies. Of course, we will need to pay a transaction fee for one of these exchange so that they can give us their cryptocurrencies and we give them our fiat currencies, the same as the traditional foreign exchange system.

There are some trading platforms of cryptocurrencies decided to be centralized to help sellers and buyers to meet, however, that is also a weak spot for hackers to steal money. Therefore, decentralized exchange platforms have been developed put in use with more security measure as the results from many hack events happened to some big centralized exchanges such as Mt.Gox and Bitfinex.

2.4.2 Blockchain

Bitcoin can be seen as both a currency and an application for payment that runs on the blockchain technology. One of the biggest advantages of the blockchain is that it's almost impossible to be hacked even though it's open-sourced, which means everybody can see the code and modify if they want to.

Blockchain, also known as the public ledger, is a distributed database, a global spreadsheet that runs in millions of computers. The blockchain technology can keep track of every transaction and its historical data so that no one can just invent a fake

one. A transaction that is not followed the consensus will be ignored by the network. And users must provide proofs that they have the credential private key to spend the money that they claim to have. The historical data of a transaction is bundled into blocks and verified by miners following the procedure simplified above. Mining Bitcoin is an expensive and difficult procedure, therefore, miners are unlikely to want to destroy the network that they spent so much effort to get into. And even if someone wants to hack the blockchain system or to sabotage it, it is almost impossible.

Because, first of all, each block of data is built on and is strictly connected to the previous blocks, that's why it's called blockchain. When you want to take control of the system, you must find a way to change the information in all of the blocks that have been created from the first day of the blockchain system. And secondly, it is decentralized so that everyone can see and verify it, you have to manage to change and "convince" 51% of the network to accept your version. To do so, you have to simultaneously hack in 51% the total number of computers that are in the system which is why it is almost impossible.

However in case that you succeed to manipulate some percentages of the network, then now what is happening is called a "fork" when you now have your own version of a blockchain system that is branched out from the original one. The cryptocurrency that your system is using and creating will not be the same as the original one, in other words, you have your own system and your own cryptocurrency. Your next step is to convince the whole market that your currencies should worth something and be able to do something so that people would use it.

In fact, the "fork" happens sometimes in the blockchain network and community but not because of being hacked, but usually because members in the community have different opinions on how to improve the system, how to make it run faster and more economical. And when many of them agree to modify the system, a new branch of coin is introduced from the original one. This is why we have different copies of Bitcoin such as Bitcoin Cash, Bitcoin Gold and so on.

Cases that many people's cryptocurrency wallets were stolen or hacked do not affect the blockchain system, in fact, these hacks happened out of the blockchain system and did not target the system itself, but the wallet holders. Metaphorically speaking, when

your house or vault is robbed, it is not the security issue of the banking system but your own security system.

In short, you can change the consensus as much as you want and create your own coins, but they won't have any value or be accepted by others unless you manage to convince the market that your coins serve something that market needs. For a hacker, even if he manages to hack into some miner's computer, he will most likely be unable to have time and resources to persuade other miners in different parts of the world to follow his new rules, not to mention the possibility that the hacker might choose to hack the right miner who would be chosen to participate in the next transaction.

Blockchain technology has been rapidly improving and evolving nowadays, and many people still believe that blockchain technology is something new. However, it was rooted in decades ago and gained a lot of attention in the cyberpunk community. One of the first noted researchers, Wei Dai, introduced a b-money proposal that would create money by solving computational puzzles and decentralized consensus, but was low in implementation details. In 2005, Hal Finney introduced a concept of "reusable proof of work," a system based on the idea of b-money together with Adam Back's computationally challenging Hashcash puzzles to create a concept for a cryptocurrency, but run on a centralized trusted back-end system. Blockchain finally took root in 2009 with the Bitcoin made by Satoshi Nakamoto. Its white paper outlines the details required for a protocol establishing a cryptocurrency, operating it on a trust-less network that is not controlled by individuals biased towards a particular country, state or governing body. In the initial years, Bitcoin was perceived as an economic experiment outside the cyberpunk community. The version of Bitcoin's blockchain technology represented the first version of blockchain, the blockchain 1.0, which was used globally as an innovative payment method.

A Russian-Canadian programmer, Vitalik Buterin, made the new blockchain version in 2013, based on the first one, and it underlies the second biggest cryptocurrency Ethereum. Vitalik witnessed the problems of implementing Bitcoin, such as waste of mining hardware, centralized mining community, and lack of network scalability. He came up with a platform for the community of developers and entrepreneurs to build Distributed (Decentralized) Applications – Dapps, for the Blockchain network. In addition to a currency, he referred to this concept of trust as "smart contracts" or even "Decentralized Autonomous Organizations" (DAOs) based on blockchain.

