

DIGITAL DESIGNS (PART I)

WHAT CENTRAL-BANK DIGITAL CURRENCIES MIGHT AND MIGHT NOT BE ABLE TO DELIVER.



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IN A NUTSHELL

- _ Digital currencies raise economic questions as old as economics itself.
- _ Among recent technological developments, blockchains stand out – but not quite for the reasons you might think.
- _ Money and payment systems are intrinsically linked. Thinking about one necessarily requires thinking about the other.

1 / Introduction

“Even before the first Web shop had made its first sale,” The Economist reported in 1997, “new e-money companies were devising suitably wired ways for consumers to pay. (...) Each firm’s technology was mathematically brilliant; most were built on encryption so elegant, so fascinating, that no one bothered to ask: who needs it?”¹

Almost 25 years later, the boffins are at it again. Except that this time around, they are working at or consulting for central banks.² The many weighty publications devoted to central-bank-backed digital currencies over the past few years could easily fill a medium-sized library.³ Just as new e-money companies were mushrooming in the mid-1990s, hardly a week goes by without some new whitepaper being published or pilot study being announced by one central bank or the other. On April 19, for example, the UK moved a step closer towards a digital pound sterling – inevitably nicknamed BritCoin – with the Bank of England (BoE) and Her Majesty’s Treasury setting up a joint task force.⁴ The European Central Bank (ECB) has already concluded a comprehensive public consultation and will probably start a formal, multi-year investigation on launching a digital euro this summer.⁵ The People’s Bank of China (PBoC) has recently added six more regions, including Shanghai and Hainan, to its China’s digital currency pilot program, as it inches towards a launch.⁶ The Federal Reserve (Fed) of Boston has teamed up with the Massachusetts Institute of Technology (MIT) on how a U.S. scheme might – hypothetically – work.⁷ A Fed discussion paper on the subject is due to appear this summer.⁸ And on May 8, even the Economist devoted its cover story and a detailed special report to *“Govcoins: The digital currencies that will transform finance.”*⁹

All of which begs a series of questions. What exactly are central bankers talking about when discussing central-bank digital currency (CBDC) schemes? How much, when – and why – might such schemes matter to every-day economic life and

¹ <https://www.economist.com/special-report/1997/05/08/cash-poor>

² <https://newsroom.accenture.com/news/digital-dollar-project-to-launch-pilot-programs-to-explore-designs-and-uses-of-a-us-central-bank-digital-currency.htm>

³ Among recent publications, see, in particular:

https://www.snb.ch/n/mmr/reference/working_paper_2021_03/source/working_paper_2021_03.n.pdf;

<https://www.bankofengland.co.uk/-/media/boe/files/paper/2020/central-bank-digital-currency-opportunities-challenges-and-design.pdf>;

https://www.ecb.europa.eu/pub/pdf/other/Report_on_a_digital_euro-4d7268b458.en.pdf;

⁴ <https://www.bankofengland.co.uk/news/2021/april/bank-of-england-statement-on-central-bank-digital-currency>

⁵ <https://www.ecb.europa.eu/press/pr/date/2021/html/ecb.pr210414-ca3013c852.en.html>

⁶ <https://www.scmp.com/economy/china-economy/article/3129343/china-digital-currency-shanghai-hainan-among-regions-added-e>

⁷ <https://dci.mit.edu/building-a-hypothetical-cbdc>

⁸ <https://www.federalreserve.gov/newsevents/speech/brainard20210524a.htm> and

<https://www.federalreserve.gov/newsevents/pressreleases/other20210520b.htm>

⁹ <https://www.economist.com/special-report/2021/05/08/a-future-with-fewer-banks>

financial markets? And, how sure can central banks be that there is actually much of a need to change? 30 years ago, earlier innovations included various private e-money schemes as well as the world's first central-bank digital currency, which has largely been forgotten. Arguably, all of these ran into a set of problems familiar to many innovators. The answer to the Economist's question – "who needs it?" – turned out to be: "not many, at least not yet. For all the beauty of digital cash, it has won precious few takers."¹⁰

As we will argue in this paper, this time is likely to be different. However, central banks are right to be cautious. To impatient financial-market observers, extensive consultation ahead of launches might seem hopelessly slow. As Gillian Tett put it in the Financial Times a while ago: "asking stodgy central bankers to embrace the type of freewheeling creativity found in fintech is like asking grandpa to listen to rap."¹¹ And yet, if the history of electronic money of the past 30 years – and that of the more traditional sort going back millennia – is any guide, there is a strong case for incremental improvements rather than revolutionary experiments.

