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Asian Insights

Digital currencies, banking, and central banking

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- *Considerable work is being done these days on digital currencies, catching the attention of the public and policy-makers alike. Ranging from cryptocurrencies backed by blockchain to the notion of central bank digital currencies, a new frontier has opened.*
- *The issues around digital and crypto currencies are fascinating but daunting. The basic concept of fiat money is formidable, with nontrivial underpinnings.*
- *The notion of digital currency entails consideration of payments system, banking, monetary policy, and financial stability.*
- *Add to that layers of computer science and cryptography necessary to understand cryptocurrencies, it is little wonder that misperceptions abound.*
- *Neither electronic payment nor electronic money is new. More than a century ago, banks and traders communicated in real time via telegraph, settling payments and executing trades. Central banks have been managing the issuance of reserves to banks electronically for many decades. Mobile payment and digital wallets have been around for nearly two decades. What has changed is mobile computer power and connection speed, making digitalisation ubiquitous.*
- *Is cash dying due to digitalisation? We begin by looking at some data on usage of cash and noncash around the world. In the context of Singapore, we present some findings based on monthly data from DBS Bank's 4.9 million accounts. We don't see cash disappearing, for some good reasons.*
- *We then lay out some key elements of the crypto currency phenomenon and its potential use and limitations. We like the technology underlying cryptos, but see many limitations getting in the way of their wide proliferation.*
- *We conclude with the provocative concept of central bank digital currency, which is at once old and new. We imagine a world without cash, and conjure what that would mean for banks, nonbanks, and policy. Giving the people central bank accounts credited with digital currency could change finance, banking, and central banking fundamentally. These are very early days; we don't see any monetary authority rushing in this direction.*

Introduction

"It is with peculiar diffidence and even apprehension that one ventures to open one's mouth on the subject of money" -- John Hicks

Considerable work is being done these days on digital currencies, catching the attention of the public and policy-makers alike. But neither electronic payment nor electronic money is new. More than a century ago, traders in London and New York communicated with each-other in real time via telegraph, exchanging market relevant news, trade instructions, and payment orders. Western Union began using its telegraph network for wiring money in way back in 1872. Central banks have been managing the issuance of reserves to banks electronically for many decades. Mobile payment and digital wallets have been around for nearly two decades. For public and private payment and settlement, systems like Real Time Gross Settlement (RTGS), FedWire, Clearing House Interbank Payments System (CHIPS), Society for Worldwide Interbank Financial Telecommunication (SWIFT), Electronics Funds Transfer System (EFTS) have been operating for decades, offering fast and low cost solutions.

What has changed over the past decade is that mobile computing power and connection speed have improved tremendously, bringing instant digital payments and settlements to our fingertips. At the same time, entrepreneurs have come forward with systems of digital currency issuance and settlement that take place privately and globally.

Starting in 2008, but gaining worldwide attention in the last five years, bitcoin perhaps epitomizes the keen interest in digital currencies, although the universe of cryptocurrency has expanded rapidly. One glance at coinmarketcap.com reveals over 1,600 types of tradable cryptocurrencies. Call it speculative, precautionary, or simply a part of portfolio diversification, digital currencies have captured the investor zeitgeist.

The issue is fascinating but at the same time daunting. The basic concept of fiat money is formidable, with nontrivial underpinnings (amply underscored by the John Hicks quote above). The notion of digital currency entails consideration of payments system, banking, monetary policy, and financial stability. Each of these topics have vast history, extensive literature, best practice, and legal and jurisdictional implications. Add on top of that layers of computer science and cryptography necessary to understand digital cryptocurrencies, it is little wonder that misperceptions abound.

We will attempt to touch the key bases associated with digital currencies without sacrificing sophistication, so we hope there will be something for both the uninitiated and the practitioner in this paper. We will begin by looking at some data on usage of cash and noncash around the world. In the context of Singapore, we will present some findings based on monthly data from DBS Bank's 4.9 million accounts. We will then lay out some key elements of the crypto currency phenomenon. We will finish with provocative concept of central bank digital currency, which is at once old and new. We will imagine a world without cash, and conjure what that would