In 1996, an American cryptographer and programmer called Nick Szabo actually described the principle of Smart Contracts which are digital information transfer protocols using mathematical algorithms to automatically execute a transaction once the conditions are fulfilled and the process is fully controlled. To simplify it, smart contract is a contract that all of the requirements and agreed conditions are coded into the blockchain. Once the conditions have been fulfilled, the smart contract executes transactions independently and ensures that the agreement is adhered to. The obligations of the participants are placed in the "if-then" form of the smart contract, for example, if Party A transfers the money then Party B has to hand over the key to the apartment. There may be two or more parties and they may be individuals or organizations.

3 The development of Macroeconomics theories

Our modern economic system and monetary policies have been built and based on many different economic theories. In the previous part, we have looked at the development of money throughout the world modern history and the effect of some major historical events on money. This part of the paper, we will look at the development of macroeconomics theories throughout the development of money and history.

3.1 Keynesian theories

John Maynard Keynes, in his book *The General Theory of Employment, Interest and Money*, described governments as a central role to steer the market demand. Keynes argued that when the mechanisms of the market failed to stimulate the recovery of the economic, it's the state's job to step in and create more demand in order to create jobs, by running, a large budget deficit if necessary. It could be done by raising loans and/or using the money to finance public works that could be put on line relatively quickly, such as building railways, roads, or investing in infrastructure that would not only create work, but also leave a useful legacy for private enterprise. According to Keynes, the government should act as the country's main shopper to create demand until more widespread off-demand sources can return.

When it comes to the repayment of the public loans, Keynes applied his theory of “Multiplier Effect”. Firstly, governments could save some of the money by creating jobs through public works, instead of spending on unemployment benefits. Secondly, the increase in employment would also create more spending power, therefore boost the tax receipts and the economy. Opportunities to serve the programs of public works would also have an indirect effect on businesses. Eventually, it would lead to an increasing in tax revenue from businesses. Then, the receipts from tax revenues would then pay off the debts created by the initial expenditure.

After the second World War, Keynesian policies had been adopted for about 30 years across the capitalist countries. Unemployment hit the record lows and levels of economic growth hit the record high. Keynes’ theories became the new orthodoxy and were particularly attractive to the political Left. By the 1970s, Friedrich Hayek and Milton Friedman criticized Keynes’ ideas, and gained ground with politicians in countries like the US and Britain. And in the same period, the US and Great Britain began to experience high inflation together with high unemployment rates, known as “stagflation” that made the US to abandon the Gold Standard. Keynes’ ideas became discredited because this phenomenon could not be explained by Keynesian economics.

Mainstream economists could explain the reasons and cures for Recession very well from Keynes’ theory. That’s when aggregate demand falls but prices and wages are stuck at the same level, especially when prices are above the level of market clearing, we have surpluses. On the labour market, a surplus is called unemployment. In goods and services, surpluses cause businesses to shut down production, factories are producing in idle below capacity or event. As a result, we have a recession as production drops and unemployment rises. The theoretical ‘cure’ for recession is pumping up aggregate demand. And to do this, central banks need to expand the money supply by creating new money and use it to buy financial assets, mortgage-backed securities and buy back government bonds to stimulate investment and other forms of spending. As banks loan the newly created money into the circulation, interest rate will be lowered. And while the money circulates in the economy, the aggregate demand will re-employ the idle resources. Factory will be opened back again, workers will be put back to work, and the economy should start to boom again. According to the theory, it should be relatively easy not only to end recession, but also to prevent it from happening. We just have to put our best and brightest minds in charge of money

supply, along with a good forecast, and print money liberally at the first sign of trouble. Yet there were still many recession and/or depressions that proved otherwise throughout modern history.

3.2 Keynesian theories and interest rate

In the modern time, when the creation of money is mostly through the credit system of the banks. As mentioned when we discuss about what money is, the modern money that is in circulation is in the form of cash and bank deposits. Bank of England reported that in England, the total amount of cash circulating is only 3% of the total money in circulation, and the rest 97% of the money in circulation within the economy comprises of credit money that has been created by banks (Ryan-Collins, Greenham, Werner, & Jackson, 2011).

