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So far, Central Bank Digital Currencies have failed

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Abstract

This article examines the experiences of Central Bank Digital Currencies (CBDCs) implemented so far. To date, CBDCs have been implemented in two countries (Finland and Ecuador) where they have failed and been abandoned. They have also been implemented in three Caribbean cases and in China and Nigeria; these five cases are ongoing. These experiences can be summarised as a series of abandoned experiments, embarrassing flops and monumental exercises in policymaker hubris, one of which has already produced a major disaster. In each case where data exist to assess the situation, the public demand for CBDCs has been extremely low. Experience suggests that CBDCs do not offer tangible benefits which existing alternatives cannot already deliver. One might speculate that future CBDCs will fail for similar reasons.

KEYWORDS

central banks, cryptocurrency, digital currency

JEL CLASSIFICATION

E58, G21

1 | INTRODUCTION

One consequence of the rise of cryptocurrencies has been to spur interest in Central Bank Digital Currencies (CBDCs), digital currencies issued by central banks usually for retail payments purposes.[1] Facebook's announcement of its proposed new Libra currency in 2019 was especially

significant in this respect. Central banks across the world interpreted Libra as a wake-up call that posed a major threat to their own currencies and to their future monetary sovereignty. They responded by accelerating their CBDC plans, and the race to implement CBDCs went into overdrive.

As of 23 August 2023, the Atlantic Council CBDC tracker[2] reported that 130 countries were exploring a CBDC, 64 of which were at an advanced (development, pilot or launch) phase; 19 of the G20 countries had CBDC schemes at advanced stages of development. Two further countries, Finland and Ecuador, had already tried to implement CBDCs and had abandoned them, and a further five central banks – three in the Caribbean plus the central banks of China and Nigeria – have launched live CBDC programmes that are ongoing.

This article is the first to examine the CBDC experience across all seven cases where CBDCs have been implemented to date. I find that every single CBDC experiment has been a failure, in the sense that it failed to make the population any better off. In every case where data exist to assess the case, the public have been reluctant to adopt them. It also appears that CBDCs failed to offer any benefits that could not already be obtained using existing payments media. At best, these findings suggest that CBDCs are much more difficult to establish than their advocates realise. At worst, they suggest that CBDCs are a losing proposition for their advocates because the public are unlikely to accept them. From this evidence and for additional reasons explained in my forthcoming book (Dowd, 2024) I venture to predict that they will all fail and that the Great CBDC Project, the 'current thing' in central banking, will eventually be abandoned and will be looked back upon as an embarrassment to those currently promoting it.

We start with the two CBDCs that have already failed.

2 | FINLAND

The[3] world's first CBDC was the Avant smart card system created by the Bank of Finland in the early 1990s, long before the term 'CBDC' came into use. Using modern CBDC terminology, it would be described as a 'token-based retail CBDC'.

A key difference between Avant and contemporary CBDC systems is that for modern CBDC systems cards might be an additional feature, whereas in Avant cards were the main component. Avant cards were based on smart card technology, which was nascent at the time, similar to that used in debit and credit cards today. It was intended that the new payment instrument should resemble cash as much as possible, and that paying with it should be easy and anonymous.

The Bank of Finland launched its Avant project in 1993. By 1995, the total number of outstanding cards reached 500,000. During its first three years, the business entity that issued Avant cards was fully owned by the central bank. Avant was then spun off to the private sector. Though it had been positioned as a low-value payment instrument to replace cash and small denomination banknotes, it turned out to be similar in effect to debit cards. Fees were later added for reloading, which dented demand, and over time debit cards became more popular. Avant was discontinued in 2006.

The Bank of Finland had expected that Avant would take over from coins for small purchases but Avant never really took off. Users weren't happy about fees, merchant take-up was low and alternative debit- and credit-card networks were much more functional.

As David Gerrard observes, Avant's lesson for future payment systems is that user convenience is king. He adds:

> The existing debit card systems are *really very good* – they have user take-up, they have merchant take-up, and they're actually displacing cash – and they give the typical user the reassurances they really want. Did you know that if you lose your card ... your money is safe, and not lost? You can't say that about a £20 note.
> CBDC advocacy hasn't changed since Avant. CBDCs are the sort of thing the vendor loves – but I've yet to see the case for consumers.
> CBDCs will have to be *better* than debit cards – for the typical consumer. A technically exciting back end, that gets other vendors to sign on with you, is not enough – your market is users, not other vendors.
> You might think that's obvious – but it's a lesson that history keeps having to hit technology vendors over the head with, repeatedly.
>
> (Gerrard, 2020a; emphasis in original)

3 | ECUADOR

In[4] 2014 the Ecuadorian government announced to great fanfare that the Ecuadorian Central Bank (BCE) would soon begin issuing an electronic money (dinero electrónico, or DE), a form of retail CBDC. Users would keep account balances on the central bank's own balance sheet and transfer them using a mobile phone app. Enabling legislation was passed in September and accounts became spendable in February 2015. Ecuador becomes the first country in the world to roll out a CBDC, declared the media. The stated objectives of the new currency were to benefit the unbanked and to reduce reliance on physical cash. At the same time, private digital currencies and cryptos were banned.

The DE flopped.

When it was launched, the government was optimistic that the system would rapidly prove popular. According to Lawrence White (2018), the leading newspaper *El Comercio* reported on Christmas Day of 2014 that authorities expected some 500,000 people to use it in 2015. In the event, the number of accounts opened in 2015 turned out to be less than 1 per cent of this number. By the end of January 2016, the DE accounted for than 0.003 per cent of the monetary liabilities of the Ecuadorian financial system; and the system peaked with DE balances of less than 0.05 per cent of the country's narrow money stock M1. The impact on financial inclusion was undetectable.

A key reason the DE failed to be adopted was that, after previous defaults, it appears that the public did not trust the government as much as they trusted private banks. So they preferred private sector alternatives to the DE, and the authorities abandoned the scheme in early 2018.[5]

This episode teaches an important lesson about the limits to a central bank's ability to introduce a new CBDC when the public lack trust in the central bank and prefer alternative payments media. As White (2018) explains:

> The Ecuadorian case ... shows that implementation of a central bank electronic money system isn't so easy. It requires more than merely setting up a website ... and letting households and firms open deposits. A convenient point-of-sale deposit-transfer mechanism, requiring both hardware and software, must be provided to many thousands of merchants. Consumer service and marketing are part of the business of providing retail payments. There is no reason to think that central banks are or would be good at a commercial business operation.

And it turns out that in Ecuador they weren't.

David Gerard offers this explanation:

> One lesson that [this case] does teach us is to work hard on retail acceptance of your exciting new payment system. I keep finding all these whizz-bang payment system plans – and they all died of minor inconvenience. ... Serving customers at scale keeps turning out to be *quite difficult in practice*.
>
> And ... don't try to back your system with a bank that your users don't trust ....
>
> (Gerrard, 2020b, emphasis in original)

However much the fanfare, if people don't trust it, then they won't use it.

Ecuador provides an object lesson in what can happen when economic planners meet economic reality.