Money and payment systems are intrinsically linked and often delicately balanced. Thinking about one necessarily requires thinking about the other. If and where payment and monetary systems work reasonably well (as is largely the case for domestic payments in advanced economies), doing no harm is already an important policy objective. If and where current arrangements do not work so well – as in international payments or some emerging economies – it is often far from clear that digitalization can provide a satisfactory answer. Or at least, not yet, without further study, including among policymakers.

Just adding "digital" doesn't solve any problems

The term central-bank digital currencies – and the somewhat unseemly acronym CBDC – was popularized by Ben Broadbent, Deputy Governor for Monetary Policy at the BoE in a 2016 speech at the London School of Economics. The previous year, the BoE had issued an excellent primer on innovations in payment technologies and a companion paper on the economics of (private-sector) cryptocurrencies.¹² Which is a bit ironic, as Broadbent kept poking mild fun at the resurgent fascination with all things digital:

*"The word "digital" has become so ubiquitous that its meaning isn't always clear. The word seems to get tacked on to just about anything, no matter how tenuous its connection with computers (...) even something called "digital parenting", whatever that is. (If it means having to ask your 11-year-old son what's gone wrong with the computer then I would certainly qualify as a "digital parent")"*¹³

Like it or not, however, central banks and investors have long been living in a digital age. Nowadays many financial assets exist purely as digital records. For example, most money sits in commercial bank accounts, as an entry in digital ledgers. In Western monetary history, paper currency started out as handwritten promissory notes or IOUs (the phonetic acronym of the words "I owe you"). Initially, these IOUs were issued by goldsmiths, who promised depositors to pay out gold or silver on demand. In those days, transferring money required "the bearer of a note to first convert it into gold and then to physically transport it to the new bank, a cumbersome process."¹⁴

The key innovation was to do away with the need to physically transport precious metals – by giving commercial banks access to a centralized system for settling payments, with one central ledger. Perhaps most relevant for us is how little such payment systems have changed in centuries: "In modern payment systems, payments are made by reducing the balance in a customer's account and increasing the balance in the recipient's account by an equivalent amount — a process that has not changed since the 16th century. The difference lies in the technology employed to record the balances and transfer them between different banks."¹⁵

¹⁰ <https://www.economist.com/special-report/1997/05/08/cash-poor>

¹¹ <https://www.ft.com/content/8356521a-0bb1-4a80-973b-a9c6d60a0f19?emailId=605cc41a448fb6000482933e&segmentId=7d033110-c776-45bf-e9f2-7c3a03d2dd26>

¹² Available at: <https://www.bankofengland.co.uk/-/media/boe/files/digital-currencies/the-economics-of-digital-currencies> and <https://www.bankofengland.co.uk/-/media/boe/files/quarterly-bulletin/2014/innovations-in-payment-technologies-and-the-emergence-of-digital-currencies.pdf>

¹³ <https://www.bankofengland.co.uk/-/media/boe/files/speech/2016/central-banks-and-digital-currencies.pdf?la=en&hash=8D9B0F2911064BD7570B10370DF521FAE174217D> p. 11

¹⁴ <https://www.bankofengland.co.uk/-/media/boe/files/quarterly-bulletin/2014/innovations-in-payment-technologies-and-the-emergence-of-digital-currencies.pdf> p. 264

¹⁵ <https://www.bankofengland.co.uk/-/media/boe/files/quarterly-bulletin/2014/innovations-in-payment-technologies-and-the-emergence-of-digital-currencies.pdf> p. 263.

By the same logic, any potential flaws older centralized payment systems suffered from can still cause problems. For example, there are counterparty risks, whenever somebody promises to honor a financial commitment – whether it is a goldsmith promising to do so with a handwritten note, or a modern bank facing a cash crunch because its customers are trying to empty their online savings accounts. Indeed, Broadbent devoted much of his speech on CBDCs to stressing that *“some of the economic questions it raises have actually been around for a long time, for as long as economics itself.”*¹⁶

Before getting to some of those old economic dilemmas, a closer look at recent innovations is warranted, particularly when considering centralized payment systems. The role of one particular technology stands out. You might have heard of it, without necessarily knowing how and why it was first developed. Experiences since its first deployment by Estonia in 2008 suggest how and why it indeed has to offer a lot for government services – including the monies central banks are in charge of, as well as the payment systems and settlement systems they share responsibilities for.

