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# THE FUTURE OF DIGITAL CURRENCY IN THE UK

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## Abstract

This paper provides an exploration of the available economic literature surrounding private digital currencies and central bank digital currencies (CBDC), to understand the future landscape of digital money. The paper discusses the risks posed to the UK's financial and monetary stability by cryptocurrencies through first identifying Bitcoin's features and how they satisfy the present day understanding of money. CBDC is as a potential solution to the threat of private digital currencies and the deficiencies of the modern financial and monetary systems, but it comes with its own considerations and implications onto the UK economy.

## Introduction

The report begins with a brief illustration of the history of currency in the UK, to contextualize the current monetary landscape and its evolution. It then presents the money tree, a framework of five means of payment which illustrates the prevalence of commercial bank e-money and enables us to categorise the different forms of money (Adrian and Mancini-Griffoli, 2021). We then move on to highlight the increasing digitisation of money and its future impact on the UK economy.

The first type of digital currency that the report focuses on is cryptocurrency which is generated and secured with cryptography by private individuals and firms. Amongst the plethora of crypto currencies, the first and most prolific is Bitcoin, which the paper will explore deeply and use an example to highlight the key technical features of cryptocurrencies and their impact on the traditional financial system and economy. Through this example the paper questions whether private digital currencies could be a threat to financial and monetary stability in the UK?

The second type of digital currency the paper examines is called central bank digital currency (CBDC) which is entirely digital sovereign money, developed and managed by a nation's monetary authority. Through the example of CBDC (Chapter 3) a comparison between private and sovereign digital currencies is made. The paper presents the economic implications of CBDC to commercial banks, interest rates, monetary policy and inflation targeting.

Finally, the available literature has provided modern trends in financial and monetary economics and the consumer habits indicating the nature of currency that will be dominant in the UK in the near future. Digitisation has increased rapidly in the UK (Markose and Loke, 2003; UKF, 2021) and is likely to increase (Fabris, 2019). Meanwhile the invention of novel Cryptocurrencies has spurred an international boon in research regarding Central Bank Digital Currencies (CBDC) including the Bank of England who have now opened a discussion forum regarding the topic which indicates that even traditionally run organizations are openly considering technological alternatives to present day money. Whether or not these alternatives are viable in the future will remain the main discussion of this dissertation.

## Chapter 1: Money and its history

### Evolution of Money

Money is continually evolving across all ages of human civilization. Anthropological evidence suggests that prior to developing commodity or fiat currencies as understood in the modern sense, communities were debt based, or adopted a wide range of cultural practices to facilitate trade amongst one another (Graeber, 2014). Currencies developed to streamline trade, by creating a “double coincidence of wants” where in, if one trader does not possess items of interest to the other, a common currency would enable the two traders to transact based on a common, desirable asset.

Time/Period	Currency Event (Chard, 2018)
Mid-2 <sup>nd</sup> Century BCE	Coins, Gallo-Belgic Stators, believed to be first circulated in Britain as the result of trade with Gaul.
43 – 409 CE	Roman conquest of the British Isles helped to spread the use of coinage from the south of England to across Britain.
Late-18 <sup>th</sup> Century CE	During the reign of King George the only coins consistently issued were gold coins, used exclusively for international exchange and trade amongst the wealthy. Merchants and businesses issued “Condor” coins for making transactions of smaller denominations. However, traders often only accepted Condor coins locally to where they were issued, limiting their circulation and liquidity
1793	The Bank of England issued the first £1 notes in response to the need for smaller denominations.
1816	Following the conclusion of the Napoleonic wars, a major coinage reformation act was passed, to standardise British currency.
Reign of Queen Victoria	To fuel British Imperial expansion, the Royal Mint established branches in Canada, Australia, South Africa, and India. Millions of coins were produced in many denominations suited to the nature of trade in each colonial country.
1918	Post world war Britain reduced the fineness of silver coins, since a great deal of precious metals had been exported to the US to finance the war.
1925 - 1931	Britain re-joins the gold standard for a short time. The value of the pound had inflated too much, and the country was too indebted to peg the of its currency to gold, and the gold standard was abandoned again in 1931.
1947	British coinage was again devalued. Silver was replaced entirely by cupro-nickel.

Table 1: A history of coinage in Britain (Chard, 2018)

Table 1 above outlines some of the key events in the history of British coinage; one of the most recognized and durable forms of currency. It should serve as a reminder that currencies evolve over time. When the sovereign currency has failed to enable trade amongst the populace, privately produced currencies have emerged, until the state resolves the issues.

### Functions of Money

Regardless of the history of money, which remains a highly contentious subject amongst academics (Wray, 2012), the economic literature widely agrees that money is the stock of assets that can be readily used to complete transactions. The terms “money and “currency” will be used interchangeably throughout this paper, to refer to the most liquid asset used to complete transactions. It can take the form of any object or claim, tangible, or intangible, which performs at least some if not all of the following three functions (Ali et al, 2014):

- 1) Store of value: it can be used for exchange in the future,
- 2) Unit of account: creating a common unit of account in which vendors can value products,
- 3) Medium of exchange: which prevents the need for a double coincidence of wants amongst traders.

Since President Nixon’s decision to unpeg the value of the dollar from precious metals in August 1971, all other countries have abandoned the international gold standard. International currencies are now “fiat currencies,” backed only by public trust (Graeber, 2014). The value of money is now completely unbacked against precious metals, as it previously had been for centuries (Velde, 1998).

For early deposit funded goldsmiths that gave paper receipts out in exchange for precious metals stored in their vaults, the paper receipts presented a significant step forward in evolution of currencies. As Precious metals were cumbersome and an easy target for theft, Bank notes were soon favored as an acceptable form of money. However, to traders, the paper IOUs were often worth a discount of the value of gold which they were able to redeem from the goldsmiths. The discounting was a result of fraudulent bank notes which created distrust amongst traders, and the added costs to redeem the value of the receipt. Eventually, the paper bank notes that were once redeemable at banks for precious metals transformed and since 1971 paper money has become the prime commodity. Digital money was initially a digital account of physical money, but it has now become the predominant means of payment, with 13.7 million consumers in the UK having reported using cash once or less a month in 2020 (UKF, 2021).

## The Five Different Means of Payment

Adrian and Mancini-Griffoli (2021) differentiate five recognisable means of payment; (1) (Bank) B-money, issued by banks; (2) (Electronic) E-money, offered by new private sector firms; (3) (Investment) I-money, issued by private investment funds; (4) CBDC or central bank digital currency, and (5) Cryptocurrency. They offer a simple framework called the “money tree”, which can be used to easily compare the five different types of money mentioned above. They highlighted four attributes that differentiate the four means of payments we use today from one another - type, value, backstops, and technology.