We next look at the schemes currently being deployed.

4 | THE BAHAMAS

The Bahamas has one of the highest per capita incomes in the Americas. Its currency, the Bahamian dollar, is pegged to the US dollar, and over 94 per cent of adults have a bank account. Against this background, the central bank announced a retail CBDC in 2017 and launched it in October 2020. The Bahamian 'Sand Dollar' generated much interest and was widely praised around the world. An article published by the Official Monetary and Financial Institutions Forum hailed it as a "groundbreaking innovation" and according to the Bahamian central bank itself, "The Bahamas is considered a global leader in CBDC development" (Walker, 2022). And no one is more excited about it than IT expert Vipid Bharathan:

> All in all, this is an important milestone in the development of CBDCs. The benefits are not quantifiable a priori, as with any far- reaching solution the effects are emergent. It requires a certain amount of courage to embark on such a project. A population created by forced globalization with a 90% Afro-Bahamian population, a history of piracy, known as a haven for escaped slaves, but a beacon for financial freedom and economic opportunity today, is the right setting for the release of such a revolutionary form of money.
>
> (Bharathan, 2020)

The Sand Dollar had the usual objectives: to modernise and streamline financial stability, to reduce delivery costs, to increase transactional efficiency, and above all to increase financial inclusion, notwithstanding that the Bahamas already had a reasonably high degree of financial inclusion.

The main feature of the project is a digital version of the Bahamian dollar. The CBDC can be used for all domestic transactions, does not pay interest and has low transaction fees. There is also an ecosystem of Authorized Financial Institutions (AFIs) to provide Know Your Customer/Anti-Money Laundering (KYC/AML) checks, wallet services and custodial services for customers. There are two tiers of individual wallets available: (*a*) tier 1 holders can hold only $500 at a time and cannot spend more than $1,000 a month; these wallets do not require government identification but cannot be linked a bank account; and (*b*) tier 2 holders can hold only

$8,000 at a time and cannot spend more than $10,000 a month; these wallets require government identification can be linked a bank account.[6]

More than two years later, Governor John Rolle gave a talk on progress thus far to an EU digital euro audience, its status as a CBDC pioneer meaning that its experience was being closely followed across the world. Efforts to encourage wider adoption were "still in very early stages", but he emphasised they were building a network of merchants that accept and encourage CBDC use and efforts are "beginning to accelerate through direct outreach to the business community"; achieving interoperability with the traditional banking system; enlisting participation from the traditional banking sector and credit unions; and so on and so on, and "messaging is being crafted to inspire user confidence ..." (Hall, 2022).

The data tell a different story, however. The total amount of Sand Dollars rose to about $300 k by the end of 2021, around a million dollars a year later, and has hovered around that same level ever since. Figure 1 shows a plot of the ratio of Sand Dollars to the amount of bank notes in circulation.

We see that the ratio of Sand Dollars to notes in circulation has been hovering around 0.2 per cent since December 2022. Thus, with a population of around 393,000, the per capita circulation of Sand Dollars is still less than 3 dollars.

Consider also that over the period since its introduction, the amount of notes in circulation increased by $73 million, which is 243 times the entire Sand Dollar issue, and that even the

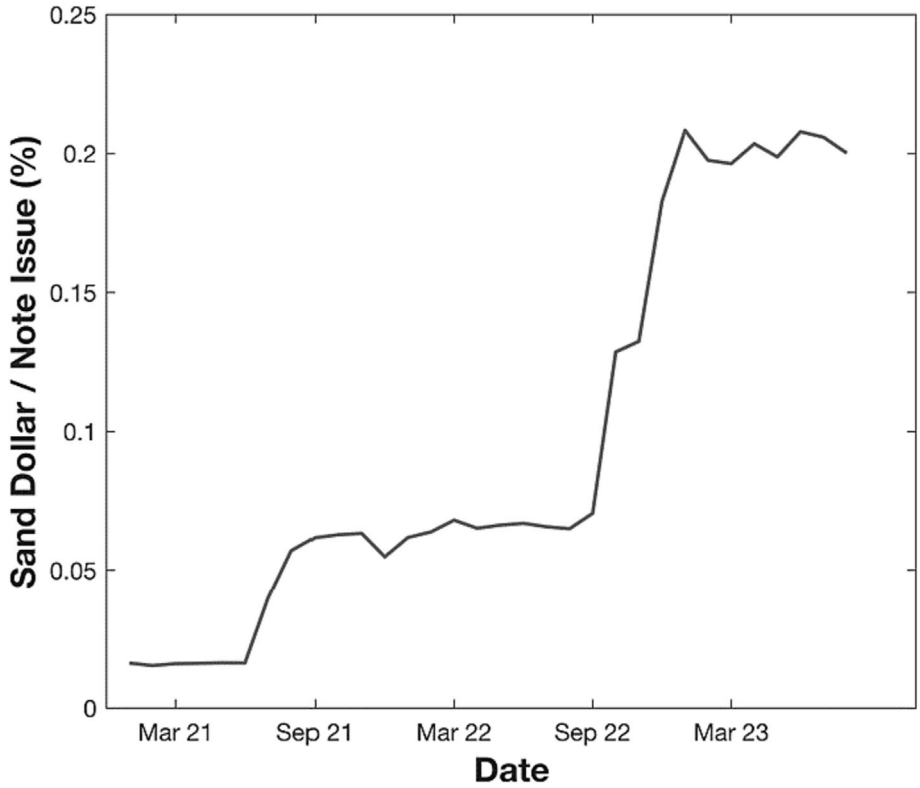

FIGURE 1 Ratio of Sand Dollars to notes in circulation, 2021–2023. *Source*: Based on asset and liability statements of the Central Bank of the Bahamas.

value of *coins* in circulation increased by more than twice the entire Sand Dollar issue. The Sand Dollar "barely registers as a form of currency", as Walker (2022) puts it.

Despite gimmicks such as spending some $1 million on incentivising (i.e. bribing) people to adopt the Sand Dollar and sending out Sand Dollar 'ambassadors' to encourage adoption, it was still acknowledged that with barely 1,500 merchants (and even fewer businesses) having adopted it, the Sand Dollar was "barely scratching the surface" when it came to adoption (Hartnell, 2023). Walker (2022) draws some pointed lessons:

> The lessons of the sand dollar (to-date) apply to all CBDC projects, if not fintech innovations in general. Firstly, they need to be aimed at real problems. Financial exclusion in the Bahamas does not seem to be a major problem by international standards. Secondly, the proposed solution needs to genuinely solve the problem (even if relatively small). The minimal impact of the sand dollar to date suggests it does not. Finally, 'pilots' of the type so frequently carried out in fintech, particularly by central banks, need to be re-considered as a form of proof. Simply implementing something [and] judging whether it 'works' is not a good guide for either policy making or commercial investments, unless there is an objective evaluation of alternatives.

And if it were absolutely insisted that the government had to intervene to do something:

> In the case of the sand dollar, the obvious alternative to creating a new payments and banking infrastructure would have been to encourage greater use of bank issued debit cards and more efforts to educate the older generation in the use of electronic payments.

