Central bank digital currencies: an opportunity for the monetary system

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This year's Annual Economic Report features a special chapter on central bank digital currencies (CBDCs). Last year, we laid out the central bank's core mission in the payment system.[1] This year's report discusses how the big idea of CBDCs can be put into practice.

We do so by laying out the design choices for CBDCs and by providing an economic analysis of their implications for users, financial institutions and the central bank.

Central bank foundations of the monetary system

The foundation of the monetary system is the trust in the currency. As the central bank provides the unit of account, trust in the currency is grounded on trust in the central bank itself. This principle has been the fixed point of the monetary system even as it has seen rapid transformation with changes in the digital landscape.

CBDCs offer in digital form the unique advantages of central bank money by ensuring the finality of payments, providing liquidity and ensuring that central bank money is "neutral" in that it is provided on an equal basis to all commercial parties with the commitment to competitive fairness.

In terms of the architecture, CBDCs should be seen in the context of the two-tier system, where the central bank and the private sector each focus on what they do best. The central bank operates the core of the system by ensuring sound money, liquidity and overall security. The private sector uses its creativity and ingenuity to serve customers. It builds on top of the central bank foundations.

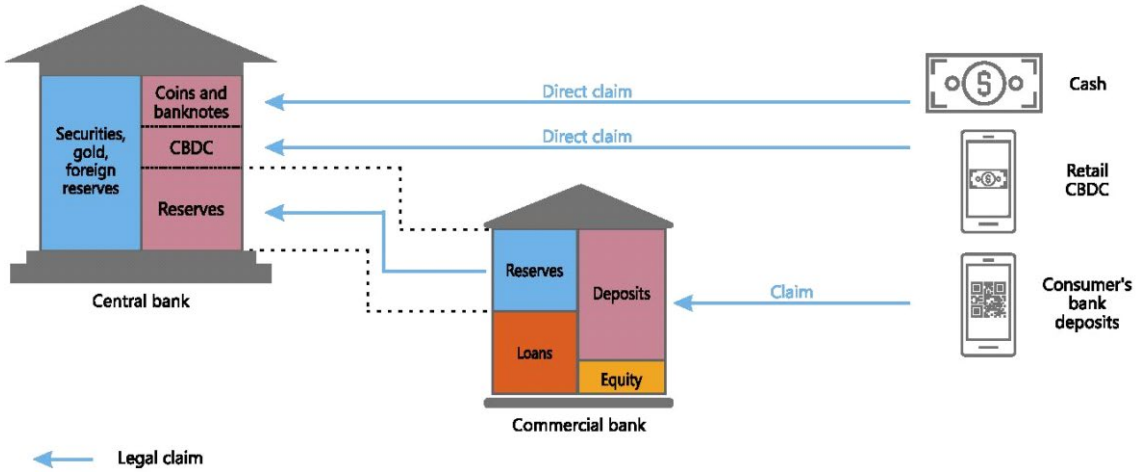
Retail CBDCs build on the conventional two-tier monetary system and make central bank digital money available to the general public, just as cash is a direct claim on the central bank (Graph 1).[2] They are a salient marker of the trust in sound money available to the general public, just as cash is today.

[1] BIS, "Central banks and payments in the digital era", *Annual Economic Report 2020*, June 2020, Chapter III.

[2] R Auer and R Böhme, "Central bank digital currency: the quest for minimally invasive technology", *BIS Working Papers*, no 948, June 2021.

An example of a monetary system with retail CBDC and commercial banks

Graph 1



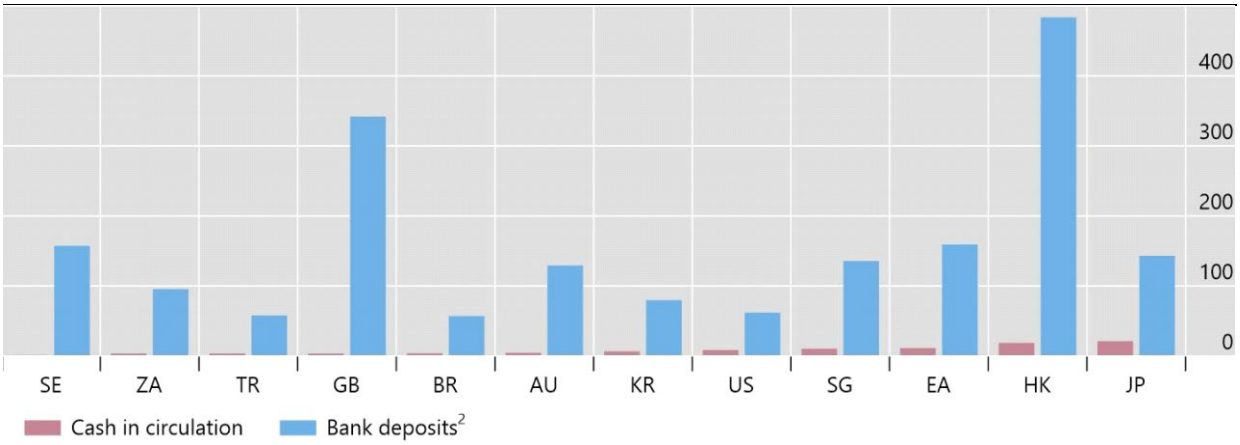
Source: R Auer and R Böhme, "Central bank digital currency: the quest for minimally invasive technology", *BIS Working Papers*, no 948, June 2021.