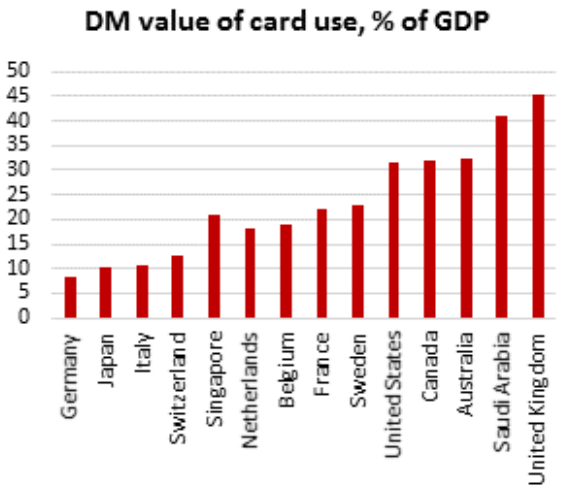
mean for banks, nonbanks, and policy. Given the current nature of the discussion, we will draw heavily on the literature of the past year or so while doing this.

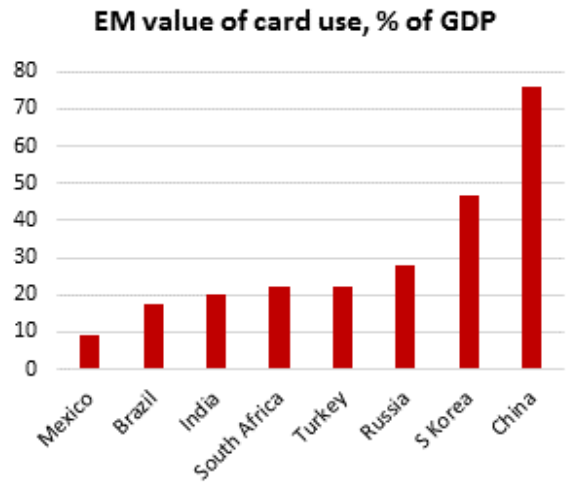
Is cash dying? Evidence from around the world

The advent of credit and debit cards ushered in an era of cash and check-less payments several decades ago, and their usage continues to rise in developed and developing countries. Estimates made by BIS (2018) show that card payments as a share of GDP have roughly doubled in both advanced and emerging market economies since 2000 (to about 25% of GDP). People have more cards per head and they use them more frequently. At the same time, they spend less per usage, understandable as payment infrastructure has deepened and day-to-day basic transactions can now be settled using a card. In addition to card usages, online payments have soared.

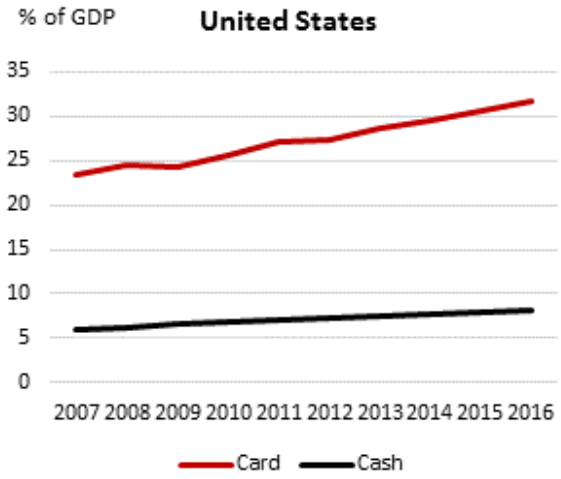
But the sharp rise in electronic transactions does not mean cash is dying. Despite the prevalence of payment facilities that replace cash transactions, in general, the demand for cash is still on the rise. Cash demand as a share of GDP has increased in most countries in the past decade. The key exception is **Sweden**, where a decline in cash demand has been observed.

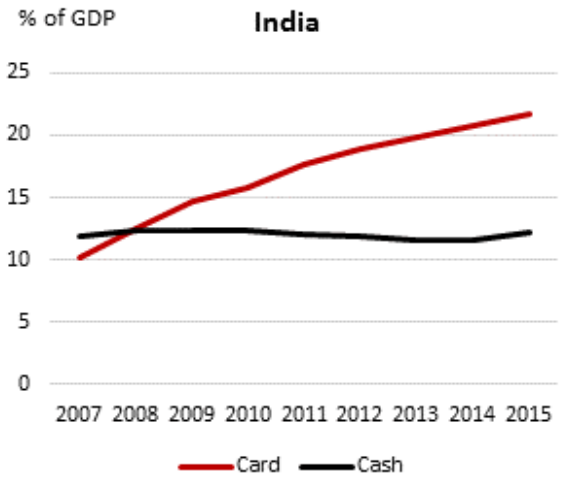
The most interesting experiment with cash usage has been recently in **India**, where in late 2016 the government made a surprise demonetization announcement, requiring the deposit of all high-value notes, followed by a gradual introduction of new notes. The process was complemented by a push for e-payments. By the end of 2017, e-payments had jumped, as expected, but cash in circulation also returned to previous levels (and rose well past previous peaks in 2018).