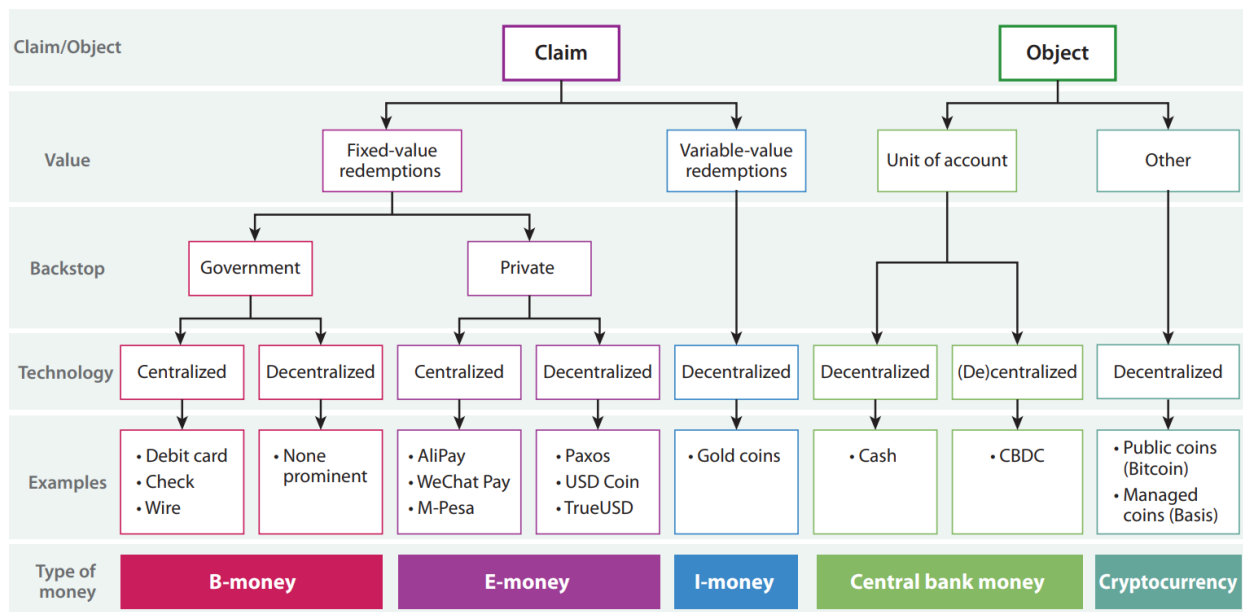


Figure 1: Adrian & Mancini-Griffoli's (2021) “money tree”

### Type

The first attribute is *type* – either a claim or an object. Cash and cryptocurrencies are object-based means of payment which means if both transactors deem the object valid, the transaction is settled immediately. Whereas in a debit card purchase, a claim is transferred from the bank account of the buyer of the goods to the seller, in the pre-decided value of the product. Hence all forms of E-money and B-money are claims. The number of pounds held in our bank account is a record of the amount of money owed to us by the bank and when we transfer pounds out of our account, we are transferring a part of the banks IOU to another account.

### Value

The second characteristic is whether the claim is redeemed in fixed or variable *value*. Fixed value claims guarantee redemption at a pre-established face value denominated in the unit of account. These claims could be said to resemble debt instruments, which can be redeemed upon demand at face value. When classifying object-based means of payment the concern is whether they are denominated in the domestic unit of account or their own, since the concept of redemption does not apply to object-based currencies.

### Backstops

The third attribute applies only to fixed value claims. Either the redemption guarantee is backstopped (guaranteed) by the government (fully in the case of CBDC and partially for B-money) or relies on the prudent business practices and legal structures of the issuer, as is the case with e-money and any private digital currency.

## Technology

The last and in current times the most important attribute is technology; differentiating whether the settlement is centralised or decentralised (Adrian and Mancini-Griffoli, 2021). Centralised means of payment must be approved (settled) by trusted intermediaries. Decentralised transaction on the other hand, utilise distributed ledger technologies (DLT). Authorisation on these can be either limited to a trusted few (“permissioned” networks) or are open to the public (“permissionless”) (Adrian and Mancini-Griffoli, 2021).

DLT makes it possible to automate transactions, providing real-time settlement, while maintaining strong controls against fraud (Lewis, McPartland, and Ranjan, 2019). Additionally, DLT allows cheap and easy cross-border payments, which are an essential component of international trade and maintaining our modern way of life.

Developing an overview of the five means of payment allows us to understand the different forms of currency and its differentiating factors. It further allows us to articulate where cryptocurrencies and CBDC fit in the diverse payments landscape, and to make predictions about the most probable currency to succeed in the era of digitisation, especially in the UK.

## Cashless UK

By the mid 1990’s, Electronic Fund Transfer at Point of Sale (EFTPOS) had become the dominant technology solution to combat the double spend problem, discussed further in chapter 2. EFTPOS has facilitated the real time verification of cashless transactions and brought about a permanent decline in MO (cash and coinage) in circulation. By 1994 inflation in OECD countries had fallen to an average of 2.5%, and nominal interest rates had also declined precipitously to historic lows because of the higher liquidity inferred from e-money (Markose, 2003).

Chart 1.1 Payment volumes (millions) 2010 to 2020

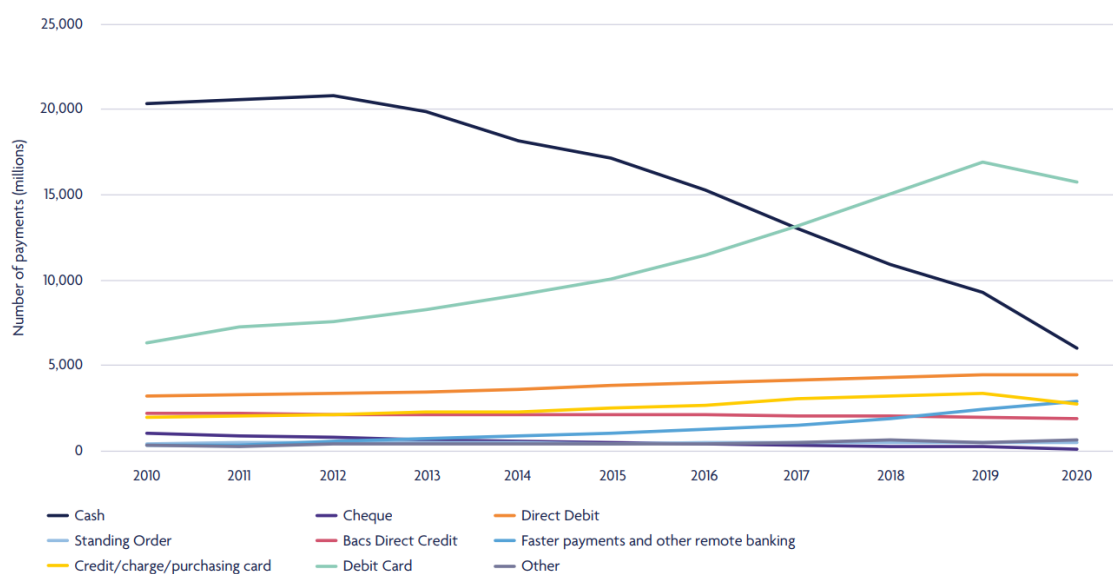


Figure 22: Chart showing UK payment volumes (millions) 2010 - 2020 (source: UKF, 2021)