One guiding principle on the design of CBDCs is that most of the operational tasks and consumer-facing activities should be taken on by commercial banks and other payment service providers (PSPs). As Graph 2 shows, cash is typically a small fraction of bank deposits. This reflects the fact that cash is not widely used as a store of value. In the same way, CBDCs can be designed to retain a small footprint in the financial system, just as cash does today. Central bank money can then preserve its core attribute of neutrality.

CBDCs can be designed to have a limited financial system footprint – like cash today[1]

As a percentage of GDP

Graph 2



[1] Data for 2019. [2] Closest alternative where data are not available.

Source: R Auer, R Böhme, "Central bank digital currency: the quest for minimally invasive technology", *BIS Working Papers*, no 948, June 2021.

To fully appreciate the public interest case for CBDCs, it is important to recognise the centrality of data in the digital economy. This is because an essential by-product of the digital economy is the huge volume of personal data that is collected and processed as an input into business activity. Data and their network effects present several related challenges for central banks.

The first is that network effects make the payment system prone to concentration and enable the formation of data silos that entrench the market power of firms that have exclusive use of the data. The second is privacy and data governance. Data concentration not only has a detrimental economic impact, but it gives rise to concerns about data privacy, and data governance more broadly. However, both the competition and data governance imperatives need to be met while ensuring the third imperative: that of ensuring the integrity of the payment system against money laundering, ransomware attacks and other illicit activities.

Thus, digital innovation implies a "triple imperative" for the central bank in its role at the foundation of the monetary system: competition, data privacy and the integrity of the payment system.

Competition and financial inclusion

The ultimate benefits of a new payment technology depend on the underlying competitive structure of the payment system and data governance arrangements. The same technology that generates a virtuous circle of greater access, lower costs and better services could equally generate a vicious circle of data silos, market power and anti-competitive practices. To put it another way, technological innovation in payments can quickly lead to the emergence of data silos and walled gardens, depending on the underlying economic structure and data governance arrangements. Walled gardens are very nice on the inside, but it can be difficult to escape once inside. And the emergence of such separate walled gardens leads to data concentration and hinders competition.

Instead, the public interest imperative argues for an open marketplace. Data governance frameworks can grant ownership of data to users. These can be combined with technical standards such as application programming interfaces (APIs) that impose a common format for data exchange between service providers.

Open platforms with APIs also feature in the latest generation of retail fast payment systems (FPS) that do not use a CBDC. Indeed, there is a close family resemblance between these systems and those based on CBDCs. They are best viewed as being part of a continuum. These arrangements can lead to an open platform where everyone can transact with everyone else, just as one does in an open marketplace. Open platforms are most conducive to a virtuous circle of greater access, lower costs and innovation that leads to better services.

CBDCs are an opportunity to address both long-standing and emerging challenges. Among the long-standing issues, it is striking that in spite of technological progress and the decline in information processing costs, digital payments have remained stubbornly expensive. Graph 3 shows the costs to merchants from a €25 transaction, as estimated by the European Commission in 2015.[3] Credit and debit cards are notably more expensive to merchants than cash, in particular due to the merchant service costs. Consumers do not see these charges directly, as they are levied

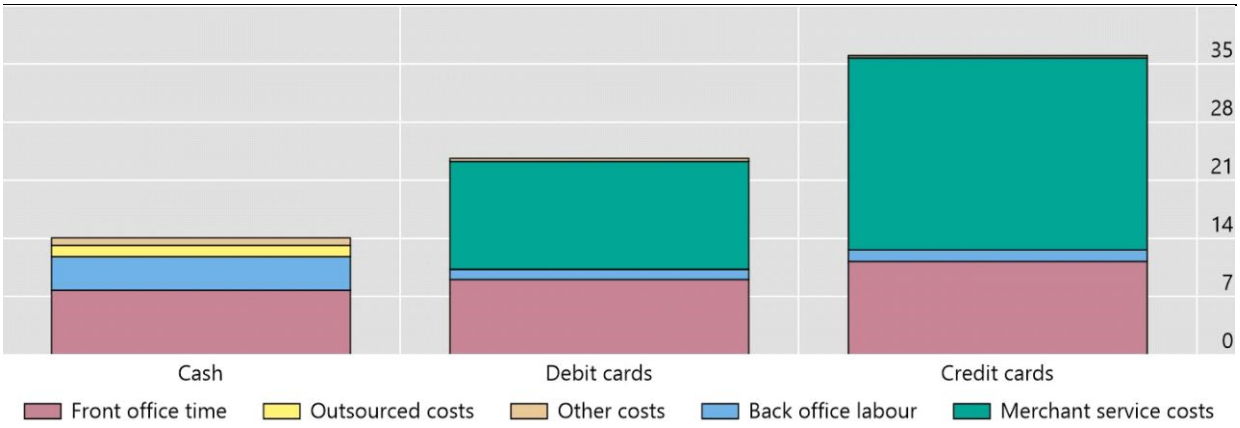
[3] European Commission, *Survey on merchants' costs of processing cash and card payments*, March 2015.