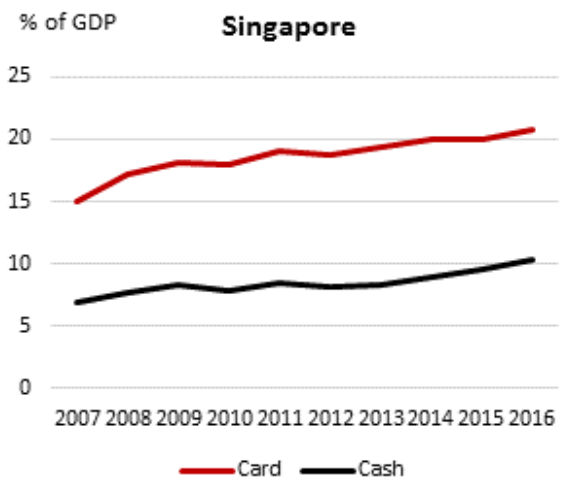




Source: BIS, DBS. Data from 2016







Source for all charts: BIS, DBS

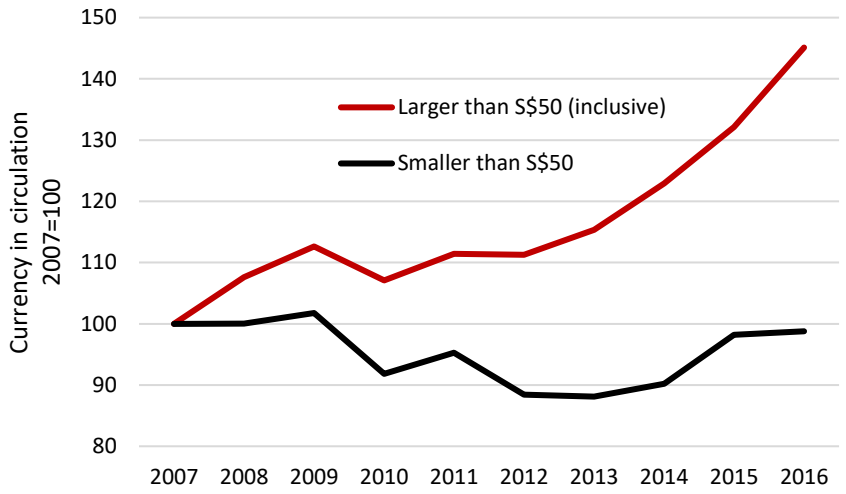
BIS (2018) finds cash demand up by about 2% of GDP globally since 2000, although the demand varies considerably among countries. Interestingly, the variation does not depend on the level of development; **Japan** is characterized by high cash demand (20% of GDP) while in the case of **China**, cash demand has fallen by 5% of GDP (to 9%).

It appears that the 2008-09 global financial crisis had a chastening impact in many developed economies, pushing up cash demand. **Iceland** is the starkest example, where cash in circulation doubled after the 2008 banking crisis.

How about our home market **Singapore**? The chart above shows that on an aggregate basis, both cash and non-cash usages have been steadily rising in the island state over the past decade. This appears puzzling. Why has the demand for cash increased despite wider adoption of card payments? It may be helpful to differentiate between means-of-payment and store-of-value demand for coins and banknotes. The easiest way to determine the type of demand for cash holding is to

examine the distribution of currencies according to their denominations. Large denomination banknotes, due to their portability, are suited for storing value. Whereas, small denomination banknotes and coins are more likely to be used for payments.

We plot a breakdown of currency in circulation for Singapore in the chart below. In Singapore, currencies are issued in denominations of S$10,000, S$1,000, S$100, S$50, S$10, S$5 and S$2. We observe that between 2007 and 2016, there has been a slight decline in the demand for currencies of denominations smaller than S$50. This indicates reduced demand for payments. However, the currency withdrawn for storing value has increased sharply, consisting the S$10,000, S$1,000, S$100 and S$50 banknotes.