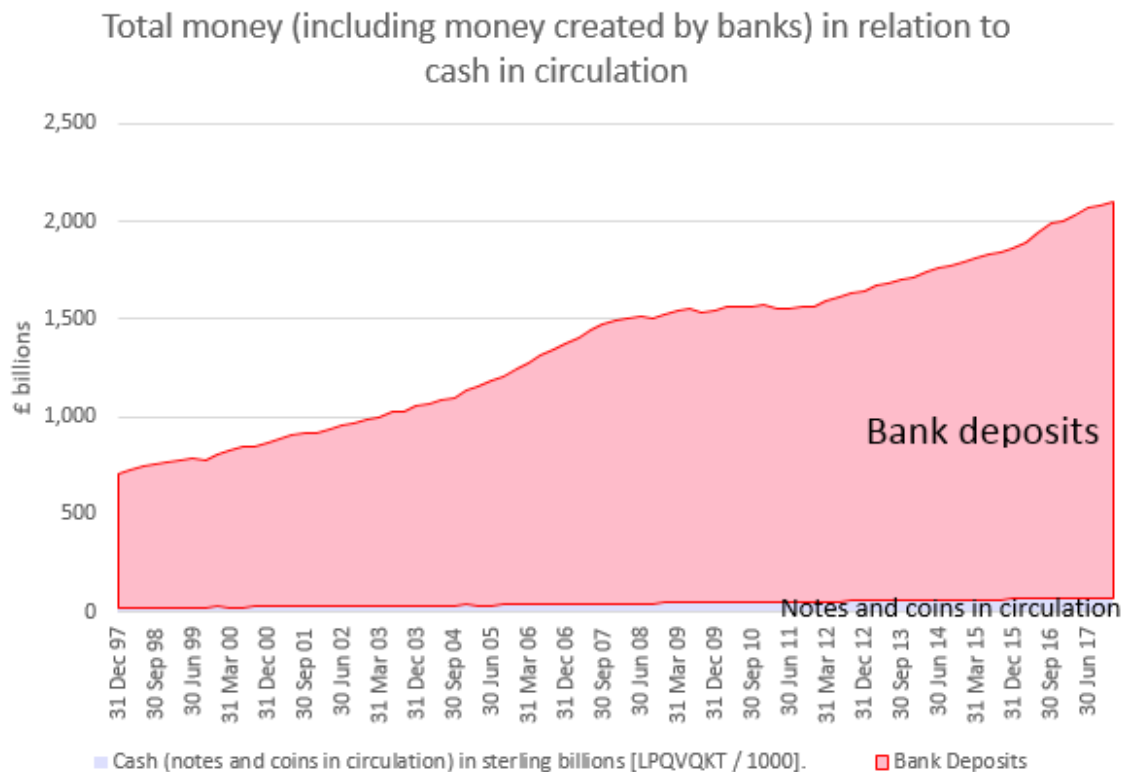


Figure 9: Total money in relation to cash in circulation – Source: Bank of England

Central bank reserves refer to the reserves of commercial banks that are held at the central bank, for example in the UK the central bank is Bank of England, which are represented in the central bank’s electronic record of the amount owed by central bank to each commercial bank to facilitate large scale payments between commercial banks.

Central bank reserves are used to settle net amounts owed between commercial banks at the end of each working day. Central bank reserves do not circulate in the wider economy outside of the banking system, and so are not considered when represent the total amount of money circulating within the economy. However, the central bank will convert electronic reserves into physical notes and coins that circulate within the economy, at the request of commercial banks when they require additional cash to satisfy the general public's demand for for cash

Bank deposits, account for about 97% of the money supply in the UK, are sometimes referred to as 'credit money' because the majority of bank deposits were originally created by banks issuing new loans. The numbers that you see when you check your account balance are just accounting entries in the banks' computers. These numbers are a 'liability' or IOU from your bank to you. But by using your debit card or internet banking, you can spend these IOUs as though they were the same as £10 notes. By creating these electronic IOUs, banks can effectively create a substitute for money. Every new loan that a bank makes creates new money. While this is often hard to believe at first, it's common knowledge to the people that manage the banking system. In March 2014, the Bank of England release a report called "Money Creation in the Modern Economy", where they stated that:

"Commercial banks create money, in the form of bank deposits, by making new loans. When a bank makes a loan, for example to someone taking out a mortgage to buy a house, it does not typically do so by giving them thousands of pounds worth of banknotes. Instead, it credits their bank account with a bank deposit of the size of the mortgage. At that moment, new money is created." - Bank of England

By creating money in this way, banks have increased the amount of money in the economy by an average of 11.5% a year over the last 40 years. This has pushed up the prices of houses and priced out an entire generation.