on the merchants. But the ultimate burden could fall more broadly if the costs are passed on in the form of higher prices at the checkout.

In spite of technological progress and declining information processing costs, card payments are still more expensive than cash for a €25 transaction[1]

Marginal cost, EUR cents

Graph 3



[1] Data for Europe (AT, BE, DE, ES, FR, GB, IT, NL, PL and SE), 2015. The graph reflects a scenario in which merchants were asked to assess fixed or variable costs for accepting cash, debit card and credit card payments for a €25 transaction over a three- to four-year time horizon.

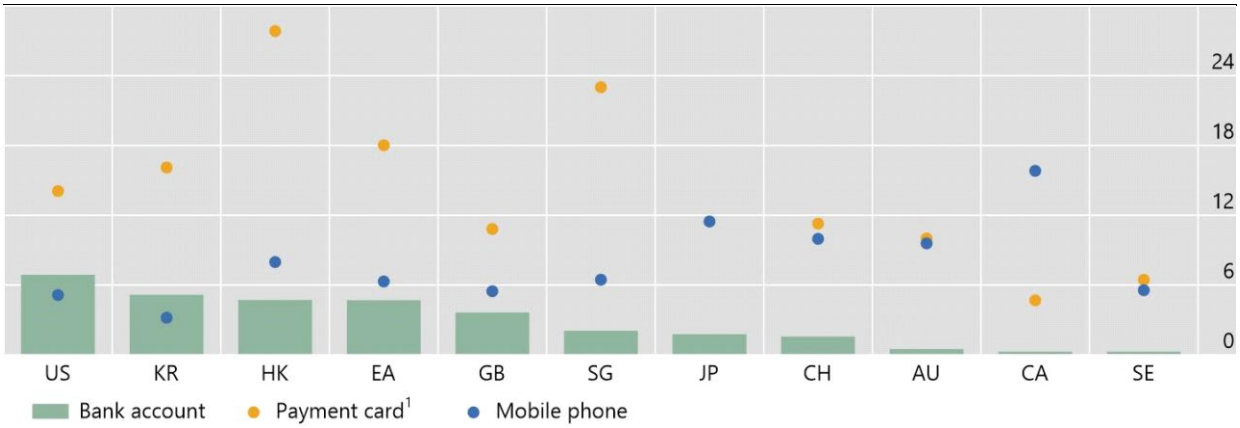
Source: European Commission, *Survey on merchants' costs of processing cash and card payments*, March 2015.

Digital innovation also raises well known issues around financial inclusion and universal access. As can be seen in Graph 4, even in advanced economies, many households do not have bank accounts, payment cards and mobile phones. This means that significant segments of the population cannot use digital means of payments. Lower-income individuals, the homeless, migrants and other vulnerable groups are most likely to rely on cash.

Even in advanced economies, many households did not have bank accounts, payment cards and mobile phones in 2017

In per cent

Graph 4



[1] Debit or credit card used to make a purchase in the past 12 months.

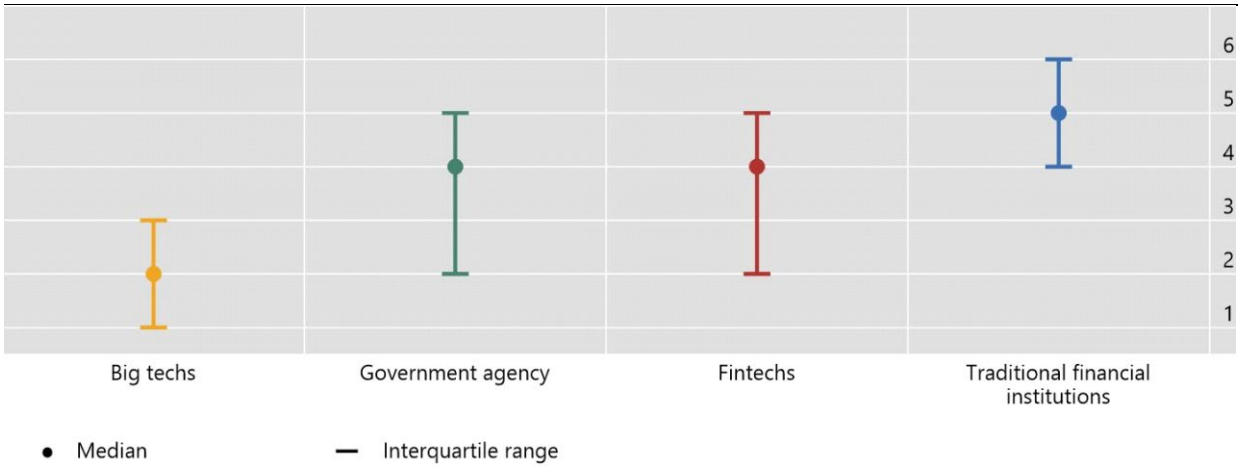
Source: Global Findex database.