Source: BIS, DBS

Cash, therefore, seems to be mounting a strong resistance against obsolescence, even in a highly connected and advanced economy like Singapore. Beyond the issue of store of value, cash has other appeal. It may be susceptible to counterfeiting, but no one can hack into cash; power outage cannot disrupt cash transactions. For Singaporean SMEs that do considerable business with their vendors across the border in Indonesia and Malaysia, cash remains a key source of settlement.

Finally, there may a genuine demand for cash from those who carry out legal but private transactions. Helping a struggling relative, paying for a potentially embarrassing habit or guilty pleasure, these are often carried out without the eye of any records, but that doesn't make them illegal. In such private matters where both the payee and the recipient want to remain in the shadows, cash is the only conduit to guarantee privacy.

What do we find in the DBS transaction database?

To get a deeper look at the retail level activity, we look at monthly data from DBS Bank's 4.9 million consumer accounts. We have data, starting in January 2016 to April of this year, that covers ATM and point of sale cash withdrawals, and non-cash

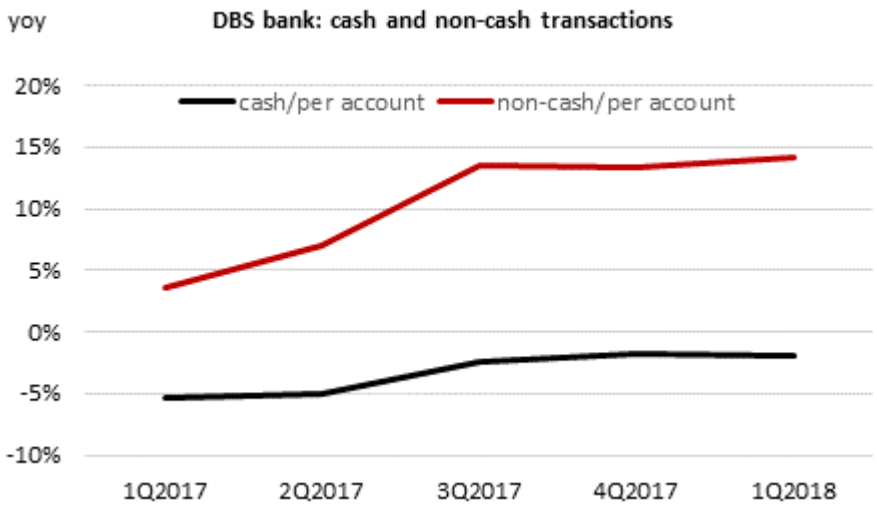
usage spanning Debit and credit cards, and various e-transfer platforms such as GIRO, Nets, EZ-link, and Paylah.

The chart below shows that cash transactions per account have in fact been declining, while non-cash transactions per account have been rising robustly. Note that company level transaction is not captured here, so this finding should not be considered a contradiction of the earlier findings.

Separately, we also find that:

- The aggregate amount of cash to non-cash transaction ratio has declined from 0.54 in January 2016 to 0.33 in April 2018 (so, presently, three times more transaction value is cleared through non-cash means over cash).

- As for number of non-cash transactions carried out in a given month, that is now 4 times that of the number of cash transactions.



Source: DBS bank, consumer banking database. Cash transactions include ATM and cashpoint withdrawals. Non-cash withdrawals include credit cards, debit cards, GIRO, Nets, EZ-link, Paylah.

Cryptocurrencies: what does the future hold?