The development of monetary system for credit creation and management was a revolutionary advance for civilization because it provided wider financial availability. This financing therefore generated more economic activities such as employment, innovation, scientific inquiry, the provision of goods and services. Then these economic activities generated income or wages, profits and tax revenue. Hence the interest rate is fundamental to the health and stability of an economy. The interest rate being sustainable is very important as well as keeping the debt repayment affordable. Too

high interest rates stifle enterprise, creativity an initiative, and ultimately render debts that are unpaid. The root cause of the 2008 crisis, which led to the bankruptcy of many banks including Lehman Brothers Bank, was the bursting of a vast bubble of inexpensive credit. Very few economists blame 'cheap credit' for the cause of the crisis, which was offered at very high interest rates to sub-prime borrowers. The opposite of cheap credit is 'tight credit,' which means that credit creation is carefully regulated and offered only to firms, individuals or projects that can expect to generate sound potential income flow. The best form of credit creation, according to Keynes, is tight but cheap credit.

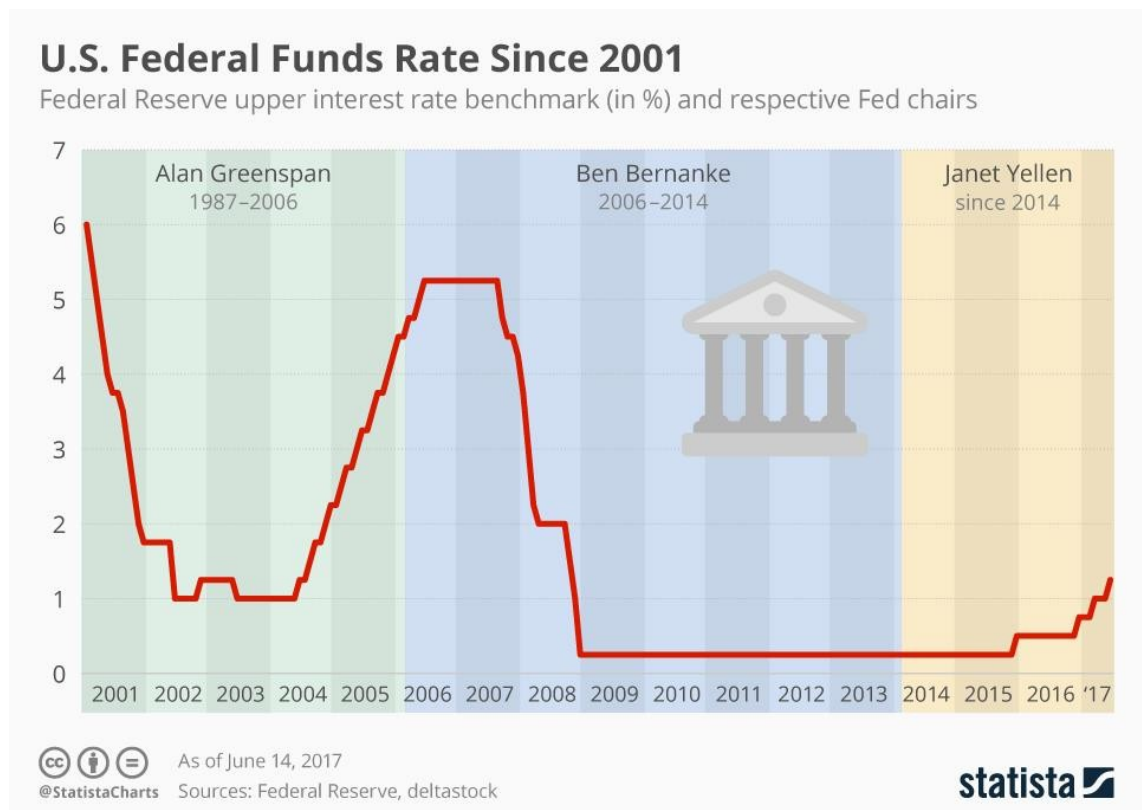


Figure 10: The US interest rate history

The interest rate was set quite low as a reaction to restore the market after the dot-com bubble burst in 2001, and so many people believed that this low rate laid the ground for the next crisis. Between 2005 and 2007 was the height of the credit boom, loans and mortgages were still being offered to individuals, households and firms without any real carefully assessment by bankers of the ability to pay back. Some of these borrowers were sub-prime borrowers or, in other words, high-risk borrowers because they would not normally be qualified to take the loan and therefore had a very high interest rate for their loans. The returns on these loans were so high that banks demanded more of

such lending from their agents. These sub-prime mortgages were collected, bundled up, and new assets were created artificially. They called them "Collateralized Debt Obligations" or CDOs— a mixed bundle of mortgages and loans. Until the households, firms, and individuals at the heart of the CDOs failed, and the sub-prime crisis erupted.