Or, alternatively, the authorities could simplify their own KYC/AMC regulations, if only US regulatory authorities would allow them to do so. At the end of the day, the Sand Dollar was a puny sand castle that its inventors mistook for a ground-breaking fintech innovation.

5 | EAST CARIBBEAN CURRENCY UNION

The East Caribbean Currency Union is a currency union between Anguilla, Antigua and Barbuda, Dominica, Grenada, Montserrat, St Kitts and Nevis, St Lucia and St Vincent, and the Grenadines. Its currency is the East Caribbean dollar, which is pegged to the US dollar at a rate of EC$2.70 to US$1.

The East Caribbean Central Bank (ECCB) launched DCash, its CBDC, in March 2021. DCash was aimed at "achieving three policy goals: payments system efficiency, financial inclusion of the unbanked and underbanked populations, and increased resilience and competitiveness in the ECCU", the central bank said (*Vixio*, 2022). As ECCB Governor Timothy Antoine explained in an announcement just prior to the launch, "DCash is a major innovation ... a faster, cheaper and safer alternative to physical cash and other payment options. A huge motivation and big benefit of DCash is the *significant reduction in the cost of financial transactions*" (Antoine, 2021; emphasis in original). In his announcement statement Governor Antoine also stressed the "careful attention [that] has been paid to the underlying infrastructure which supports the DCash ecosystem".

Data on DCash adoption appear to be impossible to find, however. The ECCB doesn't report any on its website and my email request to the ECCB itself for data received no answer.

Failing to provide data is not the only instance of the ECCB's lack of basic professionalism, however. On 4 January 2022, the ECCB announced on its website that

> the DCash platform [had] experienced an interruption in service that has affected all users. This break in service has been caused by a technical issue and the subsequent necessity for additional upgrades. Therefore, DCash transactions are not being processed at this time.
>
> (ECCB, 2022)

The problem, it turned out, was that the version of Hyperledger Fabric, the network that hosts DCash's distributed ledger, had a certificate expiry. As David Black comments:

> Did it go down for an hour? Bad. A day? REALLY bad. A week or more? A complete, unmitigated, no-excuses disaster.
> What if you were a user of DCash and you couldn't use it? It would be like having money in your bank account, but the bank claims it's unable to give you any! What are you supposed to do? To whom can you appeal? No one!
> It's worse than that. *As this writing at the end of February, a full six weeks after DCash D-Crashed, it's still down*.
>
> (Black, 2022; emphasis in original)

He concludes:

> ECCB seems to have done everything right. They carefully studied. They worked with an experienced vendor, who had experience doing CBDC. They used the leading blockchain fabric. They used Google for hosting. They did a limited trial, released it in one of their regions, and then made it more widely available. And then something went wrong. Very wrong. What it could possibly be that involves 'certificates expiring' is mysterious. How they could have built something that could be dead for over six weeks is beyond mysterious – it is extremely rare in software.
> CBDC's are a terrible idea. We don't need them. They add nothing in terms of cost or speed to the digital fiat currency and associated software that we already have. How can any government guarantee that they won't have a DCash disaster when their own CBDC rolls out? So governments are suddenly wonderful bringing out great software that works? I've got this bridge, by the way, and I can let you have it for a limited-time-only bargain price...

DCash service finally resumed on 9 March.[7]

As David Gerrard drily observed, "There's no reason to presume that when a central bank puts a blockchain into place, it'll be any less clown-shoes than any other blockchain endeavour" (Gerrard, 2022a).

This episode raises worrying questions both about the reliability of other CBDC projects and their vulnerability to single point of failure problems that can bring the whole system down. The DCash experience reminds us that a CBDC is just another public sector IT project; as such, it would be unwise to expect too much of them.

6 | JAMAICA

After a pilot scheme that started in August 2021, the Bank of Jamaica launched its Jamaica Digital Exchange or Jam-Dex[8] CBDC in July 2022.[9] Its aims were to facilitate greater financial inclusion and provide a safe, convenient and secure means to make payments and transfers (-*Jamaica Observer*, 2022). Jam-Dex operates on the *Lynk* e-money platform. Transactions are free.

As part of the launch the first 100,000 customers who signed up for Jam-Dex via the *Lynk* app were given an incentive bonus of $2,500 Jam-Dex ($16) in their wallets by the government. By 16 July 2022, over 120,000 users and 2,300 merchants had signed up and the Bank of Jamaica and the *Lynk* team embarked on an island-wide public education programme about the benefits of using Jam-Dex on *Lynk*. The *Jamaica Observer* (2022) explained it like this:

> JAM-DEX, the digital version of the country's currency, is legal tender, issued by BOJ on a one-to-one basis with banknotes and coins. JAM-DEX is stored in a digital wallet, which is an app on a mobile device such as your phone that makes it easy for users to send, receive and spend their money. *Lynk*, Jamaica's latest digital wallet, only requires users to upload one Government-issued photo ID (driver's licence, voter's ID or passport) and a copy of their Taxpayer Registration Number (TRN) in order to create a wallet. For added security, the app also collects biometric data to prevent unauthorised access to your money.

The total amount of Jam-Dex was initially very low but jumped in May 2022 to 215 million and then to 256 million the next month, and has barely moved from that level since. Figure 2 shows a plot of the ratio of Jam-Dex to the amount of notes and coins in circulation.

The ratio of Jam-Dex to notes and coins in circulation peaked at a little under 0.14 per cent in May 2022, and has fallen since to just over 0.10 per cent. This fall is due to the erratic but gradual increase in notes and coins.

The shape of the Jam-Dex plot in Figure 2 is reminiscent of the Sand Dollar plot in Figure 1, but it peaks at a noticeably lower level. The Jam-Dex plot would appear to suggest that the Jam-Dex is even less popular than the Sand Dollar. Martha Muir (2023) observes:

> And sometimes if you build it, they [still] don't come. As of February 2023, the total number of Jam-Dex customers was 190,000, while total transactions for 2022 were valued at $357mn, less than 0.01 per cent of Jamaica's $4.7tn electronic retail transactions for that year and 0.1 per cent of currency in circulation. A lack of merchant sign ups and technical difficulties in October meant that early adopters of the CBDC had nowhere to spend it.

The plot in Figure 2 suggests the situation hasn't improved since. Muir (2023) continues:

> But looking at the how and why of Jam-Dex's fortunes so far could offer some instructive lessons for other central banks with similar motives. ... "The majority of Jamaicans are financially excluded," said deputy governor Natalie Haynes in 2022. "To get those persons into the formal financial system, we decided that the central bank digital currency would be a good opportunity."