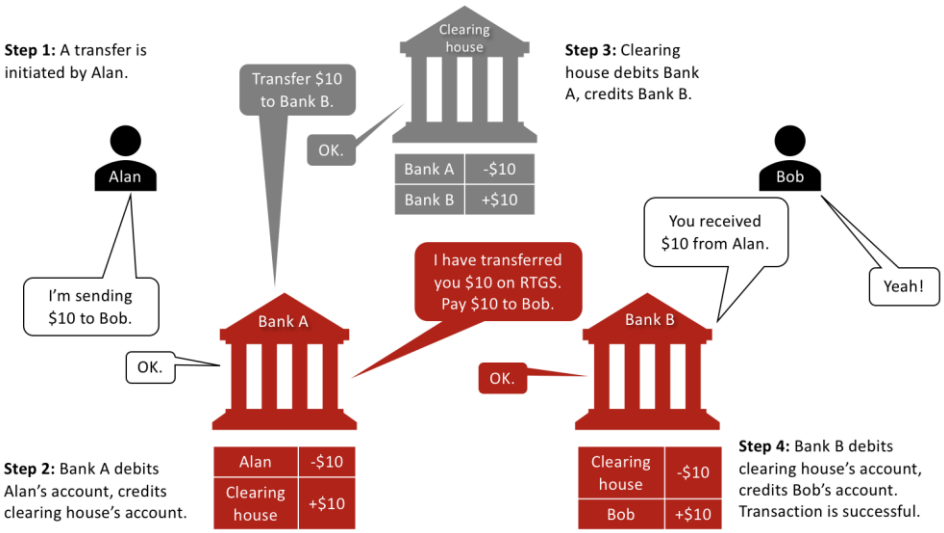
For thousands of years, the issuance of money has been the government's job. With money supply under control, governments can influence economic activities. The citizens trust the issuing authority in maintaining the value of money and in preventing counterfeiting.

Innovations in computer science now have allowed private entities to create digital currencies, with bitcoin being the most notable one. To economists, this innovation raises intriguing questions. Would the privately-issued currencies be sustainable as sound monies? Would the government's job in stabilizing inflation be confronted with the proliferation of private currencies?

Centralized and decentralized payment systems

The key innovation of cryptocurrencies is their ability to make peer-to-peer electronic payments without a third-party clearing house.

To see why payments without a third party are an innovation, it is helpful to recall how traditional electronic payments like RTGS work. When Alan remits money to Bob, Alan's bank, Bank A, sends an instruction to a clearing house, usually the central bank, which debits the Bank A and credits the Bob's bank, Bank B, for the full amount of the transaction. In this process, both Alan and Bob trust that the bank responsibly records their money balances, and that the clearing house credits/debits the correct amounts. Without the clearing house overseeing the money balances, Alan could falsely claim that the money had been sent. Likewise, Bob could falsely claim that the money had not been received.



Payments in cryptocurrencies, such as bitcoin, are based on the consensus mechanism. When a payment is initiated, miners on the network compete to solve a complex mathematical problem that essentially verifies the transaction between Alan and Bob. Once verified, the transaction is announced to and recorded by all users in the network. Based on the transaction records in an open, decentralized distributed ledger or the so called blockchain, everyone can verify whether Alan possesses sufficient amount.

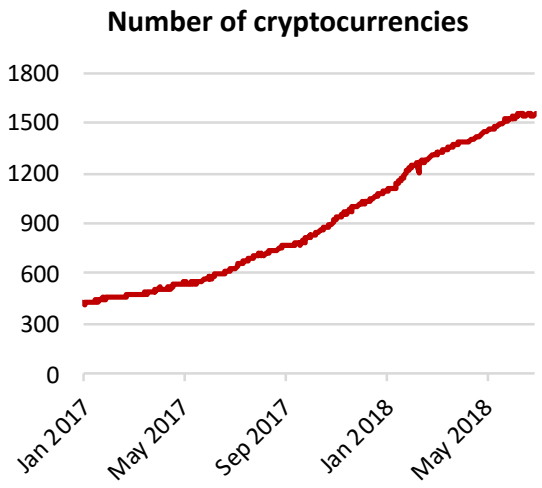
The centralized and the decentralized systems have their distinct advantages. The centralized payment system usually features less computation and faster payment speeds than a decentralized one. For example, Mastercard is capable of handling 44,000 transactions/second, while the bitcoin network can only handle 6 to 7 transactions/second (Bitcoin cash can do 60/second, while Ripple is reported to do 1500/second). Transactions require longer time to be verified on a decentralized network as computing power are disaggregated. The clearing house also takes care of refunds and charge-backs which are not possible in a decentralized network. Since the decentralized system is based on a consensus mechanism, once a transaction is verified, even if it was initiated by mistake, it cannot be reversed unless the receiver initiates another transaction to send the money back.