Among the new challenges, digital innovation raises different issues around privacy and data governance. Digital payments result in a "data trail" that can be extremely valuable in commercial terms. Personal data also flow from social media, e-commerce and other digital services. But consumers' trust in different institutions to safeguard their data differs widely. In a recent New York Fed survey, conducted in partnership with BIS economists, US households indicated that they trust big techs the least to safeguard their data.[4] They have much more trust in financial institutions, with governments and fintechs in the middle (Graph 5).

[4] O Armantier, S Doerr, J Frost, A Fuster and K Shue, "Whom do consumers trust with their data? US survey evidence", *BIS Bulletin*, no 42, June 2021.

American consumers trust big techs the least to safeguard their personal data

Score, 1–7[1] Graph 5



[1] 1 = "no trust at all"; 7 = "complete trust".

Source: O Armantier, S Doerr, J Frost, A Fuster and K Shue, "Whom do consumers trust with their data? US survey evidence", *BIS Bulletins*, no 42, May 2021.

Identification and privacy in CBDC design

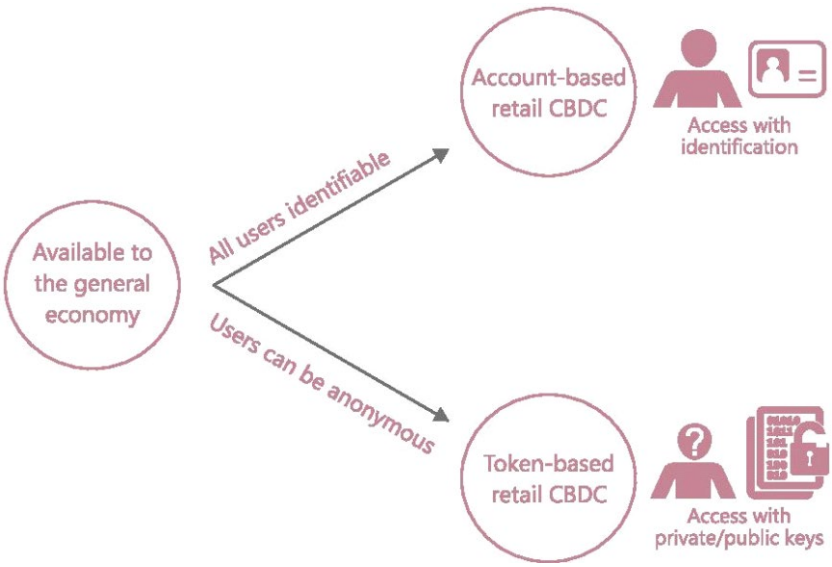
These considerations open up several design choices. A crucial aspect in the design of CBDCs is digital identity (ID). Should users be able to use CBDCs anonymously? Or should they have to reveal their real name? And if so, who would be in charge of managing the identity system, and what would such a system look like?

In technical terms, the decision is between a token-based CBDC that allows for fully anonymous transactions, and an account-based CBDC that is based on some form of user identification (Graph 6).[5] An obvious difficulty with a token-based system is that all the problems with anonymous payments, such as money laundering and other illicit activities, would be made worse. This is why some form of digital identification will be needed for the integrity of CBDC-based payment systems.

[5] See C Kahn and W Roberds, "Why pay? An introduction to payments economics", *Journal of Financial Intermediation*, vol 18, no 1, 2009.

A key design choice: should CBDCs be account-based or token-based?

Graph 6



Source: BIS elaboration.