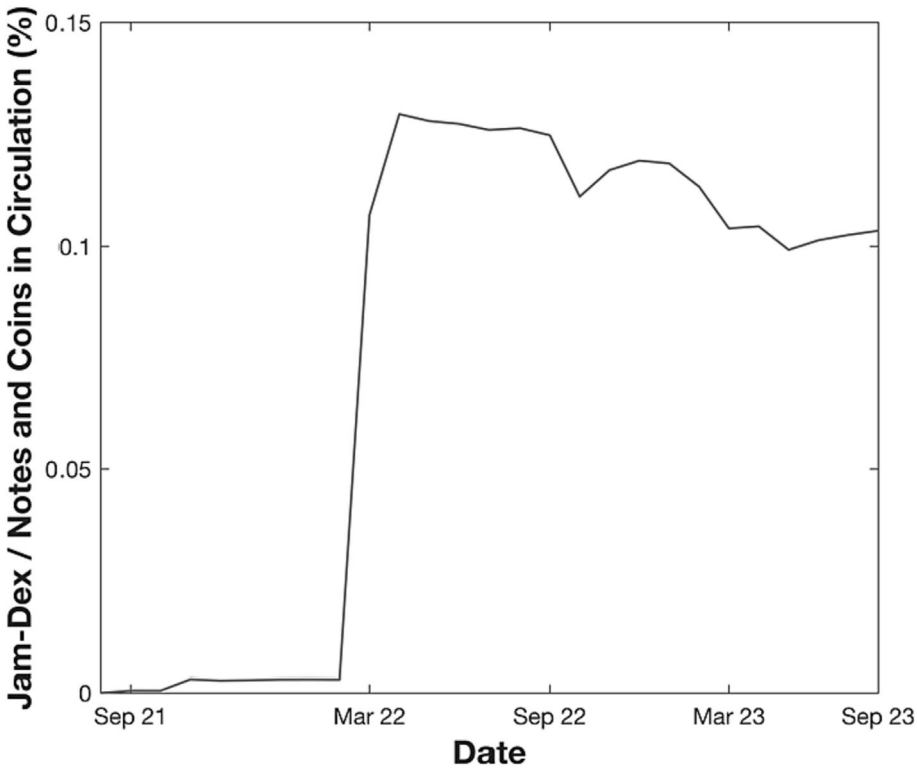

FIGURE 2 Ratio of Jam-Dex to notes and coins in circulation, 2021–2023. *Source*: Based on asset and liability statements of the Bank of Jamaica.

The problem, however, is that there is more to getting people into the financial system than offering a CBDC. The reasons that people don't engage with the financial system are varied: the banking system is uncompetitive, charges are high, many people who have bank accounts only use them to withdraw money; many Jamaicans are unable to fulfil KYC and AML requirements because they lack suitable identification documents and there is a lingering distrust of authority among much of the population. Simply offering a new digital currency – even if it is free and easy to set up and has simplified KYC requirements – does not address these problems.

7 | CHINA

"In the early age of digital money, before smartphones, the machine learning and AI algorithms necessary to make sense of hundreds of millions of transactions did not exist", writes Alex Gladstein.

> But today, governments and corporations can understand the language of global payments. Within moments of buying something online with a tap or swipe, your identity is revealed to authorities and data markets that share and trade your personal information. The end of cash and the insta-analysis of financial transactions

> enable surveillance, state control, and, eventually, social engineering on a scale never thought possible.
>
> In China, this is unfolding with alarming rapidity and existential social impact. Real-time linking of all payments to identities has allowed for the beginnings of a vast social credit system that – though more Kafkaesque than Orwellian and seemingly patchwork for the time being – lays the foundation for eventual financial omniscience ... When the government can take financial privileges away for posting the wrong word on social media, saying the wrong thing in a call to parents, or sending the wrong photo to relatives, individuals self-censor and exercise extreme caution. In this way, control over money can create a social chilling effect.
>
> (Gladstein, 2021, pp. 280–1)

7.1 | Chinese Social Credit

The first point is that we need to appreciate the e-yuan as a means to reinforce the Chinese Social Credit system, that is, to control the Chinese population. This system, first announced in 2014, aims to reinforce the idea that "keeping trust is glorious and breaking trust is disgraceful", as the government liked to put it (Creemers, 2015). The idea is to impose standards of behaviour by rewarding good behaviour and penalising poor behaviour. The government decides which is which and how good or bad the behaviour might be. You are under surveillance when you go out and you get points added to or subtracted from your social credit score depending on how you behave. If your social credit score falls low enough, you get penalised. There is no single Social Credit system yet, but a patchwork of different systems across the country. Participation is mandatory.

Infractions include bad driving, smoking in non-smoking zones, or buying too many video games. It also includes numerous political offences, such as circulating pictures of Winnie the Pooh, posting fake news, and criticising the Social Credit system. Punishments include not being allowed to buy a train or plane ticket, having your dog taken away, having your child denied a good school or job or having your internet connection slowed.

A couple of examples show how damaging this system can be.

> Liu Hu is a journalist in China, writing about censorship and government corruption. Because of his work, Liu has been arrested and fined – and blacklisted. Liu found he was named on a List of Dishonest Persons Subject to Enforcement by the Supreme People's Court as "not qualified" to buy a plane ticket, and banned from travelling some train lines, buying property, or taking out a loan. "There was no file, no police warrant, no official advance notification. They just cut me off from the things I was once entitled to. What's really scary is there's nothing you can do about it. You can report to no one. You are stuck in the middle of nowhere."
>
> (Kobie, 2019)

A low credit rating leaves the victim exposed to the danger of a downward spiral that can cause a lot of problems such as extra paperwork and additional fees, and be difficult to escape from.

As another example, in April 2018 the Civil Aviation Administration of China sent letters to international airlines demanding that they show Taiwan as part of China, stating that the

government would 'make a record of your company's serious dishonesty and take disciplinary actions' against any that didn't comply. They all eventually did (Kobie, 2019).

"It's all about building trust", says the Chinese government. But this claim is false: the Social Credit System is about government power. "China's social credit system is a state-driven program designed to do one thing, to uphold and expand the Chinese Communist Party's power", writes Australian academic Samantha Hoffman (quoted in Kobie, 2019).

As the *Washington Post* (2020) put it in, China's Social Credit System

> uses omnipresent cameras, smartphone apps and more to sort people into categories, track their movements and even take preemptive action against those considered threats. This strategy is fully realized in Xinjiang as part of China's cultural genocide of the Uighur minority, but the expansion of the nation's Social Credit System promises a wider rollout. China infamously censors its Internet with its Great Firewall, and a new cybersecurity law allows the government legal cover to snoop on civilians' online activity even within this restricted space.
> China doesn't want these capabilities to remain only in China ... China hopes to shape international guidelines towards digital authoritarianism too. ...
> China is trying to convince the world ... that closed is better than open and that controlled is better than free. ...
> China's system of digital authoritarianism is a great danger to those living within that country's borders. It's also a danger to the rest of the world.

7.2 | Origin of the e-yuan

China's private mobile payments industry began in 2004 with the launch of the Alipay wallet app, Alipay being a payments provider that is owned by Ant Financial which is part of the Alibaba Group. Its user base had grown to about 1.2 billion by 2023. A second private payment provider is WeChat Pay, which is part of the WeChat family owned and operated by Tencent. It was founded in 2011 and had over 1 billion users by 2023. Together, these two firms leapfrogged hundreds of millions of people from cash and straight into mobile payments and together now have well over 90 per cent of the Chinese online mobile payments industry.