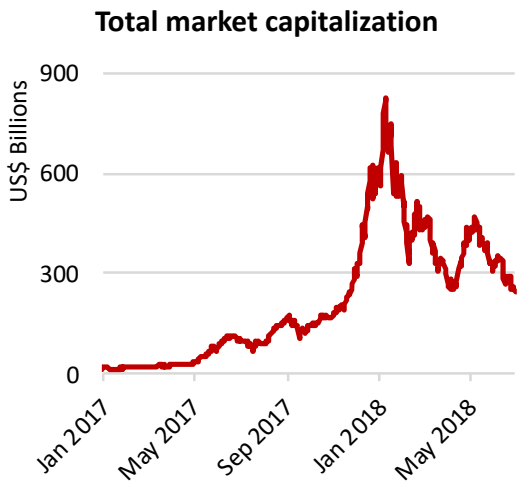
The longer transaction time and the irreversible transactions are compensated the decentralized network's security and reliability. A centralized database is constantly challenged with security threats and system failures. In contrast, it is practically impossible to hack one's bitcoin wallet if the private key to the wallet is properly kept. The centralized network is, by definition, prone to a single point of failure. In October 2014, the Bank of England's payment system failed, leaving homebuyers in limbo. More recently in February 2018, the NETS system in Singapore also failed for 2 hours. In the decentralized network, even if a few miners are down, as the ledger is recorded by all miners in the network, the verification work may continue. The decentralized system stops operating only in case of a worldwide internet failure.

Consensus is emerging that a combination of the centralized and decentralized networks may be ideal. Project Ubin, carried out by the Monetary Authority of Singapore and the private sector, is a pilot looking to relieve some workload from the central bank and at the same time boost reliability of the system. Conversely, introducing a little centralized process to the decentralized system, for example, arguably the lightning network, may help increase the efficiency in payments.

How do cryptocurrencies compete with central banks?

Monetary policy has been a tool to stabilize economic activities. During a recession, money supply is increased to enhance purchasing power, and during an economic boom, money supply is reduced to limit economic activities. Recent proliferation and increasing adoption of cryptocurrencies have the potential to challenge the monetary authority's role.





Sources: coinmarketcap.com and authors' calculations.

There are differing views on the desirability of the monetary authority competing with private entities in issuing money. Economist Milton Friedman thought the government should monopolize money supply, because allowing private entities to create currencies would lead to over-supply. Given the amount of goods to be sold in an economy, too much circulating currency would result in hyper-inflation.

Conversely, Friedrich Hayek believed competition in currency would impose discipline on the money issuers. If the money issuer wishes to make its currency competitive, it ought to limit the supply. Issuing too much currency puts the itself out of business.

The consensus between these long-held views is that an over-supply of currencies would not be desirable. In the case of cryptocurrencies, the key question is if their proliferation will lead to over-supply of currencies. Perhaps because of this concern most cryptocurrencies are designed with limited supply. It is very costly to alter the limit as an alteration requires consensus from the users on the network. This can allay fears of hyperinflation, and in fact may act as a stabilizing force in an economy experiencing hyperinflation.

But while the supply of one cryptocurrency may be capped, there is still the issue of low barrier to entry leading to the issuance many type of cryptocurrencies, leading to an over-supply in aggregate. If a proposal to change a feature, e.g. supply limit, of a cryptocurrency does not obtain enough support for the change to be executed, one may create a new cryptocurrency by forking from the old one. In such a scenario, the cryptocurrencies are likely to drive themselves out from the market (Fernández-Villaverde and Sanches 2017).

Most cryptocurrencies have functions other than being general currencies. Some are utility tokens to be used in networks, analogous to coins in computer games or mileage issued by airlines. Some are security tokens representing ownership of a company or property. The diverse functions of the cryptocurrencies ensure that they have their own target users. They are in fact likely to be tagged as crypto assets in the future as it becomes clear that they are unlikely to be used for day-to-day transactions. At the end of the day, it may still be a healthy competition if regulators could establish a framework to guide cryptocurrencies toward desired economic segments, or, a consolidation takes place and the market leaves us with a few good cryptocurrencies.

Bottomline

The future of cryptocurrencies as competitors of fiat money boils down to three economic issues, namely, the reliability of the existing payment system, the credibility of the monetary policy and utility of cryptocurrencies to their holders. The regulator's attitudes cannot be ignored either.

Central bank digital currency

The popularity of the distributed ledger technology is not confined in the private sector. Central banks around the world have started recognising the benefits of such technology and are in the process of researching and developing their own digital currencies. This type of digital currencies is called the Central Bank-issued Digital Currency (CBDC).