Mainstream economists have plenty to say about when interest rates are too high, but there's very little to say about interest rate too low. The only negative consequence of excessively low interest rates is usually mild inflation, which is typically treated as no big deal and can be handled easily by central banks.

3.3 Monetarism

Keynesian economics dominated economic theory and policy after World War II until the 1970s, when many advanced economies suffered both inflation and slow growth, a condition dubbed "stagflation." Keynesian theory's popularity waned then because it had no appropriate policy response for stagflation. Monetarist economists doubted the ability of governments to regulate the business cycle with fiscal policy and argued that judicious use of monetary policy (essentially controlling the supply of money to affect interest rates) could alleviate the crisis.

Monetarism is another framework for thinking about the cycles of business. The University of Chicago's Nobel laureate Milton Friedman was the most famous advocate of monetarism. As the name suggests, monetarism emphasizes the importance of money supply and central bank decisions on what to do with money supply. It is based on the theory of the quantity of money

$$MV = PT$$

Where M is the total money supply in the economy, V is the speed of money or the number of times money changes hands, P is the price of goods and services or the average price level and T is the volume of transactions of goods and services

The Quantity Theory of Money stated that there was a direct relationship between the price level of the goods and services sold and the quantity of money supply in the economy. The other way to understand this theory is to recognize that money is like any other commodity: increasing its supply decreases one unit of currency's buying

capacity—the marginal value. There are, therefore, two potential dangers in monetarism: too great inflation and too little inflation.

When the central bank increases the money supply (M) by creating new money, as the above equation, V and T are assumed to be constant in the short term, so when M is increased, P is increased at the same level. It is when the rate of inflation is too high. There was time when many Keynesian economists accepted the high rate of inflation as it would increase economic output, but monetarism argued that people would quickly figure out and notice the inflation that was going on, and inflation would cease to be effective in stimulating the economy.

On the other hand, excessively low inflation rates could lead to deflation. According to monetarism, aggregate demand will be too low in that scenario, and monetarists, as well as Keynesian economists, have a similar doctrine. That wages are sticky for many different reasons, and when the flow of money declines, the purchasing power declines, making employers lay off some workers and businesses have a downturn. Monetarists therefore believe that a constant rate of growth in the money supply would be legitimate, not too high and not too low. They also believe that central banks should be restricted by rules, so economists are now looking much more at money supply and central bank policies because of Milton Friedman and other monetarists. Monetarism, however, still has some issues. Such as, it doesn't have much to say about cases where business cycles can be caused by busting bubbles or credit market problems or other factors. And if the central bank sets a fixed rate of growth for the money supply, it could be more difficult to respond to some kinds of negative real shocks such as the hike in oil prices.

3.4 Austrian School of Economics

In contrast to the Keynesian framework, Austrian theory assigns critical importance to how the creation of money and credit by the financial system can often lead to cumulative imbalances over time. These imbalances, which ultimately come down to investments that do not end up profitable, eventually implode in the context of an economic crisis of some sort.

Bitcoin's creator stated in his blog post when he first introduced Bitcoin that all the trust needed to make it work is the root issue with conventional currency. The central bank must be trusted not to debase the currency, but there are many breaches of that trust in the history of fiat currencies. Banks must be trusted to hold and transfer our money electronically, but they lend it out in waves of credit bubbles with scarcely a fraction in reserve. We must trust them with our privacy, trust them not to let identity thieves drain our accounts. Their enormous overhead costs make micropayments impossible.

That idea refers to the Austrian theory of the business cycle, of which the most important proponents were Ludwig Mises and Friedrich Hayek. The central theme is the idea that market interest rates play a critical role in coordinating savings and investment. The Austrian School of Economics emphasizes market price signals and how they communicate decentralized information to entrepreneurs. It postulates how central banks could distort price signals and give rise to a boom, then a bust. For example, when a central bank sets and increases inflation rates, new credit is put into the system and it lowers interest rates on the market. The Austrian stresses that this low interest rate and the extra credit are not the real market phenomena, because of the results in central bank plans. An entrepreneur may have some investment projects, but returns on investment are lower than normal market interest rates, but when the central bank creates new credit and lowers interest rates, the entrepreneur now receives a signal that his investment projects have returns that are higher than market interest rates, so he thinks they are profitable and more homes, buildings, factories will be built and that is the boom part of the business cycle. According to the Austrian, however, these investment projects are not actually profitable because the price signals have been distorted. So overtime, these investments will be "self-reversing," eventually it will be revealed that the demand for homes is not that high, and so as the demand for what these new factories are producing. As these long-term investments turn out to be unprofitable, they are liquidated, workers are laid off, and that's the bust part of the boom-bust cycle.