2 / Why – and where – the blockchain revolution really got started

In April and May 2007, citizens in Estonia woke up to a gigantic problem. A series of cyberattacks had *“shut down the websites of all government ministries, two major banks, and several political parties. At one point, hackers even disabled the parliamentary email server. (...) Estonian authorities made a few in-country arrests but never uncovered the main culprits.”*¹⁷ In Estonia, a whole range of government services and commercial activities had gone paperless, including some 97% of bank transactions.¹⁸ At a time of heightened tensions with its Russian minority, the Baltic country proved uniquely vulnerable. *“We are back to the stone age, telling the world what is going on with phone and fax,”* an Estonian internet expert was quoted lamenting in the wake of the attacks.¹⁹

As the rest of world goes digital, Estonia offers a sobering example of the need for crisis resilience. It also suggests ways how technology can help. Specifically, Estonia realized that sensitive data needed to be secured better – and swiftly developed a homegrown solution, relying on key insights from cryptography that had been emerging since the 1980s: *“Although blockchain has only become [a] hot topic in recent years, Estonia started testing the technology already in 2008 – even before the Bitcoin white-paper that first coined the term “blockchain”, was published. At that time, in Estonia we were calling this technology ‘hash-linked time-stamping’.”*²⁰ The idea was to find a way *“to ensure integrity of data stored in government repositories and to protect its data against insider threats.”*²¹

In case of another cyberattack, Estonia needed to be able to immediately and without any ambiguity figure out who had messed with government databases. Any system should be cost effective and scalable. Finally, it should be able to quickly get up and running again in case of future cyber-attacks. For all that, it turned out that what is now commonly called “blockchain technology” has plenty to offer.

In response to the 2007 cyber-attacks, Estonia developed and deployed a digital signature scheme for its citizens. Now known as KSI Blockchain (KSI refers to Keyless Signature Infrastructure), the system allows Estonians and others eligible to digitally confirm their identity when accessing or supplying new information to government data bases.²² It makes detecting manipulation – and specifically, when it might have occurred and who the culprit might be – a lot easier.²³ And it allows approved entities such as banks to also rely on it for online identification. As a result, Estonians use their digital signatures all the time, often multiple times a day.

¹⁶ <https://www.bankofengland.co.uk/-/media/boe/files/speech/2016/central-banks-and-digital-currencies.pdf?la=en&hash=8D9B0F2911064BD7570B10370DF521FAE174217D> p.12

¹⁷ <https://scholarcommons.usf.edu/cgi/viewcontent.cgi?referer=https://www.bing.com/&httpsredir=1&article=1105&context=jss>

¹⁸ <https://e-estonia.com/wp-content/uploads/story-of-e-estonia-aug2020.pdf>

¹⁹ <https://www.economist.com/europe/2007/05/10/a-cyber-riot>

²⁰ <https://e-estonia.com/wp-content/uploads/2020mar-nochanges-faq-a4-v03-blockchain-1-1.pdf>

²¹ <https://e-estonia.com/solutions/security-and-safety/e-law/>

²² This can be done through a ID card reader (as Estonian identity cards carry a smart chip). Alternatively, and more commonly used, both app and SMS based services are available. Once set up, these rely on a combination of pin-codes and passwords (similar to identification requirements for online banking in other countries). From the perspective of users, one advantage is that only a single identification service is required for a wide range of public and private services.

²³ The underlying advances in the cryptography of blockchains predate “cryptocurrencies” even further, and notably include Stefan Konst (2000): *Sichere Log-Dateien auf Grundlage kryptographisch verketteter Einträge*, which was initially a German master thesis (Diplomarbeit). It is still available in German at Technische Universität Braunschweig: https://publikationsserver.tu-braunschweig.de/receive/dbbs_mods_64933

In case of a cyber-attack, any data breach is detected right away: *“According to the research by FireEye, one of the leading cyber security vendors in the world today, it currently takes organizations [an] average of about 7 months to detect breaches and manipulations of electronic data. With [a] blockchain solution like the one Estonia is using, these breaches and manipulations can be detected immediately.”*²⁴