The decline of cash payments is represented by figure 2, which shows that with an increase in the volume of debit card transactions, cash usage has declined in the UK. Since 2017 cash use has fallen by 15% each year, until 2020 when it fell by 35% as a result of Covid lockdown measures. Cash contributed to 56% of transactions in 2010, 45% in 2015 and only 17% in 2020. The main cause of cash's decline is the increasing use of debit cards, which accounted for 44% of all payments in the UK in 2020. Moreover the percentage of all payments made by contactless cards has risen from 7% in 2016 to 19% in 2018 and 27% in 2020 (UKF, 2021). A few examples are discussed in the following paragraphs that show the magnitude of cashless payment in the UK along with the benefits that perpetuate their adoption.

Bankers' Automated Clearing System (Bacs) Direct Credit is a popular and cost-effective payment method for business and government, specifically where both the value and timing of the payment are known in advance. More than 8/10 employees are paid via Bacs Direct Credit. The government also uses this service to pay nearly all state benefits and pensions in the UK. The system is considered reliable, fast and effective and more importantly it is automated.

The Clearing House Automated Payments System (CHAPS) has been operated by the Bank of England since 2017. It is used by 37 direct participants and over five thousand indirect participants. CHAPS is used primarily by financial institutions to make wholesale transfers between one another, and to make treasury payments. As a consequence, in 2020 CHAPS accounted for 91% of the total value of UK payments, but only 0.1% of the total volume. In the same year 4.5 million CHAPS payments transferred £91.9 trillion of wealth. It is said that CHAPS payment volumes are closely related to the state of the UK economy". (UKF, 2021).

Cashless societies can be backdated to early civilizations who once used barter, debt and other cultural practices to facilitate early trade (Graeber, 2014). A cashless society in the modern sense is one wherein the physical cash has been replaced entirely by a digital equivalent (Fabris, 2019). The payment methods mentioned above are a few of the most prevalent electronic payment methods in the UK. As digital technology benefits greatly from economies of scale and network effects, the widespread promotion and adoption of digital currencies has been made possible.

The decrease in physical cash does have associated costs. Digital finance can be difficult for elderly, uneducated and some neurodivergent people to understand. Low levels of digital literacy could prevent these parts of the population from adopting cashless payments, widening the wealth gap (Fabris, 2019). Additionally, cashless-digital economies lose the anonymity that cash provides, since digital payments leave a footprint, deterring some users who do not want an indelible record of their every transaction. A more digital economy also increases the opportunities for cyber criminals to act.

On balance cashless-ness is largely beneficial, since it leads to a reduction in the shadow economy which transacts mostly in cash (Cunliffe, 2021), and the increased monitoring abilities lead to a decrease in money laundering (Ali *et al.*, 2014). Most importantly to the average consumer, cashless payments are associated with lower transaction costs (Achord *et al.*, 2017), and accelerated development and installation of IT and digital systems to complement digital transactions (Fabris, 2019), which has positive spillover effects increasing the general productivity of the nation. Another factor that has promoted cash lessness is that cash payments are too cumbersome for online transactions and have therefore been usurped in transaction volumes by digital payment alternatives that do accommodate for e-commerce. These payment methods, however, do still fundamentally rely on cash – i.e., they are transfers of value representing equivalent cash value. Currently, UKF (2021) neglects to account for cryptocurrency payment systems alluding to the fact that they are rarely used to make transactions (Ali *et al.*, 2014). Nonetheless they have spurred countless innovations and

discussions regarding the nature of money. Below are some stylized economics of cryptocurrencies, as well as an assessment of their success as currency in the UK, and an analysis of the risks that they pose to the UK's financial and monetary stability.

## Chapter 2: Cryptocurrency in the UK

### Short History of CC

A cryptocurrency is a means of exchange that is cryptographically protected through complex coding. Research regarding distributed ledgers and private digital currencies had begun before the genesis of Bitcoin (Chohan, 2017), but as both the frequency and market value of alternative crypto currencies has grown ever larger, Bitcoin has remained the most revered by analysts and researchers (Chohan, 2022).

### Ledgers

To understand how cryptocurrencies function, we primarily need to understand ledgers. All forms of transactions are recorded in ledgers. Bookkeepers in organisations before digitisation maintained large books recording all the financial accounts of the company. These accounts were written in pen and secured at night to prevent tampering (Giancarlo, 2022). Today bank account transactions made via cards, phones or even watches rely on trusted authorities (pin and chip handlers and financial institutions) who verify the legitimacy of each transaction by automatically referring to the electronic ledger centrally held at the bank (Huberman, Leshno and Moallemi, 2021).

In October 2008 Satoshi Nakamoto published a paper describing a protocol (series of rules) for peer-to-peer online payments that did not rely on trust like the current financial system. He noted that the cost of mediation had increased the cost of transactions to a point where small and casual transactions were infeasible (Nakamoto, 2008). Bitcoin was Nakamoto's solution to this critique of the modern payments system. By framing transactions as trustless, and solving the double spend problem Nakamoto created a digital currency that could be inherently trusted, and therefore did not require intermediaries to verify its transactions (Chohan, 2017).

### Double spend problem

The double spend problem is a potential flaw with any digital cash, whereby a single digital token can be used for multiple transactions. This problem cannot occur with physical currency transactions because the cash must be exchanged and cannot be spent again by the same consumer after being used in one transaction. Analogous to counterfeit traditional money, the double spend problem creates a new supply of fraudulent money, which exerts inflationary pressure, devaluing the currency. Furthermore, the value of fiat money is directly related to the confidence that they have in the security of the currency, and the ability to double spend would greatly reduce people's faith in the currency. Reductively, digital currencies are digital files which can be duplicated and falsified. It is therefore worrisome that a singular unit of digital currency could be used to pay for two separate transactions (Chohan, 2017).

### Blockchain

Instead of relying on trusted authorities The Bitcoin payment system's (BPS) distributed ledger is recorded and updated jointly by "miners." Bitcoin has a single public ledger, called the blockchain, which acts as a timestamped record of all transaction on the network. Miners must reach a consensus for a new block to be added to the chain and a new series of transactions to be recorded in the ledger. Profit maximising miners are incentivised to be a part of the network because Nakamoto's protocols rewarded them with Bitcoin (Huberman et al., 2021). This rewarded is also considered as a subsidy which keeps the cost of Bitcoin transactions low (Ali *et al.*, 2014).