In the scenario where the central bank does nothing, but consumers have saved more, which would lower interest rates. The difference when the central bank lowers interest rates is that there is no increase in consumer savings, so the economy's savings are not geared towards supporting the extension of long-term investment goods.

In the early of 21st century, many Austrian economists have argued that, the US The Federal Reserve was too easy with credit, lowering interest rates as an effort to stimulate the economy after the dot-com bubble, promoting too many mortgages and too much investment in homes, and rooted in the global financial crisis.

Another example would be the Eurozone crisis. Many investors thought that loans to Greece were as riskless as loans to Germany after the introduction of the euro. And later, these investments turn out to be mal-investment. Even though it's not exactly the classic Austrian theory, it's still the case when government interventions send some of the wrong price signals.

What Austrians suggest is to keep the role of the government relatively small, because they see the market as functioning relatively well, and government as distorting market price signals. Many Austrians have argued and voted for relatively tight money because they do not want the government to stimulate the economy by issuing more credit or lowering interest rates. However, Austrian theory also has limitations, such as why so many smart entrepreneurs are so tricked by the central bank and the increase in money supply as they know that the central bank manipulates interest rates all the time. Moreover, Austrian theory assumes that when the boom begins, consumption and investment tend to move in each other's opposite directions, or in other words, the investment increases and consumption decreases. However, the actual data shows that Consumption and Investment tend to move together, that result does not match Austrian theory's prediction.

4 How blockchain would fit in the context?

After comparing the three major economic theories, it seems that they sometimes deny each other and yet sometime complement each other. However they all have some some limitations:

- Keynesian suggests running the higher deficit during recessions, but governments need to pay off debts and have a balance or even a surplus in good times when recessions are over. However, they like to have the deficits all the time, so there is an asymmetry built into the Keynesian system when governments have too many deficits or too many debts over time and

eventually a fiscal crisis. An example would be what happened to Greece and Japan.

- Monetarism also has limitations given the power of central banks to affect money supply, the speed of money.
- And Austrian theory seems unpractical in turning back to the Gold standard time.

Our money has been increasingly digitized nowadays, many countries are trying to become the cashless countries. However, if we could succeed in creating blockchain for our fiat currencies, central banks and bank-like institutions would work together to manage and control it. As we mentioned above about how new bitcoin is created through mining, the same could be done for the Euros (or Dollars) based on blockchain. The whole banking system would act as nodes in this blockchain system and help mining and creating the new money.

If so, new money would be created by verifying market-related transactions, including every micro transaction from grocery shopping to service charges. Banks in the banking system would be "miners" who do the verification and get paid by the blockchain system, and they can use that money to sustain their reserves. Because new money is created by "mining," it has value from banks' "labour" verifying transactions, the amount of new money created would also be transparently monitored. By using blockchain technology, new money would be gradually created, and central banks would be able to use it to gradually pump into the market at a low rate to target the inflation rate, or create their own saving account in their balance sheet. The gradually created money would prevent banks from holding money in their reserves as the market would be more stable and credit would not be risky. In Monetarism point of view, this could help to limit the power of central bank on affecting the money supply and velocity of money and not too strict that prevent central bank from deploying some measurement when needed.

The smart contract would ensure that debts are paid accordingly, and this would apply to all types of debt, including public debt. If governments are sufficiently transparent, a deficit-level condition would be coded into the contract to prevent governments from running as much deficit as they want, they would have to pay back the debt to a certain amount until they could borrow more. If so, it may take an effective Keynesian recipe to prevent recession.

Using blockchain-based money, the ability of governments to manipulate interest rates would be tightened, not entirely but at some level, as governments would not be able to create new credits as much as they want to affect interest rates. Like Bitcoin, the supply of the blockchain-based fiat currencies could not really be manipulated by central banks, it precludes the possibility of manipulating interest rates that could lead to resource misallocation. Central banks would have to balance their reserve as the newly created money from market transactions would help maintain reserves for commercial banks, resulting in a sustainable balance sheets for central banks.