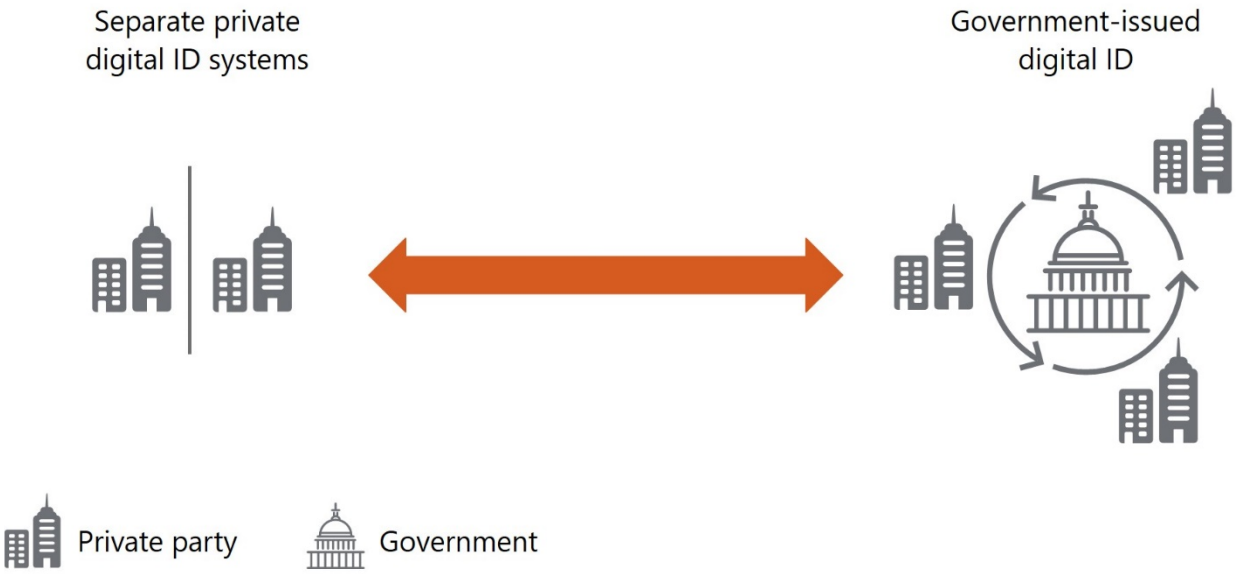
However, digital ID systems can be designed in quite a few different ways (Graph 7). At one end of the spectrum are purely private digital ID systems. Each ID could be completely separated, just as I have separate IDs for Google and Facebook. At the other end are government-issued ID schemes. For example, governments could directly issue a public digital ID which would then be accepted by all private and public service providers. This is the model used in Singapore, Estonia and Kenya, just to name three examples.

In between these two models, there are many other possible forms of governance arrangements for digital ID that are discussed in the chapter. There could be private collaborative schemes, and various forms of public-private sector cooperation with a common governance framework to ensure interoperability between services.

No matter which identity scheme is chosen, there are important questions about data privacy. How do we protect sensitive personal data from unwarranted access?

One possible way is to ensure that data access is limited to only the specific elements that are necessary to perform a task. This means thinking about anonymity with respect to specific parties. APIs are a good illustration of this principle. Imagine that while users' data on CBDC transactions are stored centrally, other parties, such as banks or other PSPs, never see the full picture of transactions. Each would see only the sliver that it needs to. If a user wants to make an outgoing payment from her bank account using the app of another bank, then this other bank needs only to know her account number and balance, but not other details like payment history, home address or date of birth.

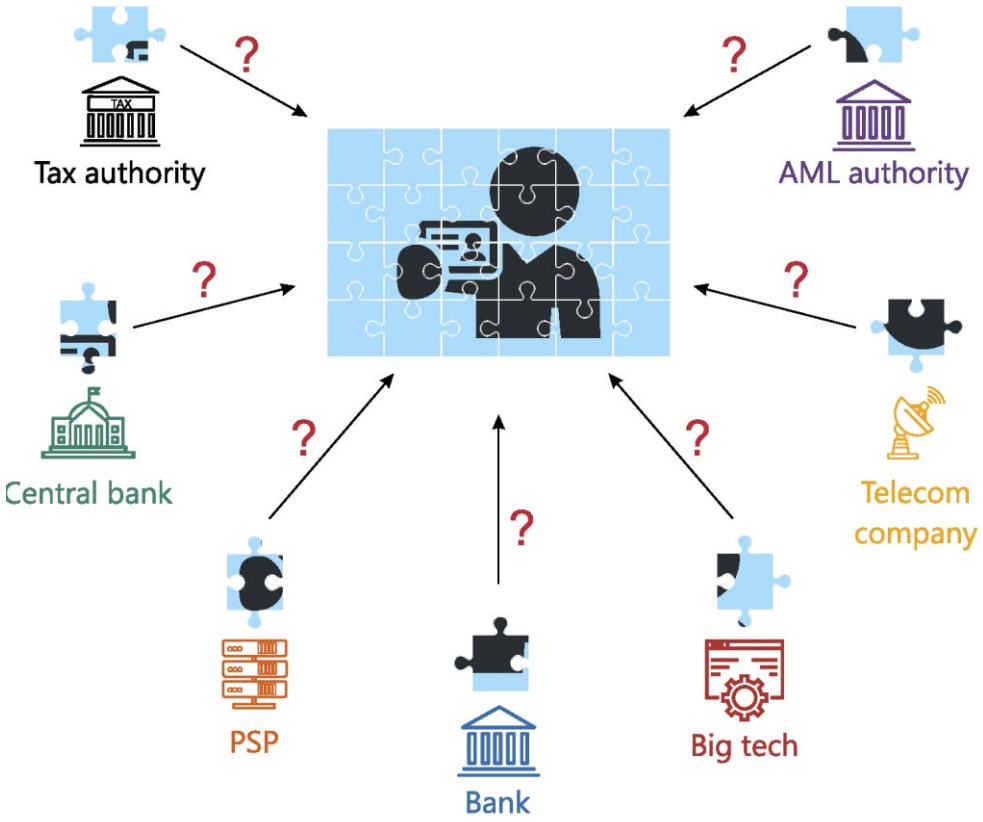
There is a continuum of governance arrangements for digital ID Graph 7