There are essentially two issues with regards to CBDC. The first issue is the decentralization of the payment system. This has been discussed in the earlier

section. The second issue is the wider digital access of the central bank's balance sheet. Currently in most countries, only banks have access to digital central bank money. Majority of households' money is in the form of bank deposits. Allowing deposits with the central bank provides a safer option as banks may fail. In what follows, we focus more on the implications of wider digital access to central bank balance sheet.

As with electronic payments, digital version of the central bank money is not new. For decades, the money markets between a central bank and the commercial banks, and among the commercial banks have been digital. Similarly, access to central bank money is not new either. The notes and coins we use in daily transactions are the liability of central bank to us. The innovation, however, other than the decentralized payment technology, is the digitisation of cash that will potentially bring some benefits and concerns to the user and the central bank.

What are the advantages of CBDC?

CBDC is a less costly alternative of the physical counterpart. It is so both in terms of production and usage. Printing paper money is costly. In 2018, the Federal Reserve budgeted $861.7 million to produce currency. Digitizing central bank money would greatly reduce the cost of production. In terms of costs involved in usage, it requires no more than a smartphone to store the money and to carry out transactions. Face-to-face transactions are not required as in the case transacting in paper money.

Secondly, if an interest-bearing design is introduced to CBDC, it may contribute to greater macroeconomic stability. Rogoff (2017) points out that it is due to the non-interest-bearing nature of physical cash that the interest rate cannot venture into the negative territory when needed, and that the effect of monetary policy cannot be fully pass through to the real economy. Bordo and Levin (2017) also highlight that an interest-bearing CBDC facilitates price level targeting regime (as opposed to inflation targeting), allowing households to plan consumption and investments for the long run.

Thirdly, not only does the issuance of digitized central bank money works as a monetary tool, it can also work as a fiscal stimulus in the event of economic downturn. If everyone in the society had a central bank account, funds could be deposited directly into the accounts of say, low-income households, cushioning their purchasing power from the effects of the downturn as well as from the temporarily negative interest rate.

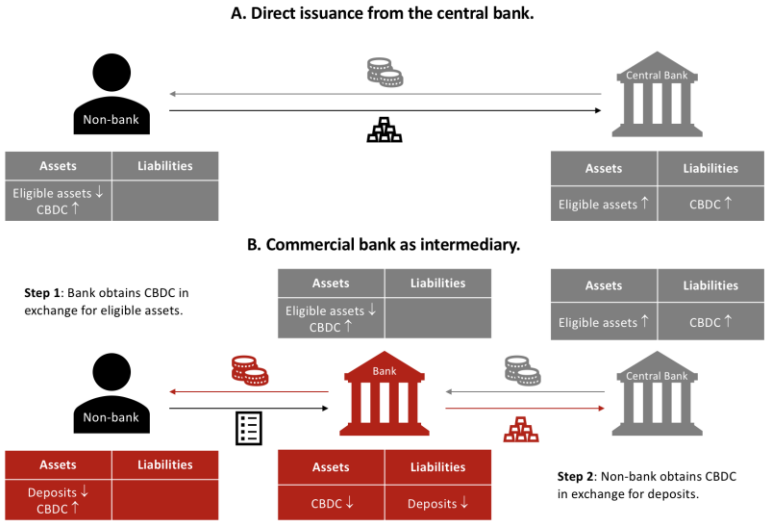
Digital bank runs

Digital bank runs have been deemed the most severe threat to the implementation of CBDC. As CBDC directly competes with bank deposits, in a systemic crisis, despite deposit insurance, households could seek to hold their wealth in the riskless central bank liability rather than riskier private sector one. On-demand conversion between deposits and CBDC could cause flights to CBDC in a cheaper and faster manner than the case with physical money.

Of course, if bank runs were to happen, they would be as likely with physical cash as with CBDC. Also, cash, and hence its digital replacement, is usually not issued against deposits with commercial banks, but other eligible assets such as government bonds and, in the case of Singapore, foreign assets.

Bank runs are not more likely to happen because the currency in circulation is in digital form. If a bank is in trouble, depositors are equally like to switch their deposits with this bank to other assets. Traditionally, due to the long waiting time at the branches and ATMs for cash withdrawals, it is easier for depositors to switch their deposits at the problematic bank to the best banks in their minds. With CBDC, simply switching deposits to CBDC appears to be a faster way to safeguard one's deposits.