### Miners

New transactions are only processed once they have been included in a block which has been added to the ledger. Each miner holds a copy of the verified ledger containing all previous blocks, and all

transaction requests are sent to all miners. To ensure that Bitcoin maintains a unique record of transactions, a single miner is randomly selected to add their block to the chain. To be eligible for selection, the miners “exert energy” (the computers solving the algorithms are highly dependent on electricity) known as proof of work. A winner can only withdraw their prize (fees) once the block is fully integrated into the chain, and another block has been built on top. (Huberman et. al., 2021)

Ali et al (2014) recognise that Bitcoin has low transaction fees due to greater competition than traditional payment systems and the extra revenue incurred from the verification process. These two factors mean miners are accepting transaction fees significantly lower than the marginal cost of successfully verifying a block. In the short run, this incentivises miners to promote Bitcoin, increasing demand and driving up the value of their future revenue. In the long run however, the subsidy to the miners will not sustain, since total supply of Bitcoin is fixed at 21 million. Only if miners' conglomerate to benefit from economies of scale will they be able charge transaction fees similar to like that of the traditional financial system. However, monopoly or even oligopoly control of the financial system is antithetical to the philosophy of Bitcoin and generates more opportunities for fraud (Ali et al, 2014).

### BPS Security

One service that BPS cannot provide is reversibility of transactions. Bitcoin transactions are designed in such a way that they are “computationally impractical” to reverse, to protect users from fraud. However, this also means that users cannot reverse accidental transactions (Nakamoto, 2008). To further protect BPS from fraud, users’ credentials are not saved on the blockchain, so once a password has been lost the Bitcoin is inaccessible (Chohan, 2022). As the BPS market has matured, private Bitcoin exchanges have begun to offer password retrieval services, but this has been exploited by hackers.

### Forks

Nakamoto’s vision of a non-reversible, non-editable currency has already been corrupted by the deployment of “forks” in the Bitcoin timeline. A fork occurs when the userbase of a blockchain decides to change its protocol or basic rules. The chain then splits, producing a second parallel blockchain, which shares all its history with the original but is headed in a new direction. Examples include Bitcoin Cash, which wanted to increase the size of a block, thereby increasing the number of transactions executable per second from 7 to 24 and reducing transaction wait time. Another example is Bitcoin Gold, a 2017 initiative to exclude large Chinese miners from the market. However, they suffered repeated DDOS attacks and a 51% attack, where a miner commandeered 51% of the network, took control of the network and minted coins for themselves unchecked (Spade, 2020).

### CC Present State in UK

Nakamoto’s innovation has since sparked a digital currency boon. Data from Coin Market Cap (CMC, 2022) indicates there are 18,216 crypto-currencies, only 11 of which have a 24 hour trading volume of \$1B, being traded across 462 exchanges. In 2013 bitcoin represented 90% of the market cap of cryptocurrencies, which has today fallen to 50% (Chohan, 2022).

Data from coinhill.com (2022), a cryptocurrency analytics site, shows that in the 24hrs to the 15<sup>th</sup> of March 2022, the GBP was the 5th most traded national currency against Bitcoin (0.67% of total volume), after the Korean Won (4.09%), Japanese Yen (6.23%), the Euro (6.54%) and the US Dollar (80.92%). The market capitalization of Bitcoin in the same month in 2022 is approaching \$750B (CMC, 2022). Aligned with this is data from FCA research into the consumer attitudes and awareness of cryptocurrencies, which estimates that 2.3m adults in the UK were holding crypto in 2020, up from around 1.9m in 2019 from 3.9% to 4.4% of the adult population. The median holding has risen from

£260 to £300 (FCA, 2021). As the market for Bitcoin matures and the capitalization continues to rise, we should expect to see more individuals willing to invest.

### Cryptocurrencies as Investments

Ali et al (2014) found that digital currencies were primarily viewed as a store of value (with significant price risk) since they are treated as an investment more than a means of payment. Bitcoin is very rarely used for completing transactions and is an unsuitable currency to do so because of the strong price fluctuations. With swinging and regular price fluctuations it is difficult for one merchant to mark a price in Bitcoin since the price is likely to change drastically in the next twenty-four hours.

In the US, the Commodities and Futures Trading Commission has implicitly allowed the trading of Bitcoin futures on several platforms. The situation was closely monitored in case of liquidity issues with traders or the financial institutions brokering the transactions, but it was concluded that allowing market participants to short crypto currencies would make the market more stable (Giancarlo, 2022).

### Decentralised finance

Decentralised finance (DeFi) is a fast-growing part of the crypto-financial system with continual innovation potential but risks that need to be addressed. These are financial institutions designed outside of the traditional financial system. These include crowd funding firms, blockchain technologies and cryptocurrency exchanges.

The recent boom in crypto activity, leading to the increase in coin market capitalization is mainly due to the increased activity of DeFi platforms. The main vulnerabilities of which are from the financial stability perspective like; investors' high leverage and liquidity mismatches, lack of shock absorber capacities and engrained connectivity of crypto ecosystem (Aramonte, Huang and Schrimpf, 2021).

One DeFi firm to grow large and powerful before its ban was Binance, a multinational group offering digital asset services. In June 2021, the FCA said that their “complex and high-risk financial products” posed “a significant risk to customers”. As Binance did not have a fixed global headquarters it was difficult to regulate the business, which circulated \$5tn dollars in trades for 13.5m customers in 2021. The FCA’s failure to completely cease the UK operations of the trading platform show they have little power to regulate DeFi firms, beyond warning the 2.3m British users of crypto to not invest more than they are willing to lose (Samson, Stafford and Szalay, 2021).

### Regulatory Oversight

UK government agencies are very quick to suggest that cryptocurrency markets are rife with fraud, and it is generally a risky investment (Ali *et al.*, 2014; Cunliffe, 2021; FCA, 2021). There certainly is a large concentration of cons and thefts in the cryptocurrency market. Often a new coin is supported by celebrities who have been paid to endorse, and therefore legitimize the financial asset. After a Treasury consultation, UK chancellor Rishi Sunak has brought the promotion of cryptocurrencies under the same “high standards” as the marketing of traditional financial products such as stocks, ETFs and insurance. Under these rules, a financial ad must originate from a company authorized by the FCA or PRA (Stafford and Oliver, 2022). Whilst risks relating to consumer exploitation and money laundering have been identified as a matter of priority, the UK authorities appear to be taking a measured approach to regulation of crypto assets. They also remain supportive of the adoption of distributed ledger technology in financial services, whilst noting some potential challenges to scalability (Maxson, Davis and Moulton, 2019).

As of now, it is unclear how international authorities want the generally accepted accounting principles (GAAP) applied to crypto assets. In the absence of any clear rules, companies holding crypto

assets have taken account of these however they see fit. Microstrategy, the self-claimed largest publicly traded holder of Bitcoin, reported a write-down in the value of their Bitcoin in one instance, but excluded this from the profit and loss statement previously reported in earnings press release. Tesla insulated the impact of a write-down by bundling in other accounting items, while Coinbase and Square have reported impairments and holdings explicitly (McKenna, 2022), presumably to help legitimize the currencies that their businesses are run to serve.