Thanks to KSI Blockchain, Estonia has been able to create *“one platform that supports electronic authentication and digital signatures to enable paperless communications across both the private and public sectors.”*²⁵ The system is designed as a sort of “digital defence dust” intended to ensure that those up to no good would risk leaving digital finger prints. Guardtime, the company that developed it, runs the servers verifying cryptographic signatures needed to add data (though it never sees, nor controls protected data).²⁶ That makes the scheme scalable and cost efficient to run, without creating undue dependence on a single private provider. Guardtime, or indeed any other company that might get the contract in the future, only *“provides the “digital defence dust” solution that can ensure its integrity and mitigate internal threats. So nothing happens when a blockchain company disappears, all the data protected will remain verifiable for its integrity for forever based on the shared blockchain.”*²⁷

In our view, KSI Blockchain is an excellent example of how cryptographic solutions might indeed help solve some of the pre-existing flaws in how most financial information is organized. As described, most traditional payment and settlement ledgers are highly centralized – including the tiered payment systems used in most countries with a central bank at its center. An alternative is to use distributed ledgers, which are essentially shared data-bases – the ledger exists across several locations or institutions, with all participants having access to it at all times. This can have big advantages: most importantly, it would be more resilient, with many redundant back-ups. Think of one location being hit by a hurricane, for example. A payment system based on distributed ledgers could continue to function, provided that at least some locations are still up and running.²⁸

Blockchains are just one – sometimes quite vaguely defined – way of implementing such a system. One vendor concludes its accessible overview on the differences between blockchains and distributed ledgers with the following sound advice: *“The next time you sit through a sales pitch that begins with the words, ‘blockchain is the future,’ maybe you should ask about distributed ledger. This could help you see just how well the self-proclaimed guru or sales representative knows their subject.”*²⁹

While distributed ledgers can have all sorts of designs, a blockchain is a very peculiar way of organizing a shared database. Changes to the database can only be made by creating new encrypted entries. These must be confirmed, before new data is added. The confirmation might consist, for example, of verifying cryptographic signatures called a hash. The name blockchain refers to the “blocks” that get added to the chain of transaction records once the verification is complete. Each new entry, moreover, logically depends on all the preceding ones.

All of which may make blockchains and distributed ledgers quite interesting and potentially useful for certain applications. As the BoE’s Ben Broadbent suggests, you can think of them as ways to build and run *“decentralised virtual clearinghouse and asset registers.”*³⁰ Compared to current centralized clearance and custody systems for equities, for example, they may provide new, more efficient ways to keep timely and accurate ownership records. Especially as most financial assets – think of loans, bonds, stocks and derivatives – already exist largely and often only as digital records! Under the leadership of the technology-affine SEC chair Gary Gensler, prospects for progress in this area look pretty bright.³¹ Using distributed ledgers might cut trading costs, speed up settlement times, reduce the scope for errors or fraud when distributing and taxing dividends, and perhaps pave the way for a whole new range of financial services.³² In due course, blockchain-based cryptoasset schemes might even turn out to have been an early and ultimately successful attempt to create an “internet of finance,” rather than just money.³³

²⁴ <https://e-estonia.com/wp-content/uploads/2020mar-nochanges-faq-a4-v03-blockchain-1-1.pdf>

²⁵ For a good overview with plenty of concrete examples what that means see: <https://apnews.com/article/da5e0dd3bf364bbda436fc16690f842c>

²⁶ <https://www.zdnet.com/article/the-estonian-cryptography-startup-that-wants-to-be-the-qualcomm-of-data-security/>

²⁷ <https://e-estonia.com/wp-content/uploads/2020mar-nochanges-faq-a4-v03-blockchain-1-1.pdf>

²⁸ For more details on distributed ledger technologies and what they might mean for asset management, see our previous publication available at [insert link to: GRI_Blockchain.pdf from April 2018]

²⁹ <https://tradeix.com/distributed-ledger-technology/>

³⁰ <https://www.bankofengland.co.uk/-/media/boe/files/speech/2016/central-banks-and-digital-currencies.pdf?la=en&hash=8D9B0F2911064BD7570B10370DF521FAE174217D>

³¹ <https://mitsloan.mit.edu/ideas-made-to-matter/heres-what-mit-students-will-learn-new-blockchain-and-money-class>

³² For some interesting recent developments on equities trading, see: <https://www.ft.com/content/9e38bee8-d70a-4f28-a771-c3d77068e9ba?emailId=606eeaf671874d0004740633&segmentId=7d033110-c776-45bf-e9f2-7c3a03d2dd26>

³³ <https://www.bankofengland.co.uk/-/media/boe/files/quarterly-bulletin/2014/innovations-in-payment-technologies-and-the-emergence-of-digital-currencies.pdf> p. 263.