The principle for the issuance of CBDC (or cash) is that it must be issued against eligible assets not including bank deposits. Because CBDC entails direct deposits with the central bank, non-banks can now obtain CBDC from the central bank by selling eligible assets. Alternatively, CBDC may also be issued indirectly with the intermediary of banks. Banks exchange their eligible assets for CBDC from the central bank, and subsequently issue CBDC to non-banks in exchange for deposits. This is also how the "exchanges" between cash and deposits happen in the current banking system. In short, a bank needs to capitalize itself with enough eligible assets so as to handle high demand for CBDC.



In the event of a bank run, sudden surge in the demand for CBDC arises. A bank needs to capitalize itself to fulfill the demand. This can be done by exchanging its non-eligible assets, e.g. bank loans, for eligible assets with either another bank or non-bank. As long as there are enough eligible assets in the private sector, the demand for CBDC can be contained without central bank's intervention. In the extreme case when no one is willing to exchange eligible assets for the bank's non-eligible assets, the central bank may intervene by first fulfilling the demand for CBDC, then resolving the issue with bank. Due to the faster transaction speed than physical cash, such a plan can be executed momentarily.

It is worth noting the advantage of having CBDC as compared to physical. Bank runs cause panic in part because the speed of replenishing cash at branches is slow. The long queues exacerbate the panic in the public. With CBDC, the central bank could issue cash to consumers' accounts at the soonest moment, isolating the systemic effect then resolving issues with the problematic institution. Just imagine, if the scale of bank runs were so large that all banks fail, would it be easier and more comforting if the central bank immediately credited the deposit insurance to consumers' CBDC accounts, or if the central bank distributed physical cash to the queue outside its building?

Imagining banking and central banking in 2030

The technology to provide each citizen with central bank account is already available. A blockchain based payment system, overseen by a central bank, but decentralized nonetheless, is also doable, although the prevailing system of efficiency and security of central bank payments is many times ahead of the new, emerging technologies.

Imagine a time in the not-too-distant future when some economies find it worthwhile to issue each citizen with a central bank account. Developing countries like Brazil, India, and Indonesia have, for years, attempted various forms of bank accounts for the population, with financial inclusion, targeting of social subsidies, and poverty alleviation in mind. In our scenario, central bank accounts turn out to be a cost-effective answer for their needs. Also, advanced economies find it in their interest to roll out central bank accounts, with the option to achieve negative interest rates and to carry out instant benefit transfers to the population.

In this world, regulators conclude that banks will have to become "narrow" banks, i.e. they will only provide the function of taking deposits that are fully backed by government bonds (resembling, to a large extent, a money market fund). This makes the banks completely safe, taking away the need for capital requirements or deposit insurance, but this also all but eliminates the banking system's ability to extend loans. Whatever services banks can offer are financed by the margin they earn by investing in government securities (minus the deposit interest rate).

All loans to individuals and companies are carried out by non-bank financial companies, financed by the private sector (perhaps banks own some of these companies). Because the barrier to entry to this type of business is significantly lower than starting a traditional bank, many firms take part, reducing concentration risk to the financial system.

Does this world of no bank runs and little public funds at risk appeal to today's policy makers? Reading the speeches and ruminations of the leading central bankers around the world, we see a desire to allow innovation go forward, but at the same time considerable reluctance to embrace a narrow bank model. Regulators seem to believe there is substantial efficiency in a single point of control for currency and regulation. While they see the difficulties posed by concentration risk, the idea of numerous small firms carrying out all lending, the essence of modern finance, does not come across as a solution to them. The financial system is susceptible to

common shocks; the number of financial entities does not appear matter one way or the other when it comes to systemic risk. As was seen in the 2008 Global Financial crisis, commons shocks affected banks around the world simultaneously; it is doubtful if the existence of narrow banks would have prevented the securitisation of sub-prime mortgages from building up.

Conclusion

Human beings evolve by building on past successes and dealing with challenges. The banking system is not an exception. The wide coverage of mobile networks and increasing computing powers of mobile phones accelerated the adoption of digital payments. Reciprocally, this accelerated adoption has posed challenges to the current payment systems which rely on centralized clearing houses.

Security threats and system failures are constantly challenging the system operators. Cryptocurrencies emerged to provide a decentralized, secured, and reliable way of payments, but at the same time they face the challenges of inefficiency and over-supply. Nevertheless, the innovation in cryptocurrencies has proved to be useful for the future of central banking, in that the central banks may decentralize their payment systems to achieve higher security and resilience.

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