### Financial Stability Risk Posed by Cryptocurrency

Financial stability is the resilience of the UK financial system to weather endogenous shocks. To ensure the resilience of the UK financial system the Financial Policy Committee (FPC), since its establishment in 2013, regularly conducts stress test on banks to assess their resilience to a variety of threats including climate change (FPC, 2021). The FPC also has the power to set the level of the countercyclical buffer – a type of sector specific reserves employed during booms to limit the runaway growth of a sector of the economy.

The FPC was intended to be a strong, macro-prudential authority within the Bank of England, to address gaps in the previous regulatory framework. Even when firms are considered stable on an individual case basis, the aggregate behaviour of firms has the potential to seriously impair the stability of the financial system. It is therefore the responsibility of the FPC to oversee the system as a whole, identify risks to its stability and take specific actions to address them (HMT, 2012).

If the crypto “bubble” bursts, this could be disastrous for UK financial institutions exposed to crypto assets. If the entire system is exposed or is interconnect with elements that do fail, then the bubble bursting would have a negative systemic effect across the entire financial system. The financial stability risks posed by cryptocurrencies are limited at this time. However, policy makers should remain vigilant, as current applications could quickly develop from a concern into a financial stability threat. This is because the rapid growth of cryptocurrency applications is unregulated, and their functions are derived from assets with no intrinsic value. (Cunliffe, 2021).

In the USA, several prestigious financial institutions had begun offering Bitcoin Futures. In 2017 the Chicago Board of Options Exchange (CBOE) and Chicago mercantile exchange (CME) group both self-certified Bitcoin futures products. Self-certification is a process congress designed to allow the speedy development of financial products. It is not approval by the CFTC, but it does appear like that to the public. These initial products broadened the range of Bitcoin financial products, and developed consumer trust since they had been granted a pseudo-regulated status. (Giancarlo, 2022, pg. 126-128).

To bolster the stability of the financial system, authorities must regulate crypto currencies and DeFi firms. But this should be seen as a double-edged sword since regulatory oversight will attract more users away from traditional financial systems creating a certain degree of creative destruction within the financial industry.

## Monetary stability Risk of CC

Monetary stability (price stability) refers to a stable price level or low inflation in the economy in general. The Bank of England maintains price stability through open market operations (OMO) - the purchasing and selling of treasury bonds and junk bonds from and to financial institutions – and by adjusting the base rate, which in turn changes the rate charged to borrowers and given to savers by their financial institutions. The quantity theory of money shows the relationship between the growth rate of the money supply and the rate of inflation in the economy in the following identity:

$$M \times V = P \times T$$

Where P is the general price level, T is the number of transactions (the number of time that goods and services are exchanged for money), M is the stock of money and V is the velocity of money in the economy (the rate at which currency circulates).

This equation can be interpreted as:

$$M \times \bar{V} = P \times Y$$

This is because the velocity of money is assumed to be constant over time and total output of an economy is taken as a proxy for the total value of transactions. Since the velocity of money is constant, any change to the supply of money (M) must create a proportional change in real GDP (P X Y). Written in terms of growth rates, and given that  $\frac{\Delta \bar{V}}{\bar{V}} = 0$ .

$$\pi = \frac{\Delta M}{M} - \frac{\Delta Y}{Y}$$

which says that the growth rate of the overall price level ( $\frac{\Delta P}{P}$ )  $\pi$  is given by the difference between the growth rate of money supplied and the growth rate of real output (or real GDP). Money growth above greater than the growth in real GDP, will lead to excess supply of money and therefore greater inflation rate in the economy.

In the UK Economy, the price stability is maintained by the Bank of England, who manage the supply of Pound Sterling in the economy, to maintain equilibrium with real money demand. However, central banks have no such control over the supply of privately created digital currencies. When a currency other than the domestic currency becomes widespread in an economy, it hinders the central banks' ability to control inflation and stabilize the macroeconomy using the above mechanism.

If UK consumers were to purchase goods and services using Bitcoin, its use becomes systemic. With Bitcoin as the national unit of account and main currency of transactions, any fluctuation in the price of Bitcoin would lead to a change in the price of the goods and services that people need to survive. From a sample of all the coins with a capitalization greater than 1 million USD (1,707 coins, from the first day of 2011 to the last day of 2018), it was found that the mean standard deviation of their monthly prices was 5.46% intraday, 16.50% across a week, and 70.8% in a month (Liu and Tsyvinski, 2021). The mean and standard deviation of crypto coin returns are an order of magnitude higher than those of the stock market across the same period and many orders of magnitude greater than national fiat currencies.

Intra-day price fluctuations of Bitcoin would cause real problems in the economy. All the usual inflationary costs would occur (reduced international competitiveness, uncertainty, boom and bust cycles, and menu costs) and nothing could be done to change the supply of money to provide countercyclical stability. With a sovereign currency, the money supply could be adjusted to change



the exchange rate and adjust the price level. Cryptocurrencies are decentralized by nature and therefore cannot be controlled by the central bank as a monetary policy tool.

Nelson (2018) asserts that for a digital currency to impair the financial stability and the power of monetary policy in an economy, its use must be widespread. In the UK the number of people owning cryptocurrencies is growing but is still insubstantial. In 2015 the £60mn of Bitcoin circulating in the UK represented only 0.003% of broad money balances (M4) in the UK (Ali et al, 2015). The FCA (2021) estimates that 2.3 million people in the UK held an average of £300 of diversified crypto currencies in July of 2021, while aggregate sterling M4 amounted to £2,917bn (Statista, 2022). This would mean roughly 0.023% of broad money balances in the UK is now attributed to crypto currencies. This is not entirely comparable to the 0.003% figure from Ali et al (2014), since theirs is based on crypto exchange meta data of Bitcoin, while the FCA surveyed about all crypto currencies. The growth in investment into crypto currencies does still illustrate the view of investors that crypto currencies are becoming less of a gamble and more of a complement or alternative to traditional investments (FCA, 2021).

While people may be investing more in them, the term cryptocurrency should be understood as a misnomer since the literature suggests that they do not perform the functions of money mentioned previously (Ali et al., 2014). Other than fringe examples, very few people use Bitcoin and other cryptocurrencies for transactions in the UK, hence it is exceedingly rare that assets are valued in terms of cryptocurrencies by traders. It is important to note that currencies do not have to perform all three functions at once, but private digital currencies are very rarely performing any, and are instead treated as speculative assets.

Consequently, Nelson (2018) finds it unlikely that people who lose faith in their domestic currency will find confidence in a digital currency but gives little reference to alternative currencies that are likely to experience growth in place of crypto currencies. He ultimately reflects a sentiment often shared in the economic literature, which is that the market of private digital currencies is a bubble - the name given to stocks and other financial securities, whose price inflates beyond reasonable expectation only to then burst and fall back to 'normal' levels (Downes and Goodman, 2010).