Furthermore, the blockchain and smart contract used for the legal tender of governments could also be used for other social services such as tax collection, payment of wages, voting, health care databases, criminal records, citizens' information, etc. In another word, in a decentralized platform, we could centralize our social systems. Of course, access rights should be restricted to different kinds of information, and it could be done by making rules in the source code of the smart contract.

In international trade agreements, trust plays a crucial role, yet, it is also a major problems. Fears fuelled by the global situation of refugees and terrorist threats have resulted in tighter border controls—and these come at a cost. Every goods inspection, every stop along the supply chain costs time and drives up prices. It harms both businesses and consumers. Those involved in international trade—whether manufacturers, trading houses, transportation companies or banks—are looking for ways to ease the situation and reduce time and costs. The application of a trust-less system to assure the responsibilities of all parties is also a possible application of blockchain technology. The distributed ledger ensures records can not be duplicated, manipulated or faked, and increased visibility in parts of the supply chain fosters an unprecedented level of trust. It means that governments can better protect citizens, while business partners can be real with certain trading documents. Consumers can check product quality and provenance, and banks can reduce processing time.

5 Conclusion

Technology is being developed and evolving constantly, especially now that many industries have started to get involved with the blockchain technology, it is crucial that government and the banking system consider the possibility of adapting blockchain. The fact that, as many people argue, blockchain and cryptocurrencies are being used in the underground and criminal world, makes it easier and safer for criminals to operate and stay away from being tracked. That is true, however, it also proves that that system, in which money is powered by the blockchain, could actually work if it is used for the mainstream system. In macroeconomics, there is no such thing as an absolutely right theory, every theory has to evolve and/or change in order to serve its purpose as a foundation for policy makers. Therefore, in this era when almost everything is about technology, the monetary policies and monetary system need to be updated and prepare for upcoming changes, and in order to do so, blockchain technology should be put and considered in the context of all aspects of macroeconomics and microeconomics so that we can have some preparation or at least an option to consider when needed.

As said, this paper is just an open up for some more bigger and more in-depth researches in industry level of how blockchain would negatively and/or positively affect the current system. In the next five to ten years, we could experience changes in many industries that use blockchain technology. Slower adopters will suffer as a result of this new revolution. There are opportunities that blockchain technology could help the world overcome many existing and emerging crises, but one of the most advantages of blockchain technology is transparency, which could also be the biggest threat for some politicians and governments.

The discussion of what could be a good monetary policy and management system for money can never be ended with an absolute answer, however, by looking at the potential of what blockchain technology can do to the current limitation of our economics theories and policies. Of course there are limitations of the blockchain such as the huge cost of operation and maintenance, however, since the blockchain 1.0 to 2.0, there has been a lot of improvement, therefore we can count on the improvement of the future version of blockchain, just like we always do to improve any other advance technologies nowadays.

The proposed ideas in this paper, on how blockchain can be used for our current currencies will need more in-depth and high level analysis and research, such as if the state-backed blockchain-based money is implemented, how much should the total amount of money in produced by the blockchain be? How the mining procedure would actually be implemented. In addition to that, more researches in micro-economics level should also be conducted. However, it seems at this stage that the potentials of blockchain are huge and very promising.

6 References

2001-2009.state.gov. (2019). The Bretton Woods Conference, 1944. [online] Available at: <https://2001-2009.state.gov/r/pa/ho/time/wwii/98681.htm> [Accessed 27 Apr. 2019].

Bank of England, W. (2019). What is legal tender?. [online] Bankofengland.co.uk. Available at: <https://www.bankofengland.co.uk/knowledgebank/what-is-legal-tender> [Accessed 27 Apr. 2019].

Bitcoin open source implementation of P2P currency - P2P Foundation. 2018. Bitcoin open source implementation of P2P currency - P2P Foundation. [ONLINE] Available at: <http://p2pfoundation.ning.com/forum/topics/bitcoin-open-source>. [Accessed 23 February 2018]

BitcoinWiki. (2019). Bitcoin History – Price since 2009 to 2018, BTC Charts – BitcoinWiki.[online] Available at: https://en.bitcoinwiki.org/wiki/Bitcoin_history#Bitcoin_in_2008 [Accessed 27 Apr. 2019].

Delanceyplace. 2018. The Problem with the Gold Standard | Big Think. [ONLINE] Available at: <http://bigthink.com/delancey-place/the-problem-with-the-gold-standard>. [Accessed 23 February 2018].