Source: BIS elaboration.

Instead, users have control over their data and only share the piece of the puzzle that is needed in a specific case, for instance to support a credit application or transfer money. Without the other puzzle pieces, no entity will have a complete picture of the user. By separating payment services from control over the resulting data, CBDC designs can thus ensure users' privacy. The same "jigsaw puzzle principle" could be applied between different types of entities, for instance a government department or the central bank itself (Graph 8).

Jigsaw puzzle principle: each provider has access to data strictly needed for their task; only the user has the full picture Graph 8



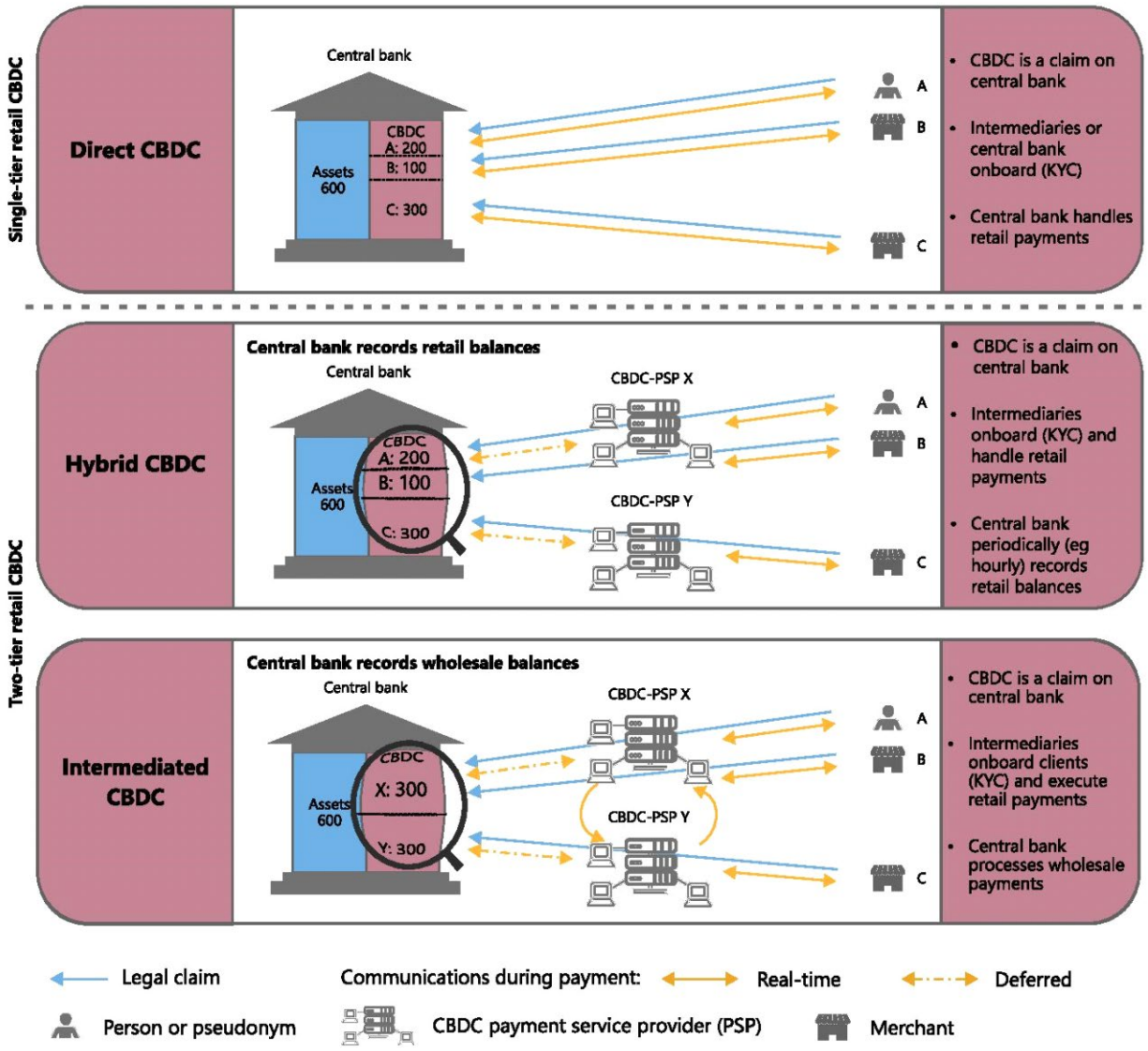
Source: BIS elaboration.