For all these potential attractions, though, public and fully decentralized blockchain protocols also have their limits. What makes the KSI scheme efficient to run is precisely that the Estonian government has chosen one particular company it trusts. Unlike the protocols running private cryptocurrencies, KSI is a private and permissioned blockchain. It allows only selected and verified participants to enter data, according to the specific permissions that have been allocated to various users on the network. That design choice is critical in terms of scalability, as well as cost and energy efficiency. The care Estonia took in deciding which data to put on the actual blockchain, so as to ensure privacy protection, is also noteworthy. A key decision taken early on was to keep different databases for different government services. KSI's blockchain solution is only used for authentication. In addition, Estonia relies on a data-exchange layer now called X-tee to enable secure Internet-based data exchanges between different information systems.³⁴ The same basic approach has since been implemented by several other countries keen on digital government services as well.³⁵

It is far too early to say how useful these particular design approaches will prove for CBDC schemes, especially in large ones that would have to process tens, if not hundreds of thousands of transactions every second. Perhaps, a bigger lesson from KSI is that such government-backed schemes can be quite helpful in fostering private-sector innovation. For example, Estonia was early in establishing domestic instant payments.³⁶ Non-digital payments (such as cheques) have largely died out.³⁷ Another lesson is that protecting citizens' data and access to digital services will increasingly be seen as matter of national defense. With so much sensitive data stored digitally – and the constant threats of according to Estonian authorities allegedly state-sponsored cyber-attacks – there was a clear need to ensure that the data remains safe, that culprits for any inaccuracies can be quickly identified and that new technologies be deployed to improve crisis resilience. We think it likely that whatever the precise design choices, CBDC will become an increasingly urgent political matter, especially if designed to protect users' privacy.

Where to find details on ongoing CBDC projects

At this point at the latest, you would probably expect a list of all the different CBDC projects being planned or already launched, and how exactly the national digital currencies offered do or might differ. We are sorry to disappoint: reading through the various publications from central banks around the world, it quickly becomes clear that there are different motives in different countries, from hurricane resilience in a country like the Bahamas, with its 700 remote islands, to financial inclusion in places like rural Sweden, to the hope for moderate cost or energy savings. Different institutional legacies, policy objectives and constraints will shape projects in different ways. As a general rule, there remains a lot of genuine uncertainty as to when projects might happen and how exactly they will work. If one prediction can be made with confidence, it is that the projects will change, as more people get consulted, more is learnt about how CBDC might be useful, and new pitfalls become apparent.

Moreover, others, notably the Bank for International Settlements (BIS), are doing an excellent job at regularly charting policy discussions.³⁸ The BIS also takes regular surveys among over 60 central banks on their current thinking, motivations, assessments of the use of cryptocurrencies and stablecoins³⁹ within their jurisdictions, as well as potential CBDC issuance plans. One especially important recent finding is that about two thirds of central banks, as of late 2020, were either unsure or thought they lacked a legal mandate to issue a CBDC:

LEGAL AUTHORITY OF CENTRAL BANKS TO ISSUE A CBDC

³⁴ <https://www.ria.ee/en/state-information-system/x-tee.html>

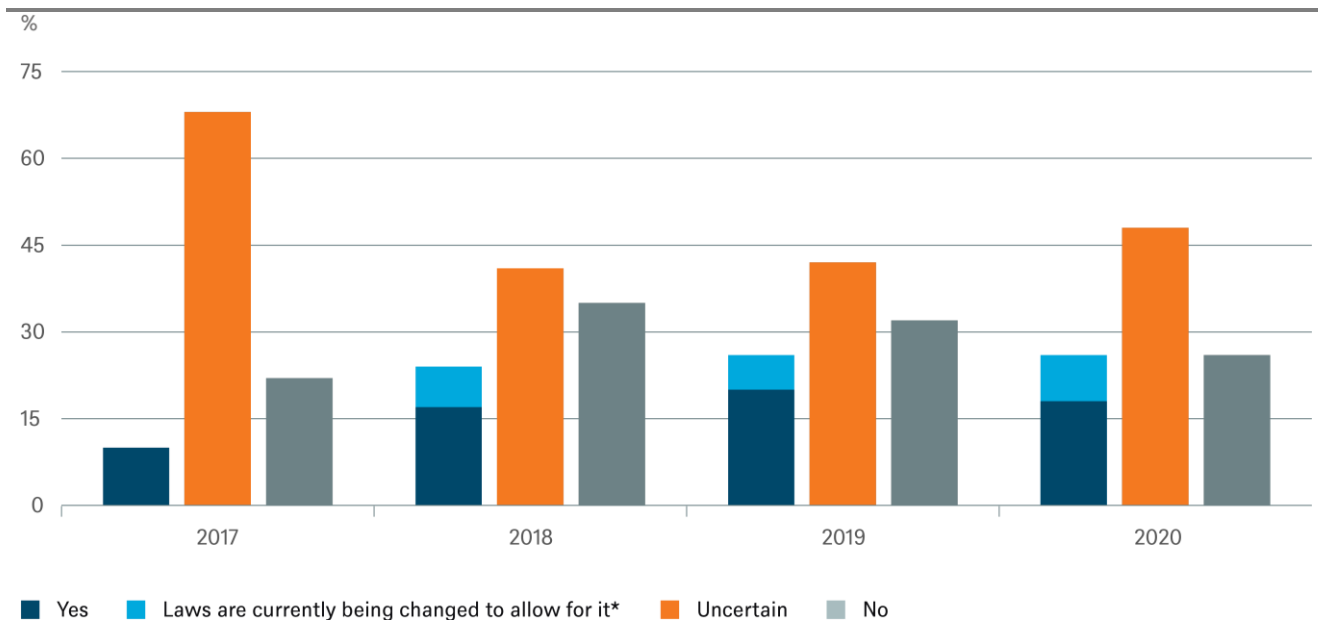
³⁵ <https://www.niis.org/blog/2020/3/30/x-road-implementation-models>

³⁶ See: <https://www.europeanpaymentscouncil.eu/news-insights/insight/country-profile-digital-and-instant-payments-are-norm-estonia>.

³⁷ See: <https://www.europeanpaymentscouncil.eu/sites/default/files/infographic/2020-09/Estonian%20payment%20landscape.pdf>

³⁸ As an introductory overview, we would especially recommend: <https://www.bis.org/publ/work.pdf>

³⁹ Stablecoins are virtual money directly tied to the value of an existing currency or some other exchange traded instrument (such as gold). If a stable coin is tied to an existing (fiat) currency, this is one without official backing of the central bank issuing the currency. Ideally, stablecoins would need to be backed by sufficient reserves in that currency, in case of redemptions. We will have more to say about the economic concerns involved with this concept when talking about Ecuador's experience with a dollar backed CBDC.



* There was no option for "laws are currently being changed to allow for it" in the 2017 survey
 Source: C. Boar and A. Wehrli, "Ready, steady, go? Results of the third BIS survey on central bank digital currency", BIS Papers, no 114 as of 1/27/21

That is one of the reasons why it will probably take a while for different projects to come to fruition.⁴⁰ Given how fast assessments are likely to change, any overview would rapidly be out of date. To keep track between BIS publications (or of central banks not part of the BIS), the regularly updated Atlantic Council CBDC Tracker could be of help.⁴¹

Instead, in the rest of this initial analysis we are going to focus on another main building block we outlined in the introduction: payment systems and how they historically emerged. This is well illustrated by the Bank of England, as both its history and recent research can tell you a lot as to what to expect.

3 / Don't just think about money – think about payment and settlement systems

Once upon a time, it might have made sense to talk about "money," without also talking about payment systems. A simple example is to think about coins made of precious metals as an early method of making payments for other goods and services. Physical possession of the coin denotes ownership. The payment system is simply the act of handing over the physical coin. Modern bank notes still function the same way.

Nowadays, though, *"money and payment systems are intrinsically linked."*⁴² Partly, that is because for quite a long time, handing over physical cash has only accounted for a small fraction of economic activity. What is cash? Technically, the bank notes and coins members of the public own are a liability of the central banks issuing them, just like money you deposit with your commercial bank is a liability of your commercial bank. To this day each pound sterling carries the pledge that "I promise to pay the bearer on demand the sum of..." with the amount and the signature of the BoE's Chief Cashier printed below.