### Alternative Private Digital Currencies

Crypto currencies are not the only type of private digital currency however. Birch (2020) recognises the innovative applications of BCT and discusses a future payment system dominated by a collection of privately issued digital tokens. In his view complex algorithms will be used to clear the markets between many digital tokens, removing the need of one single currency. This would be digitally analogous to the condor coins discussed in chapter 1 or a more pervasive version of 'gift card' type economic system, where individuals would own a multitude of currencies, each redeemable for goods and services from a specific firm.

Birch (2020) also presents stablecoins, offering Facebook's 'Diem' (formerly 'Libra') as an example where he differentiates between three forms of stablecoins: 1) fiat currencies, which are backed by traditional fiat currency reserves: 2) Algorithmic currencies, which maintain price stability through mathematical coding which balances the supply and demand of money: 3) Asset currencies, which are backed by a basket of assets. Stablecoins provide a solution to the price risk inherent in other cryptocurrencies but provide little in the way of security from illiquidity or insolvency. To alleviate these problems Birch suggests that private digital currencies should be backed by central bank reserves to eliminate liquidity and ensure depositor confidence.



## Chapter 3: Central Bank Digital Currencies

Continued provision to stability of commercial bank money and stablecoins through the fractional reserve system, there are opposing proposals that central banks should introduce their own digital currency aptly named as the central bank digital currency (CBDC). Which is being designed as the digital currency denominated in the sovereign unit of account, pound sterling for instance. So, £10 of a UK digital currency would be the digital equivalent of a £10 note. CBDC combines the benefits of blockchain, such as lower transaction costs and faster payments, with the consumer protection and stability of the central bank. CBDC will be as stable and trustworthy as the central bank operating it.

Following are few examples of nations experimenting with CBDC and launching testing programs to understand its usage and applications. So far, China's Central Bank Digital Currency (CBDC) program has evolved the quickest, and authorities have begun testing its real time applications in major cities like Beijing, Shanghai, and Shenzhen. In October of 2021, Nigeria became the first African country to launch a CBDC pilot. A few months prior The European Central Bank initiated a 24-month investigation into the feasibility of a digital Euro, to be followed by a three year implementation period (BBC, 2021). Meanwhile, The Bank of Thailand is interested in developing a CBDC because they want to build a more efficient payment route between Hong Kong and itself (Sporer, 2021).

The Central Bank of the Bahamas has also begun to issue a digital version of the Bahamian Dollar – the Sand Dollar – through authorised financial institutions (AFIs). It is aimed towards increasing the efficiency of their payment systems through a more secure and faster settlement process. The ease of access should also improve financial inclusion, since mobile banking and digital cash can reach people that are otherwise isolated on the Bahamas 700 islands and would have great difficulties in reaching a physical branch (Bharathan, 2020).

### Retail and wholesale CBDC

The primary distinction to be made is between retail and wholesale CBDC. Wholesale central bank money is that which is made available to banks and financial institutions. Both the Governor of The Bank of England Andrew Bailey and Deputy Governor Sir Jon Cunliffe have dismissed the development of a wholesale CBDC on the grounds that CHAPS already fulfills the function of a digital currency clearing in real-time for the transactions of large sums between financial institutions (Insights, 2021). To that end, the Bank of England is consulting with CHAPS direct participants to renew the Real-Time Gross Settlement (RTGS) service, which holds the accounts of banks, building societies and other financial institutions. It accounts for 91% of the total wealth transferred but only 0.1% of the volume (UKF, 2021). Retail CBDC on the other hand would be made available to the public, who conduct the majority of transaction volumes in the UK. Their development would therefore have a greater ability to positively impact the welfare of consumers and savers.

### Risk mitigation

#### Financial stability risk mitigation posed by private payment providers

Given the rapid decline in cash usage, without CBDC our payments systems will be entirely reliant on private payment providers, which poses a significant financial stability risk (Sporer, 2021). Additionally, a study by the Bank of England, using a dynamic stochastic general equilibrium (DSGE) model, found that issuing a retail CBDC up to 30% of GDP is associated with a 3% permanent rise in GDP. This is due to reductions in the real interest rate, distortionary taxes, and monetary transaction costs. Furthermore, Countercyclical CBDC price or quantity controls could be used as an additional monetary policy tool alongside that of cash (Barrdear and Kumhof, 2016).

Fernández-Villaverde *et al.* (2021), focus on the traditional maturity-transforming role of commercial banks critiqued by Diamond and Dybvig (1983). Commercial banks typically accept deposits of varying sizes, bundle them, and distribute the money in the form of loans to individuals and long-term investments to businesses. Fernández-Villaverde *et al.* (2021), finds that the set of allocations achieved through private financial intermediation can also be achieved with a CBDC, given that competition with commercial banks is still allowed and consumers do not panic and cause a run. In this model, the central bank itself cannot invest in long-term projects, and must instead rely on the expertise of investment banks to do so.

### CBDC Design Trade-offs

Auer and Böhme (2020) outline the underlying trade-offs between the potential design choices of CBDCs. They provide a clear guide as to the hierarchy of consumers needs with regards to the design choices, in a successful attempt to stimulate further discussion around CBDC. They find CBDC must be secure and accessible, offer cash-like convenience and safeguard privacy. They illustrate their approach with their “CBDC pyramid” (figure 2) which displays consumer needs and six associated features on the left-hand side and corresponding design choices facing the central bank on the right.