Such a design would not only protect individuals against data hoarding and abuse of personal data by commercial parties. It could also prevent unwarranted access by the central bank and other public authorities. Yet law enforcement authorities could still request data in exceptional cases – similar to today's data privacy safeguards.

CBDC architectures and the financial system

Another important design feature concerns the operational arrangements of a CBDC. There are good arguments against a one-tier system fully operated by the central bank, a so-called direct CBDC (Graph 9, top panel). In a direct CBDC, not only is the CBDC a direct claim on the central bank, but the central bank also handles all communication with the users, including account opening and maintenance and enforcement of rules regarding anti-money laundering and countering the financing of terrorism (AML/CFT), as well as day-to-day customer service. The central bank also maintains a full ledger of retail transactions. Such an architecture would imply a large shift of operational tasks – and costs – to the central bank. This would detract from the central bank's role a relatively lean and focused public institution at the helm of economic policy.

The direct, hybrid and intermediated CBDC architectures Graph 9



In the direct CBDC model (top panel), the central bank handles all payments in real time and thus keeps a record of all retail holdings. A hybrid CBDC architecture (centre panel) incorporates a two-tier structure with direct claims on the central bank, while real-time payments are handled by intermediaries. However, the central bank periodically updates and retains a copy of all retail CBDC holdings. By contrast, an intermediated CBDC architecture runs a wholesale ledger (bottom panel). In this architecture, PSPs would need to be closely supervised to ensure at all times that the wholesale holdings they communicate to the central bank indeed add up to the sum of all retail accounts.

Source: Adapted from R Auer and R Böhme, "Central bank digital currency: the quest for minimally invasive technology", *BIS Working Papers*, no 948, June 2021.

An alternative model is one in which the central bank does not record retail transactions, but only the wholesale balances of individual PSPs (Graph 9, bottom panel). In this intermediated architecture, the CBDC is still a claim on the central bank but, just as with cash, the central bank does not keep a record of all the detailed records of retail transactions. Those are maintained by the private sector. This means that the central bank has only a wholesale ledger of payments between the private sector PSPs, not those between the individual users.

The benefits of such an intermediated CBDC architecture would be a much simpler operational setup for the central bank, and a larger role for the private sector. By reducing the concentration of data, such designs could also enhance privacy. The downside is that additional safeguards and prudential standards would be necessary, as PSPs would need to be supervised to ensure at all times that the wholesale holdings they communicate to the central bank accurately reflect their clients' retail holdings.

The third possible architecture, the so-called hybrid model, sits in between the direct and intermediated models. In the hybrid model, the PSPs perform all consumer-facing payment services but the central bank regularly receives a backup of transactions and account balances of individual users (Graph 9, centre panel). The operational involvement in the hybrid model is thus much lower than that in a direct model, but higher than that in an intermediated one.

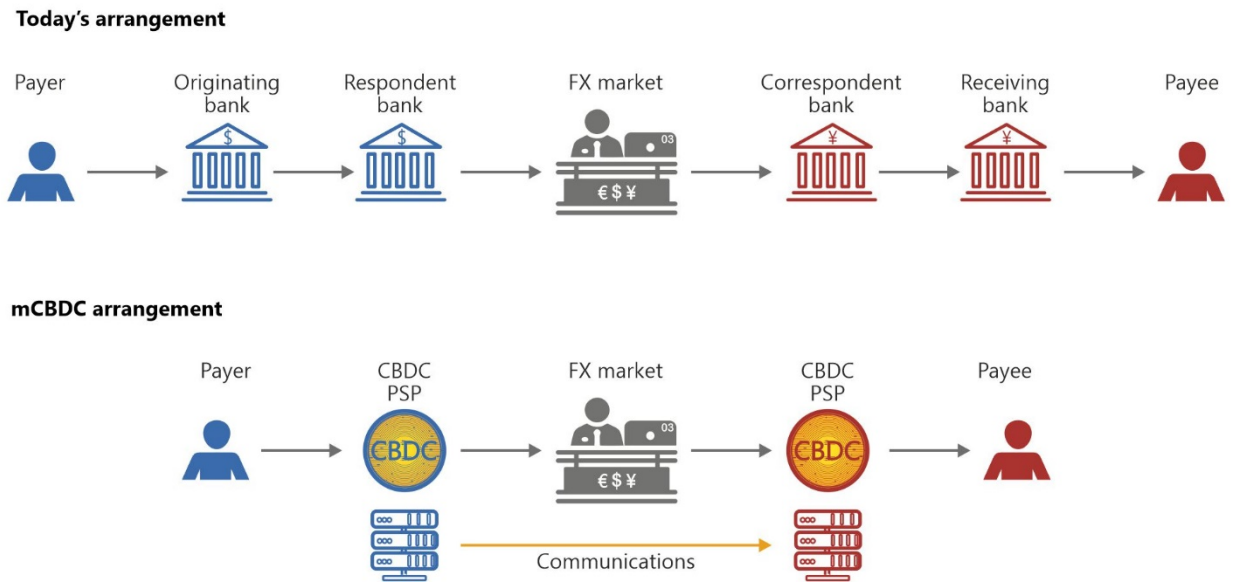
The international dimension of CBDC issuance