That might seem a bit anachronistic. But it serves as a reminder that it is only quite recently, namely in the second half of the 19th and early part of the 20th century, that the BoE became a central bank in the way we might commonly use the term today. Modern central banks are 'clearing' houses at the center of their currency area's financial system. Member banks are

⁴⁰ For an overview and analysis of potential legal obstacles see: <https://www.imf.org/en/Publications/WP/Issues/2020/11/20/Legal-Aspects-of-Central-Bank-Digital-Currency-Central-Bank-and-Monetary-Law-Considerations-49827>

⁴¹ <https://www.atlanticcouncil.org/blogs/econographics/the-rise-of-central-bank-digital-currencies/>

⁴² <https://www.bankofengland.co.uk/-/media/boe/files/quarterly-bulletin/2014/innovations-in-payment-technologies-and-the-emergence-of-digital-currencies.pdf> p. 264

legally required to hold accounts and maintain minimum balances (called central-bank reserves) against the risks they bring to the system.

What are those risks and where do they come from? Nowadays, physical bank notes and coins account for a diminishing fraction of money overall. The vast bulk of it only exists digitally in commercial bank accounts. New money is mainly created through the loan issuance by commercial banks, funded by the deposits of their customers. The problem is that there is typically a maturity mismatch. Most deposits can be withdrawn anytime (by turning them into physical cash), while loans last for many years and can be difficult to value and sell, especially in times of crisis. Commercial banks are therefore vulnerable to bank runs – collapsing, simply because their depositors no longer trust them. Central-bank reserves, along with prudential regulation and deposit insurance all emerged to cope with these risks. And when financial strains nevertheless occur, the central banks can serve as lender of last resort to member banks to restore confidence. Under this model, only commercial banks and some other financial intermediaries can hold central-bank reserves. In general, central banks only interact indirectly, mainly via the commercial banking sector, with non-financial companies and the broader public. In that, as in many other respects, the system operated by the BoE has served as the model on which most modern central banks have been based.

How did this system come about? Not, as you might think, through conscious planning or deliberate design. As Walter Bagehot wrote in his pioneering account of mid-19th century British and international banking and finance, the BoE's had emerged "*not deliberately founded upon definite reasons*" but as the "*gradual consequence of many singular events*."⁴³ Nor was it quite like the central banking system familiar today yet.⁴⁴

One basic issue central banks have to ponder when considering new digital currencies is whether to go back to once again allowing individual citizens to open an account with them, as the BoE did in Bagehot days. This is a matter of politics, as much as of economics. It highlights how and why states have mattered and are likely to continue to matter for money and payment systems. We will discuss this in the next follow-up to this CIO Special.

4 / Conclusion and outlook

Imagine a world without physical banknotes. In Part I of this CIO Special, we have already supplied some of the building blocks for doing so, while noting some of the reasons why most central banks are in no hurry to implement such a fundamental change. We explained why just adding "digital" doesn't solve any problems and why – and where – the blockchain revolution really got started. We outlined where to find details on ongoing CBDC projects. We concluded with how payment systems historically emerged and how money and payment systems are linked. All that, though, is hardly enough to figure out how a world without physical banknotes might be different – let alone whether it would be probable or even desirable. Doing so requires some further building blocks, starting with the role of states and the largely forgotten story of the world's first central-bank digital currency. (Spoiler alert: it happened a while ago!)

GLOSSARY

The **Bank of England (BoE)** is the central bank of the United Kingdom.

Emerging economies are economies in developing nations that are more engaged with global markets as they grow.

The **European Central Bank (ECB)** is the central bank for the Eurozone.

The word **monetary** indicates a relation to the money in a country.

People's bank of China (PBoC) is the central bank of China.

The **pound sterling (GBP)**, or simply the pound, is the official currency of the United Kingdom and its territories.

The **U.S. Federal Reserve**, often referred to as "**the Fed**," is the central bank of the United States.

⁴³ Bagehot, W. (1873) *Lombard Street: A Description of the Money Market*, Chapter 3, available at: <http://www.gutenberg.org/cache/epub/4359/pg4359.html>

⁴⁴ This is best illustrated in a charming short story by Mark Twain, called "The Million Pound Bank Note," which first appeared in 1893: Twain, Mark (1893, reprint 2021) *The Million Pound Bank Note*. Independently published, ISBN: 979-8726647104. Its basic premise is that "the Bank of England once issued two notes of a million pounds each" which any member of the public could simply go "down to the Bank" and buy (p. 10).

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