In 2017, trading in cryptocurrencies was prohibited and Chinese regulators began to demand that the private digital liabilities of these firms be held at the central bank, the People's Bank of China (PBOC). From 2019, end users' account balances have been backed 100 per cent by reserves at the PBOC.

In the meantime, the PBOC had in 2014 started researching a centralised CBDC that it initially called the Digital Currency Electronic Payment, but has also gone by the names digital yuan, e-yuan or e-CNY. It then in January 2017launched a Digital Currency Research Institute devoted to the subject. In 2019, Facebook announced its new Libra digital currency; PBOC officials expressed concerns that the Libra might undermine the monetary sovereignty of the yuan and announced they were stepping up their CBDC project in response. 'Internal tests' were then carried out across four cities – Shenzu, Suzhou, Chengdu and Xiong'an – over 2020 and in October 2020 the PBOC launched its pilot CBDC project, the e-yuan, which is technically ongoing. For reasons best known to itself, the PBOC continues to refer to the e-yuan project as being in its pilot stage, but to all intents and purposes the project has since progressed, except officially, to an undeclared launch phase. This project involved the Shenzhen government giving

out 10 million yuan (about $1.5 million) in digital currency in a lottery with 50,000 winners. The winners would download an app to receive a 'red packet', a traditional form of gift giving, worth 200 yuan (about $30) each, which they could spend at any designated retailer. The scheme was then rolled out to further cities in subsequent years and is still expanding.

The initial idea was to test the technology while also boosting spending in the wake of the Covid pandemic. More fundamentally, the new e-yuan was intended to counter the perceived threats to Chinese monetary sovereignty from cryptocurrencies and to reduce the country's dependence on Alipay and WeChat Pay. And, at the most fundamental level of all, the goal underlying e-yuan and China's other social control programmes is to create nothing less than a 'programmable society' firmly under the control of the Chinese Communist Party (CCP).

7.3 | Key features of the e-yuan

The Chinese were already very familiar with the benefits of digital currencies even before the e-yuan:

> Some 92% of people living in China's largest cities report that they use one of the two most popular digital payments platforms, WeChat Pay and Alipay, for most of their transactions. Visitors to China are frequently mystified at the sight of shoppers simply scanning their phones to pay for all goods and services, with nary a crumpled Renminbi or even a plastic card to be found.
> There is no question that digital payments systems are super convenient.
>
> (O'Sullivan, 2020)

However, the e-yuan is not coming into being as a result of strong demand from the public, but is being imposed by the PBOC acting on behalf of the government. It also comes with significant baggage. It

> looks like a potential macroeconomic dream tool for the issuing government, usable to track people's spending in real time, speed relief to disaster victims or flag criminal activity. With it, Beijing stands to gain vast new powers to tighten President Xi Jinping's authoritarian rule. ...
> The money itself is programmable. Beijing has tested expiration dates to encourage users to spend it quickly, for times when the economy needs a jump start.
> It's also trackable, adding another tool to China's heavy state surveillance. The government deploys hundreds of millions of facial-recognition cameras to monitor its population, sometimes using them to levy fines for activities such as jaywalking. A digital currency would make it possible to both mete out and collect fines as soon as an infraction was detected.
>
> (Areddy, 2021)

Such a system is also highly weaponisable and can be deployed against anyone who incurs the displeasure of those in authority, for any reason whatever:

> China's control and surveillance-based CBDC system is also an increasingly inspirational and attractive proposition for authoritarian governments from Cambodia

> to Cuba to Cameroon. Even if a few hundred million people in North America and Europe enjoy enough civil liberties and democratic rights to push back against a digital panopticon, more than 4 billion people lack those same rights and have no way to fight back.
> ... in a fully implemented CBDC system, governments could financially exclude individuals or entire groups of people with the press of a button, leaving them with nothing. Governments like the CCP could target dissidents, sexual minorities, ethnic minorities, or religious minorities. If banknotes don't exist and access to government-issued digital cash is revoked, then they are truly helpless.
>
> (Gladstein, 2021, p. 283)

> [The e-yuan] would ... create unprecedented opportunities for surveillance. ... A successful DC/EP could greatly expand the party-state's ability to monitor and shape economic behavior well beyond the borders of the PRC.
>
> (Hoffman et al. 2020, p. 3)

There is also the question of privacy, or rather, the lack of it. From the government's point of view, this issue is a no brainer:

> Gathering transaction data may be the most perfect surveillance system possible. By merely observing what a person buys, a government can get an intimate look at their whereabouts, habits, personality, heath and relationship statuses, aspirations, finances, and even their fertility. The best part about financial surveillance is that its practically invisible. No street cameras or microphones needed. The data are gathered as a necessary component of the service. Every day, we give companies a raw look into our lives and loves without a moment's thought.
> Formally creating a state-run digital currency is just the next logical step in China's progression towards financial digitization.
>
> (O'Sullivan, 2020)

The PBOC's assurances about protecting privacy therefore need to be treated sceptically. The fact is, as Alex Gladstein (2021, p. 281) points out, "Though marketed as offering privacy for users, DCEP [digital currency and electronic payment] will offer the PBOC *total* surveillance capabilities, augmented by big data analysis and AI systems" (emphasis added) while Martin Chorzempa (2021, p. 303) suggests that "all signs point to DC/EP enabling much greater surveillance of financial transactions than the current system".

7.4 | Limited usage of the e-yuan

The root problem with the e-yuan is that there is no obvious use for a new digital currency that offers an inferior service to those already available from existing private providers. As Vagisha Srivastava (2023) observes:

> The e-CNY boasts the largest registered user base of 261 million (as of January 2022) with an outstanding transaction size of approximately $14 billion. The Chinese government has made continuous efforts to expand the scope of

> transactions for increased adoption. The use case has been broadened to include payments for different services such as payment for public transportation, income tax, stamp duties, and more recently an electronic version of red packets (hongbao), the traditional Chinese way of gifting money. They have also attempted to regulate competition from private market players, banned cryptocurrency and tried to enforce circulation by using an expiration policy.

Two hundred and sixty-one million downloads sounds a lot, but the actual usage of e-yuan remains very low. Reports also suggested that average balances in those wallets were tiny: $0.47 for individual wallets and $4.90 for corporate ones (Kumar, 2022). These figures indicate that few wallets were being used for transacting or holding e-yuan and raise the suspicion that most wallet holders had downloaded wallets only to obtain the free gifts being handed out with them, and didn't use them again.

More recent reports indicate that as of end June 2023, the total issuance of e-yuan was equivalent to just 0.16 per cent of currency or M0 (see e.g. Choi, 2023, or Lindrea, 2023). Thus, the circulation of e-yuan was extremely small and it is clear that CBDCs in China are struggling to gain traction. "China's digital yuan is turning into a giant flop," remarked Tyler Durden (2021).

For comparison, over the period from October 2022, when the Shenzen experiment was introduced, to June 2023, the M0 currency supply increased by 30.1 per cent, which was over 26 times the total amount of e-yuan issued.[10] The total amount of e-yuan was little more than a rounding error in the amount of currency issued.