The merits of CBDCs are most visible in the cross-border context. By extending the unique features of central bank money directly to the general public, CBDCs entail a more parsimonious architecture of the monetary system, with additional benefits.

Compared with today's arrangement based on correspondent banks that act as middlemen between different financial institutions, multi-CBDC arrangements represent an opportunity to simplify the monetary architecture (Graph 10).

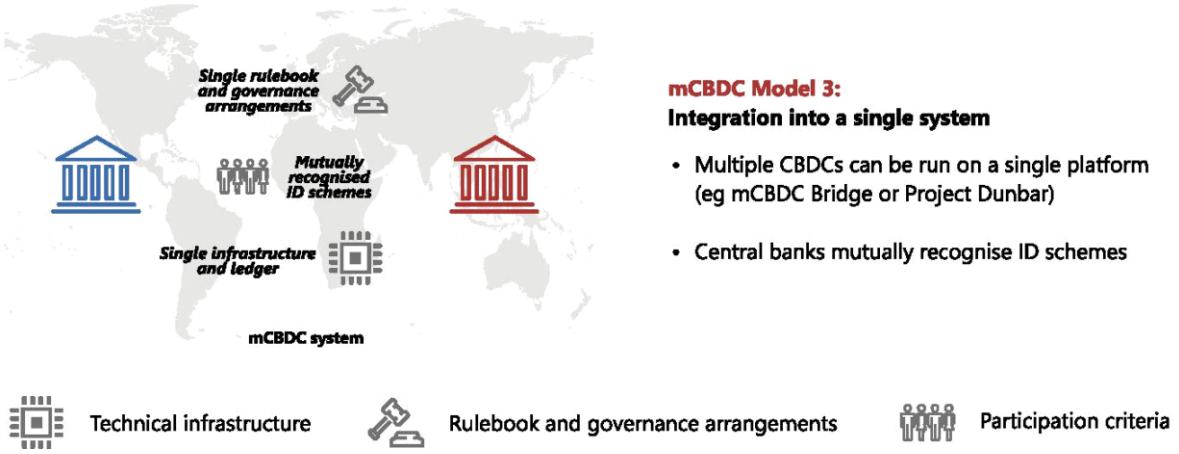
CBDCs could simplify the monetary architecture and substantially streamline the cross-border payment chain

Graph 10



Source: BIS elaboration based on R Auer, P Haene and H Holden, "Multi-CBDC arrangements and the future of cross-border payments", *BIS Papers*, no 115, March 2021.

Multi-CBDC arrangements can facilitate cross-border payments Graph 11



Source: R Auer, P Haene and H Holden, "Multi-CBDC arrangements and the future of cross-border payments", *BIS Papers*, no 115, March 2021.

Multi-CBDC arrangements that join up CBDCs across borders can mitigate many of today's frictions by starting from a "clean slate", unburdened by legacy arrangements. The greatest potential for improvement is offered by a single mCBDC system that features a jointly operated payment system hosting multiple CBDCs (Graph 11).

One possible concern with cross-border use is that a foreign CBDC would encroach on the domestic currency, leading to currency substitution. Currency substitution would be less of an issue for a digital ID-based design, as the issuing central bank would have to accept users as part of the CBDC network. The host central bank would also have discretion through domestic regulation. For all these reasons, the image of cash circulating in briefcases in the black market is not a good analogy.

In any case, it is worth bearing in mind that currencies become international currencies because there is a use case, for instance for trade settlement. Merely being digital is not going to make a currency an international currency.

Conclusion

Let me conclude. CBDCs could form the backbone of a highly efficient new digital payment system by enabling broad access and providing strong data governance and privacy standards resting on digital ID. They are the best way to promote the public interest case for digital money.

CBDCs are an idea whose time has come. They present an opportunity to design a technologically advanced representation of central bank money that preserves the core features of central bank money: finality, liquidity and integrity.

[6] See R Auer, P Haene and H Holden, "Multi-CBDC arrangements and the future of cross-border payments", *BIS Papers*, no 115, March 2021; R Auer, C Boar, G Cornelli, J Frost, H Holden and A Wehrli, "CBDCs beyond borders: results from a survey of central banks", *BIS Papers*, no 116, June 2021.