Eichengreen Barry, Exorbitant Privilege: The Rise and Fall of the Dollar and the Future of the International monetary system

Escape Velocity. 2018. Bitcoin Explained Like You're Five: Part 5 – Macroeconomics | Escape Velocity. [ONLINE] Available at: <https://chriscopacia.wordpress.com/2014/02/08/bitcoin-explained-like-youre-five-part-5-macroeconomics/>. [Accessed 23 February 2018].

European Central Bank, "Virtual Currency Schemes" 2012

Finance and Development | F&D. (2019). Finance and Development. [online] Available at: <https://www.imf.org/external/pubs/ft/fandd/2009/12/white.htm> [Accessed 27 Apr. 2019].

Financial Times. 2018. The environmental costs of bitcoin are not worth the candle. [ONLINE] Available at: https://www.ft.com/content/c166aa1e-c303-11e7-a1d2-6786f39ef675?accessToken=zWAAAWHD_hCYkdPBZqewwMR59Oh0meG8572dQ.MEUCICD60BaVXttOcWTugNZI01sHSL80egBNUyvIFbilm_aOAIeAsOXmavOebtyUBQUI5izifo-dxEibTmfuKKTlZl4K-TU&sharetype=gift. [Accessed 23 February 2018].

Financialtrustindex.org. (2019). Financial Trust Index. [ONLINE] Available at: <http://www.financialtrustindex.org/resultswave27.htm> [Accessed 27 Apr. 2019].

Frum, David (2000). How We Got Here: The '70s. New York, New York: Basic Books. pp. 295–98. ISBN 0-465-04195-7.

Garritsen de Vries Margaret, The International Monetary Fund, 1966–1971

Hacker Noon. 2018. A brief history in the evolution of blockchain technology platforms. [ONLINE] Available at: <https://hackernoon.com/a-brief-history-in-the-evolution-of-blockchain-technology-platforms-1bb2bad8960a>. [Accessed 23 February 2018].

Imf.org. (2019). What Is Keynesian Economics? - Back to Basics - Finance & Development, September 2014. [online] Available at: <https://www.imf.org/external/pubs/ft/fandd/2014/09/basics.htm> [Accessed 27 Apr. 2019].

Investopedia. (2019). Fiat Money. [online] Available at: <https://www.investopedia.com/terms/f/fiatmoney.asp> [Accessed 27 Apr. 2019].

Investopedia. (2019). Quantitative Easing Definition. [online] Available at: <https://www.investopedia.com/terms/q/quantitative-easing.asp> [Accessed 27 Apr. 2019].

Keynes John Maynard (1965) [1930]. "1. The Classification of Money". A Treatise on Money. 1. Macmillan & Co Ltd. p. 7.

Lowenstein, Roger (August 4, 2011). "The Nixon Shock". Bloomberg BusinessWeek Magazine. Retrieved 26 March 2013

Medium. 2018. How Does the Blockchain Work? – Michele D'Aliessi – Medium. [ONLINE] Available at: <https://medium.com/@micheledaliessi/how-does-the-blockchain-work-98c8cd01d2ae>. [Accessed 23 February 2018].

Mankiw N. Gregory (2014). Principles of Economics. p. 220. ISBN 978-1-285-16592-9.

Orcutt Mike. 2018. How Blockchain Is Kickstarting the Financial Lives of Refugees - MIT Technology Review. [ONLINE] Available at: <https://www.technologyreview.com/s/608764/how-blockchain-is-kickstarting-the-financial-lives-of-refugees/>. [Accessed 23 February 2018].

Park12.wakwak.com. (2019). Gold tells 20th century. [online] Available at: http://park12.wakwak.com/~kobakan/contents/0224goldtells20c_R.html [Accessed 27 Apr. 2019].

Pettifor, A., 2017. The production of money. 1st ed. UK: Verso.

Ryan-Collins, J., Greenham, T., Werner, R., & Jackson, A. (2011). *Where Does Money Come From? A Guide to the UK Monetary and Banking System*. London: New Economics Foundation.

Satoshi Nakamoto, "Bitcoin: A Peer-to-Peer Electronic Cash System" 2009

The Independent. (2019). The UK is getting closer to becoming a completely cashless society. [online] Available at: <https://www.independent.co.uk/news/business/news/uk-moves-towards-cashless-society-10267215.html> [Accessed 27 Apr. 2019].

The new Palgrave dictionary of economics. Palgrave Macmillan (Firm), (Living Reference Work ed.). United Kingdom. ISBN 9781349951215. OCLC 968345651

World Gold Council. (2019). Gold Data | Gold Statistics | Goldhub. [online] Available at: <https://www.gold.org/goldhub/data> [Accessed 27 Apr. 2019].