It was then no wonder that even a former PBOC research director was quoted (see Coghlan, 2022) as saying that a circulation of $14 billion two years after launch was "not ideal ... usage has been low, highly inactive ..." Private sector firms have "met needs for daily consumption .... People are used to [using private exchange media and change] "is difficult," he conceded.

Other observers believed that the government underestimated how difficult it would be to create a new retail payments network given that existing private ones are so good. "A lot of the ambition for this project has proven more difficult to achieve than they thought", remarked Martin Chorzempa (quoted in Orcutt, 2023). It was especially difficult to sign up enough merchants to create a rich enough ecosystem to enable the e-yuan to compete against existing payment systems. "The e-CNY has to be as useful as Alipay and WeChat Pay for it actually to have a user base, and right now there really is not a use case. People just get a red envelope, they spend it, and they generally don't open the e-CNY app again."

Srivastava (2023) argues:

> Despite all of [the effort made to promote the e-yuan], the end-user has neither additional benefits nor convenience to make a shift from existing apps like Alipay and WeChat, both of which have a sufficiently large user base and merchant integration. The incentives offered are not lucrative enough for the user to use it consistently. If this user survey is to be believed, e-CNY lacks "attractive promotions, discount coupons, and giveaways" for people to make a shift.

Her assessment seems to be correct.

Those who have actually used the e-yuan are unimpressed with it. After interviewing users of China's digital currency, *Bloomberg* (2021) noted that they showed little interest in switching from mobile payment systems run by Ant Group and Tencent, which have already replaced cash in much of the country, with some openly baulking at the digital yuan – which recall is

programmable and comes with an ad hoc expiration date – and which gives authorities access to real-time data on their financial lives.

> Meanwhile, as Bloomberg notes, it was concerns about privacy – or lack thereof – that were among the biggest turnoffs for Jan Chen, a 33-year-old civil servant. It's "a little scary" that authorities might be able to trace every payment, she said. In a country where compliance with tax laws is often patchy, some merchants may also be wary of their transactions flowing directly into a government database. The PBOC has tried to quell those concerns by making the digital yuan free to use for merchants – which currently pay service fees of around 0.6% for transactions on Alipay and WePay – and by pledging that most payments will remain anonymous. Not that anyone actually believes that.
>
> (Durden, 2021)

Other participants in the survey had similar views, which boil down to the fact that Alipay and WeChat Pay are highly competitive and already offer them all the services they want (Shen & Zuo, 2023). Once again, we have the familiar story that central banks are ill-equipped to interface with retail users, because they lack the business experience and acumen of private payments providers.

7.5 | The PBOC competes against the private institutions whose support it needs

There is also the further problem that the PBOC is actively competing against the interests of the private institutions on whose support the success of the e-yuan depends. The PBOC is then in a fundamentally contradictory position with respect to the private institutions, who have no interest in promoting the e-yuan and good reason not to.

To see this latter point, suppose a saver has funds in a bank deposit. The bank keeps a certain percentage of those funds as reserves and lends out the rest to seek the best possible return. But now suppose that the user moves those funds into an e-yuan wallet held by the same bank. The bank is now required to hold a 100 per cent reserve against those funds with the central bank. It then loses the return it would have made on the deposit, but still has to bear the costs of holding the wallet. Thus, the bank is made worse-off when the customer converts the deposit into an e-yuan holding in a digital wallet.

To compound matters further, at about the same time as it launched its e-yuan pilot, Chinese authorities launched a crackdown on the country's technology giants, including Alibaba and Tencent, the owners of Alipay and WeChat Pay. This crackdown was interpreted as CCP leaders becoming concerned about the growing influence of the technology conglomerates and wiped billions of dollars from their market valuations.

The CCP position would seem to be that it can take such actions against the big tech companies and still expect their (full?) support in helping to integrate e-yuan wallets with WeChat Pay and Alipay applications. The CCP would also seem unconcerned about the banks being asked to forgo the benefits of deposits when people switch deposits into e-yuan wallets and to be unconcerned about taking international consumers and businesses for granted, given worries about the country's capital controls, its Communist Party-dominated legal system and the country's state surveillance apparatus.

7.6 | The e-yuan experiment is not working out

The main conclusion is that the e-yuan experiment will not lead to the widespread adoption of the e-yuan that its promoters had hoped for. This is slowly becoming apparent to the more thoughtful policymakers, but their policy options to address it are limited. They could continue to push the experiment out in more cities and more applications, they could continue to promote it with more red packet programmes and similar gimmicks, they could continue to promote it among more merchants, they could continue to promote it among banks and the big payment firms, they could continue to expand the ways in which people could use it to make payments to the state, for example to pay taxes or fines and, in the limit, they could make the e-yuan the only means to make payments to, or receive payments from, the state. Such measures would increase adoption, but likely only by so much; I suspect they would not be enough to force people to use it for everyday transactions while the private providers that the state is competing against have the advantages of a superior product, an entrenched network and continued public support. More to the point, it is difficult to see how any measures to promote an inferior digital currency would make the payments system work much better than it already does.

Chinese policymakers can either accept those limits or not. If they choose not, they can effectively take an axe to a private system that is fundamentally sound and doing its job well. They might impose regulations on what the private sector is allowed to provide, thereby undermining the private system so that people turn to the e-yuan for something that would now be comparatively better, or they could nationalise the private providers. However, such measures would likely do a great deal of damage to the payments system.

It would be wiser to accept those limits, however. If policymakers chose to, they could accept that China already had a good payments system before it embarked on its great e-yuan monetary policy experiment. They could quietly drop the experiment and accept that the e-yuan adds nothing of value to the Chinese payments system, because central bankers are ill-suited to provide retail payments and will realistically never be able to beat professional private payments providers at their own game. If they wish for the best outcome, they should simply leave the private sector to do the job for them.

8 | NIGERIA

We turn now to CBDCs in Nigeria, a classic story of how *not* to introduce a CBDC. Nigeria has a population of about 225 million people with a median age of 17. Over 60 per cent of transactions are cash and about 55 per cent of the population don't have a bank account. At the same time, parts of the country are financially sophisticated and more than half of the population are said to have used cryptos.

8.1 | Launch of the e-Naira

On 25 October 2021, the Central Bank of Nigeria (CBN) launched its CBDC, the e-Naira. The e-Naira is a retail CBDC program with a zero interest rate and no provision for transactions anonymity. It was initially targeted to people with bank accounts, but further updates allowed for it to be used on phones and to those without bank accounts.

The Governor of the Central Bank of Nigeria, Godwin Emefiele, explained the reasons for introducing it:

> The e-Naira is expected to enhance financial inclusion, support poverty reduction, enable direct welfare payments to citizens, support a resilient payment ecosystem, improve availability and usability of central bank money, facilitate diaspora remittances [and] reduce the cost of processing cash.
>
> (Quoted in Ujah, 2022)

But critics objected that the e-Naira was pointless. "The issue is that all of this can already be adequately addressed using the existing financial payments system", said one analyst. "Nigeria is the fintech capital of Africa, so there are just so many options, so many ways to pay somebody, and pay them fast, already" (Munshi, 2022). Victor Asemota, a tech investor, wrote on Twitter on 27 October 2021:

> I am still at a loss on what eNaira is meant to solve other than helping the government print money.[11]

Others pointed out that the real-time nature and speedy transfer features of the eNaira are moot, since the Nigerian financial system has had instant digital payments for a decade already. "How is it superior to the existing money and payments system?" asked the CEO of a leading Nigerian bank (Idris, 2021).