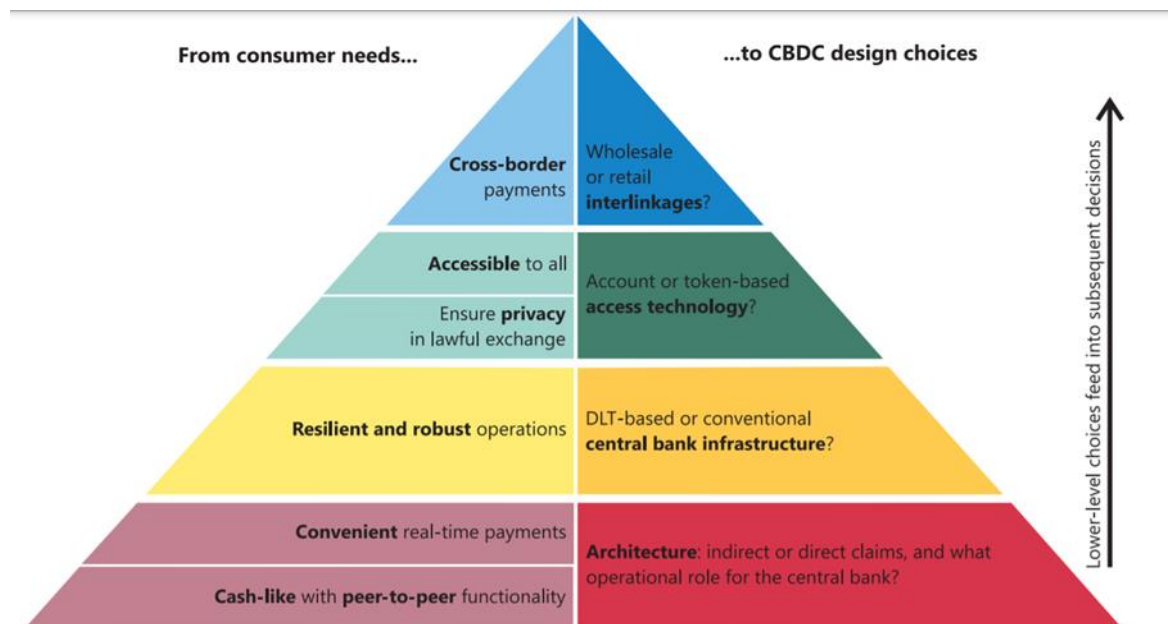


Figure 13: Auer and Bohme's (2020) CBDC Pyramid maps consumer needs (on the left-hand side) against the associated design choices faced by the central bank (right-hand side). The lower layers of choices facing the central bank affect subsequent design choices

They too observe that current electronic retail money represents a claim on an intermediary, rather than functioning as the digital equivalent of cash. To elevate this, they identify the primary function of CBDC should be an ability to be accepted for peer-to peer transactions without intermediaries. This functionality will be decided by the architectural design of the CBDC (Auer and Böhme, 2020).

### Direct CBDC

Auer and Böhme allude that Direct CBDC, a system whereby the central bank provides retail accounts without intermediaries, presents its own risks. The central bank itself will be completing operations

that are currently conducted by retail banks, such as dispute resolution and know-you-customer (KYC), which exposes them to the risk of failure in this wider field of operations where they lack experience.

#### Hybrid CBDC

They express hybrid CBDC as a solution to these problems, which allows direct claims from the central bank, allowing intermediaries to continue functioning in a “two-tier” system similar to that currently implemented in the financial system.

#### Indirect CBDC

Expressed differently, Adrian and Mancini-Griffoli (2021), builds on their earlier research regarding the rise of digital currencies (Adrian and Mancini-Griffoli, 2019) but takes a more vocal approach in advocating for synthetic central bank digital currencies (sCBDC) – analogous to indirect CBDC. They envisage a public-private partnership that will combine the innovation and customer focus of the private sector, with the stability and confidence of central bank-backed money. This could be a favourable option for the central bank, since it will limit reputational risks that could arise from distributing their own currency entirely independent of other financial intermediaries, while also allowing private institutions to continue innovating periphery payment technologies. The same authors are often cited in the literature, since they have made many comments regarding the future of digital currencies and the strengths and weaknesses of various monetary options.

It is the opinion of some that the differences between holding a CBDC directly with the central bank or with a commercial bank, via hybrid, indirect, or synthetic CBDC with reserves at the central bank are mostly inconsequential and imply the same changes on financial intermediation (Fernández-Villaverde et. al., 2021). However, synthetic CBDC seems far less innovative than the direct CBDC. Under this type of monetary regime, the public will not hold retail accounts with the central bank, and the two-tier system will reflect the current financial system and include many of the same intermediaries. The level of creative destruction in the banking industry and innovation to be conferred by novel CBDCs onto consumers and savers will be decided by its architectural and design choices.

#### *Key Design Features: Their economic and monetary implications*

In designing a CBDC The Bank of England’s objective should be to maximise the effectiveness of it in fulfilling the basic functions of any currency: efficiency as a medium of exchange, security as a store of value, and stability as a unit of account for transactions. Using these restrictions Bordo and Levin (2017) conclude that the following four characteristics would provide their optimal design of a CBDC:

- 1) An account based CBDC,
- 2) Offering a rate of return in line with other risk-free assets such as short-term government securities,
- 3) Introducing a graduated schedule of fees on transfers between cash and CBDC,
- 4) With a transparent monetary policy framework fostering **true price stability**.

#### Account Based

An account based CBDC would act as an almost costless medium of exchange. Accounts can be held either with the central bank itself (direct CBDC) or via-public private partnerships with commercial banks, like the current two-tiered financial system. Either way, there should be lower transaction costs, as there will be significantly less intermediaries. Of course, a direct CBDC would have the lowest transaction costs as only the central bank will have to authorise payments. This would be particularly beneficial for lower-income households and small businesses, who suffer from high transaction costs for small transactions.

### Interest Offering

The interest rate offered by the Bank of England on CBDC accounts would become the main tool of monetary policy. Offering a rate of return like that of other risk-free assets would maintain a secure store of value (Bordo and Levin, 2017). However, the bank of England must be careful not to subsidise the CBDC accounts too much. Deposits are an important source of funding for commercial banks, so an extremely attractive CBDC would cause mass disintermediation (Sporer, 2021). If competition from commercial banks deteriorates too far, this will adversely affect maturity transformation. Moreover, the rigidity of central bank contracts with investment banks implies they are immune from bank runs since central bank debt has seniority to all others. This could be internalised by consumers in such a way that the central bank becomes a deposit monopolist. This monopoly power would then eliminate the forces causing the central bank to deliver the socially optimal level of output (Fernández-Villaverde et. al., 2021).

### Breaking the zero-lower bound

Bordo and Levin (2017) also suggest introducing a graduated schedule of fees on transfers between cash and CBDC. Consequently, adjustments to the CBDC interest rate would not be constrained by any effective lower bound, suggesting that the real interest rate can be lowered beyond 0%. Additionally, the central bank could create a crawling-peg exchange rate between paper currency and electronic money, so that the paper currency interest rate could be lowered below zero or raised above zero loosely independent of the CBDC rate. This makes it possible to stimulate investment in net exports as much as needed to revive an economy, even when inflation, interest rates, and economic activity are low (Agarwal, 2015), as they have been in the UK for some time. This will have the effect of forcing people with stores of cash to deposit it as CBDC before it is not worth the paper it is printed on. Of Bordo and Levin's (2017) design characteristics I believe this would have the greatest negative impact, as it has the potential to increase costs for small businesses and marginalised people who the authors themselves note are most likely to pay in cash.

### True price stability

The monetary policy strategy proposed by Bordo and Levin (2017), that of aiming at true price stability differs significantly from the current practice of inflation forecast targeting. Currently, most central banks have a positive inflation target (the Bank of England's is 2% +/- 1%) giving no significance to previous deviations from the target, so that the aggregate price level follows a random walk upward drift. A price level target would still exhibit transitory price fluctuations as markets restore equilibrium, but monetary policy would ensure that the aggregate price level returns to its target over time. Thus, households and businesses would be able to formulate their plans with confidence that the cost of a representative basket of consumer items (as measured in terms of the CBDC) would be reasonably stable over the medium run and roughly constant at planning horizons of 5, 10, 20 and even 50 years into the future. Such stability could be particularly beneficial for lower-income households and small businesses, which typically have little or no access to sophisticated financial planning advice or complex financial instruments that can help insure against such risks." Bordo and Levin (2017).