There were also issues of trust or, rather, the lack of it. "The only reason to use the e-Naira over cryptocurrency would be trust in the government, and that trust has been eroded for many", said the CEO of a blockchain consultancy (Idris, 2021). Most Nigerians trusted cryptocurrency far more than they trusted the government and their mistrust of government was well founded in the recent historical record (Idris, 2021). Introducing a CBDC that gave them no rights of financial privacy was unlikely to promote the trust that the CBDC needed if it was to be accepted.

There was also the problem that a key advantage that a digital currency might have had for moving funds in and out of Nigeria is undermined with the e-Naira by the multi-rate foreign exchange system managed by the central bank, which causes major problems for international cash flows and especially remittances. Indeed, it was precisely these problems that had led Nigerians to rely so heavily on cryptocurrencies in the first place.

8.2 | Slow uptake

Uptake of the new e-currency was slow. A media report of 31 May 2022, stated that there had been 764,000 e-Naira app downloads, almost half have never used the app. Just 18,460 have funded wallets, and only 80 merchants' wallets were active because demand was so low (Ledger Insights, 2022). "The eNaira is also yet to have very many *recurring* users. It's averaging 1.35 transactions per active wallet", observed David Gerrard (2022b) in late August.

As one merchant observed, "Majority of the transfers are done using bank apps, not e-Naira. There are also channels like PoS, which the customers prefer. So the eNaira does not come into the discussion" (Ledger Insights, 2022). The e-Naira was unpopular among the banks too:

> For banks, the issue with the eNaira is that it lacks a business case. Many bank sources say operators in the financial services industry want the CBN's approval to layer their services on the eNaira technology, however, the apex bank's total control of the eNaira entire process makes their request not feasible. In the absence of a viable business case, the majority of the banks are unable to push the publicity of the eNaira.
> "If they won't let banks layer their services on the eNaira technology, the CBN should pay banks to market the eNaira," a bank source who would like to remain anonymous said.
> There is also thinking among the banks that the eNaira is a competition as it is offering nearly all the services that banks have already solved through their digital banking channels.
>
> (Eleanya, 1922)

On 18 August 2022, Governor Emefiele said that the e-naira had reached N4 billion or $9.5 million in transaction volume (Ujah, 2022). He failed, however, to mention that this $9.5 million figure translates into a ratio of CBDC transactions volume to total e-transactions volume of just 0.013 per cent,[12] that is to say, the take-up was negligible. On 25 October 2022, an IMF working paper reported:

> The average number of eNaira transactions since its inception amounts to about 14,000 per week – only 1.5 percent of the number of wallets out there. This means that 98.5 percent of wallets, for any given week, have not been used even once. The average value of eNaira transaction[s] has been 923 million naira per week – 0.0018 percent of the average amount of M3 during this period.
>
> (Ree, 2023, p. 14)

By this time, Emefiele was now revealing his true intentions, which were to establish a cashless economy by force, *whatever the cost*. He clarified that "The destination, as far as I am concerned, is to achieve a 100% cashless economy in Nigeria" (Osae-Brown et al., 2022). His deputy governor in charge of economic policy, Kinglsey Obiora, added that people just needed "a little push from the government" and they would "embrace" the e-Naira (quoted in Dietz, 2022).

8.3 | Nigerian war on cash

That 'little push' came on 23 November 2022, when the CBN announced a new currency 'redesign notes' policy. Existing notes in denominations of ₦200 ($0.45), ₦500 ($1.125) and ₦1,000 ($2.25) were to cease to be legal tender on 31 January 2023. (The deadline was later extended to 20 February, and for ₦200 notes again to 10 April, as measures to alleviate the subsequent shortage of cash.) New notes would be issued from 15 December and the public would be obliged to go to banks to have their notes exchanged. However, ATM withdrawals were limited to ₦20,000 ($45) per day or ₦100,000 ($225) per week; citizens wishing to take out larger sums were subject to a processing fee between 5 per cent and 10 per cent and only ₦200 ($0.45) notes or lower denominations were available in the machines.

The policy triggered chaos as people rushed to their banks to convert their notes. They queued for long hours and often overnight. The banks often failed to meet demands for

redemption because they had not been provided with sufficient amounts of new notes. Stories about people struggling with cash restrictions quickly spread on social media. "It seems like Nigeria wants to eradicate half the population ... No cash, bank transfers not working, people can't access basic needs", wrote one observer on Twitter.[13] The scarcity of cash drove people in droves to bank and electronic transfers, but these often broke down under the strain as people struggled with failed transactions or a poor internet. Mobile phone and Bitcoin transactions skyrocketed. Commuters were left stranded for want of cash. Many small businesses, which represent the lion's share of the economy and which predominantly rely on cash payments, had to shut because their customers didn't have the cash to pay. Protesters attacked bank ATMs and blocked streets, and demonstrations turned violent in some cities. Economic activity plunged.

To give one vivid example of the resulting suffering:

> No one in Godgift Inemesit's family of eight is sure when they will eat each day — except for her three kids, two of whom have malaria. She can't pay for the drugs they need or feed the rest of her family regularly.
> Like most Nigerians, the family's savings are trapped in the bank. ... There aren't enough new banknotes in a country reliant on cash. ...
> "We usually eat three square meals, but now we eat once sometimes because there is no money to use," Inemesit said ...
>
> (quoted in Corbishley, 2023b)

But even as ordinary people's lives were plunged into chaos, Governor Emefiele hailed it as a success, because most of the cash previously held by the private sector had been deposited with financial institutions. Finance Minister Zainab Ahmed agreed. "The only sore point is the pain it has caused to citizens", she said (quoted in Corbishley, 2023a.). The pain inflicted on millions of poor was but a small price to pay.

Heritage Falodun, a Bitcoin consultant, gives a particularly vivid picture of the situation on the ground as 11 February 2023:

> In [Emefiele's] view, Nigerians should have found that the CBDC is the solution to their financial predicaments .... Not surprisingly, the reverse has been the case, as the situation on the ground in Nigeria right now is gradually moving from 'banking the unbanked' to 'un-banking the banked.' ...
> ... the well-informed ... youth, which happens to be about 70% of Nigeria's population, understand that these regulations are mostly about financial control. They are about pushing a cashless policy in which the government has complete control over all citizens while having the luxury of tracking every single transaction. ...
> Nigerians need to know right now that the CBDCs are here and that, slowly but surely, the government will continuously restrict their access to cash until it's gone and it has fully taken away everyone's financial freedom. ...
> [But] the Nigerians disposition [for cryptos] is visible to the blind and audible to the deaf ...

To learn more about the balance between Bitcoin adoption and being forced toward the e-Naira, he then spoke with a few business owners. One told him,

> The cash swap policy has been ridiculous, to say the least. Today, February 4, 2023, alone, you could not get any physical cash in the entire Garki ultra modern market in Abuja, Nigeria. People are unable to take care of little business deals, like cash for services, transportation, etc. It's so bad because even the traditional banking applications seem to be overwhelmed by the sudden surge in transactions and cannot cope.

Even so, Emefiele was adamant, "Nigeria must go cashless", he declared in mid-February (quoted in Corbishley, 2023b).

8.4 | The Supreme Court overrules the cash redesign policy

In the meantime, a number of state governors had filed a lawsuit at the Supreme Court to challenge the cash redesign policy. On 3 March 2023, the Nigerian Supreme Court ruled that the demonetisation policy was illegal and unconstitutional: the old notes were still legal tender and should remain in circulation till 23 December 2023.

By this time, the supply of cash in circulation had fallen to 29.8 per cent of its 22 October value. There had been a big switch towards cryptos and online banking[14] and the ratio of CBDC transactions volume to total e-transactions volume around the same time had barely moved to 0.016 per cent.[15] Thus, the policy had delivered a massive reduction to the note supply, which in turn had a devastating impact on the real economy and led to a big jump in crypto and online banking, and a negligible impact on the demand for CBDCs.

8.5 | Economic cost

The economic cost of the redesign policy was enormous. On 12 March 2023, the Centre for the Promotion of Private Enterprise in Lagos released a report that estimated that CBN's demonetisation policy had cost the Nigerian economy an estimated N20 trillion ($S43.3 billion, about 10 per cent of GDP). Its CEO Dr Mada Yusuf said that the policy had crippled economic activity, and

> Millions of citizens have slipped into penury and destitution as a result of the disruptions and tribulations perpetrated by the currency redesign policy, especially the mopping up of over 70 percent of cash in the economy. Nigerians have not been this traumatised in recent history.
> The economy is gradually grinding to a halt because of the collapse of payment systems across all platforms. Digital platforms are performing sub-optimally because of congestion; physical cash is unavailable ... and the expected relief from the supreme court judgement has not [yet] materialised. The citizens are consequently left in a quandary.
>
> (Quoted in *Rate Captain*, 2023)

The supply of cash reached its nadir at the end of February. In an editorial on 11 March, the newspaper *Premium Times* (2023) called for Emefiele's arrest and prosecution, arguing that the monetary redesign policy was an infringement on the rights of the people. President Buhari apologised for the redesign policy and started to dismantle it.

On 29 May 2023 Bola Tinubu took office as the new president after winning the presidential election on 25 February. On 9 June Tinubu suspended Emefiele as governor with immediate effect, and investigations were started into his activities. The next day Emefiele was arrested and then accused of a string of offences relating to the abuse of his office, stealing public funds, sabotage and so on. Emefiele's influential overseas supporters from the IMF, the US Federal Reserve and elsewhere, who had enthusiastically cheered his pioneering policies, now remained conspicuous by their silence.

We can safely assume that the Nigerian war on cash is over. Where this leaves the CBDC experiment is, as yet, unclear, however. The Nigerian experience shows that the Nigerian public is not interested in CBDCs and much prefers cash or private sector digital alternatives such as mobile banking or cryptocurrencies. Nigeria's experience strongly suggests that the typical citizen sees through the pro-CBDC propaganda and understands that CBDCs bring little benefit except to an elite that wants to use them to tighten further its grip on the populace.

9 | CONCLUSIONS

CBDC experience to date can be summarised as a number of abandoned experiments, embarrassing flops and monumental exercises in policymakers' hubris, one of which has already produced a major disaster. If by success one means that the experiment clearly makes a population better-off, then the evidence indicates that every single CBDC experiment tried so far has failed.

We see from these experiments that the adoption rate for CBDCs has been very low. It is almost as if people don't want CBDCs. But that is exactly the point: the evidence suggests that the overwhelming majority of people don't like what CBDC advocates are trying to sell to them. I would speculate that the root problem is that central banks are not good at retail-facing activities and can never successfully compete against private payment providers which are specialists in such activities. Experience also indicates that CBDCs don't offer tangible benefits that alternatives can't already deliver. Most countries already have an existing digital payment system or rely on the legacy of card networks, and there is no clear problem with the existing system to which a CBDC is the natural solution.

I leave the last word to the American banking entrepreneur Vernon Hill: “You can't name me one retailer in this country that has pushed people where they don't want to go and succeeded.” And that, in a nutshell, is why CBDCs fail.

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ENDNOTES

[1] CBDCs can be issued for wholesale purposes too, but such instruments have been around for decades and don't give rise to rise to the innovative policy issues that arise with retail CBDCs.

[2] https://cbdctracker.org/ (accessed 23 August 2023).

[3] This discussion is based on Gerrard (2020a) and Grym (2020).

[4] This discussion draws on White (2018) and Gerrard (2020b).

[5] It also appears that not only could the government not get the DE off the ground, but they couldn't even recover their own costs on the project. White (2018) cites an Ecuadorian government accounting report that suggests that the scheme produced debt service savings of just over $900,000, but the government's expenditures on the project were apparently just under $8 m, more than eight times greater. The government couldn't even make money issuing its own digital currency.

[6] https://www.sanddollar.bs/individual (accessed 8 January 2024).

[7] Three months later, the ECCB was awarded Central Banking Publications' FinTech and RegTech Global Award for CBDC Infrastructure. Sometimes words fail ...

[8] The name Jam-Dex was met with considerable criticism. Twitter users were quick to point out that Jam-Dex suggests a digital currency but the 'DEX' in crypto parlance refers to a decentralised exchange. This ambiguity caused considerable confusion. Jaymeon Jones wrote on Twitter on 18 February 2022: "Is it a CBDC or a DEX? ... this logo cannot work. It should have been put to a broader voting mechanism – the panelists let you down here big time." https://twitter.com/Jaymeon__Jones/status/1494475878671302660 (accessed 10 January 2024).

[9] Word of the launch was not released until two weeks later due to interim problems.

[10] M0 money supply data from the PBOC's own website at pbc.gov.cn show that the amount of M0 in October 2020 was yuan 8,103,600 million. The corresponding amount in June 2023 was yuan 10,541,900 million.

[11] https://twitter.com/asemota/status/1453140948905496578 (accessed 8 January 2024).

[12] The CBDC transactions volume is $9.5 million, total e-transactions volume was N29.3 trillion and the exchange rate was N415 to $1. The ratio is then 9.5 million*415/ N29.3 trillion =0.013%. Data sources: Steward (2022); NIBSS (2022).

[13] https://twitter.com/BukolaOyebodeW/status/1628372151056142336 (accessed 8 January 2024).

[14] By March, mobile banking transactions had jumped by more than five times to 183.8 million (Adamoleikun, 2023).

[15] The CBDC transactions volume was N22 billion and total e-transactions volume was N135.5 trillion. N22 billion divided by N135.5 trillion = 0.016%. Data sources: Nwite (2023); Ledger Insights (2022).

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