Having a stable inflation rate means that fewer mistakes are made in estimating it, allowing people to therefore make better economic decisions, especially large-scale investments. The real interest rate is decided by the Fisher equation, where:

$$i_t = r_t + \pi_{t+1}^e$$

Which implies that changes in the expected rate of inflation  $\pi_{t+1}^e$  are equal to changes in the nominal interest rate  $i_t$  given a constant value of the real interest rate  $r_t$ . Business and consumers can plan

expenditures better when the realised rate of inflation is equal to the expected rate of inflation, and price changes are kept stable.

It should be noted that Bordo and Levin (2017) have here assumed that prices can adjust down, just as easily as they can increase, to return to “true price” level. However, many markets are “sticky” and prices resist adjusting. Evidence suggests that prices change frequently at the micro-level, but aggregate prices are sticky (Kehoe and Midrigan, 2015). Wage rigidity can also be found in the labour markets; however this varies depending on firm and sector (Caju, Fuss and Winttr, 2007). So, it may be possible to return to a long-term price level, but there will still exist “transitory” and localised price fluctuations.

The idea of a true price level target satisfies one of Nakamoto’s main critiques of fiat money - that a central bank cannot be trusted not to devalue the currency (Nakamoto, 2008). Furthermore, central banks are immune to bank runs, as they are the issuer of the currency, and their debt held in investment banks has seniority to that of commercial banks, making their investments secure if the firm investing it defaults or becomes insolvent (Fernández-Villaverde et. al., 2021).

### Privacy and Data

The final consideration of CBDC this paper shall make is its implications on consumer data privacy. It is already possible for the authorities to access e-money bank accounts, however it requires the cooperation of the financial institution holding the e-money account, who will not assist investigations at the risk of losing revenue generated by customers, unless legally obligated to. A new currency could be designed in such a way that the government does not need the permission of any intermediary, allowing greater detection of financial fraud, money laundering and embezzlement.

This would clearly be perceived as a bad thing by account holders who value their privacy, as they do not want the government to have a detailed account of their expenditures. However, this data need not be used for criminal investigations and could at the very least be anonymized and used by the government in creating financial and economic forecasts. Furthermore, increased accuracy of expenditure data could be used to increase government transparency, through increasing the thoroughness of audits and the visibility of state corruption. It should also be easier for economists to track the net effect of policy decisions, compounding the accountability of government.

There are suggestions that a central bank could provide better privacy and anonymity as transactions will be authorized by less intermediaries than before and data will be centrally stored with the central bank (Sporer, 2021). However, a hybrid CBDC would not be able to reconcile the fact that the private firms the central bank partners with will be leakage points for both consumption and security data, just as in the current financial system.

Crucially, direct government access to retail accounts must not lead to the taxation of savings and deposits, as was conducted by the Cypriot government in 2013 (Reuters, 2018). This may have adverse effects on consumer welfare, the exchange rate, and the reputation of the British government. In 2013, this Cypriot policy was linked with Bitcoin’s market cap exceeding \$1bn for the first time (Cohan, 2017). On the other hand, there have been suggestions that central banks with access to retail accounts would have far greater capacity to distribute fiscal and monetary stimulus direct to the individual in the case of a severe economic downturn.

## One Coin of Many

Finally, CBDC need not be aimed at monopolizing the payments system but could instead be complementary to the payment services provided by private entities (Bordo and Levin, 2017). In the boom of crypto currencies, open source blockchain software enabled anyone to create a digital currency, leading to the explosion in the volume of currencies.

This technology is now being co-opted by private institutions. A diverse monetary landscape could be like that of England in the late 18<sup>th</sup> century, where weak monetary practices by the state lead to individuals minting their own small denomination coins. Digital Condor coins might be available in specific parts of the internet, from specific organisation or for specific purposes. Already in-app purchase allows people to buy currencies in video games and Starbucks has the largest reserves in the world. Some of these currencies will be worthless outside of the ecosystem they were created in, however others of these might retain value become widespread. A CBDC would serve as the ultimate reserve currency in this situation; the currency others are valued in and that taxes are paid in. In the absence of a CBDC in this situation, private payment systems might exhibit increase returns to scale and become quasi-monopolistic, leading to complex and opaque government regulations to mitigate the systemic risk and prevent the price gauging of consumers and small businesses. (Bordo and Levin, 2017).

The use of condor coins in the 18<sup>th</sup> century shows that private currencies are produced in response to inadequate sovereign currencies. Bitcoin was produced to solve problems inherent in the traditional financial system. While the cash based financial system is being phased out, there is still time for the Bank of England to produce a worthy CBDC before people look for payment solutions in private currencies and the currency landscape becomes fragmented as it was in the era of Condor coins.

## Conclusion

This paper has surmised a brief history of currency in the UK and considered the case for both crypto currency and central bank digital currency payment systems in the economy. While forecasting is nothing more than a best guess granted by focused research, we can make some educated assumptions about the near future payment landscape of the UK.

The use of crypto currencies has grown, but they are still mostly treated as investments and rarely perform all three functions of money. If the national currency remains strong, there will be little incentive for consumers to start making transactions in highly volatile digital currencies. Crypto currencies therefore pose little threat to the stability of the financial system or the price level. As such, a focused approach from the FCA and the Bank of England on regulating emerging cryptocurrency firms will foster consumer confidence in the markets in which they operate but should also enable more educated investments by speculators.

Stablecoins and digital tokens alleviate some of the difficulties of crypto currencies but will not gain a strong foothold in the UK payments system since the pound is kept stable and trustworthy. Nakamoto's critique of commercial bank money has become internalized by the financial system, which has also sought to adopt distributed ledger technology to facilitate faster, cheaper transactions.

The UK government is likely to use these innovations in payment technology to create a CBDC. This will solve many of Nakamoto's criticisms of commercial bank money, while allowing the Bank of England to retain control of monetary policy. The Bank of England is yet to decide their optimal involvement in the retail deposit market. Becoming a deposit monopolist will likely deprive commercial banks of an important source of revenue, but attempting to duplicate the current two-tier banking model, with CBDC at the core instead of cash will imply very little innovative opportunity for new DeFi firms.

It is the design and architectural choices of the Bank of England and HMT, which will decide the effectiveness and popularity of a CBDC. Meanwhile, regulations could either choke the private currency market of innovation or instill a sense of legitimacy, and as such have been treated warily by UK regulatory bodies. The currency landscape is likely to remain mixed. CBDC will replace cash and compete with commercial bank money for retail transaction. Private digital currencies will remain niche, performing functions that traditional finance and CBDCs fail fulfill.



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