Stellar

Guidebook

UNDERSTANDING CBDCS

A guidebook for regulators and policymakers

September, 2023

ACKNOWLEDGMENTS

The following paper was prepared by the Stellar Development Foundation (SD), which supports the development of the Stellar network. This paper is part of the Central Bank Digital Currency (CBDC) series produced by SDF, and builds on the previously published Stellar for CBDCs.[1] There are references to how the Stellar system operates; however, we acknowledge that other decentralized systems operate differently and as such, some insights and applications for CDCs may not be applicable. The drafting of this paper was led by the SD CBDC working group which is composed of a cross-functional team.

The paper has also benefited from peer review through a consultation process. We are grateful for the valuable contributions from the following colleagues: Harsh Natarajan (World Bank Group), Erik Feen (World Bank Group), Matthew Gamser (World Bank Group), Elaine MacEachern (World Bank Group), Robin Newnham (Alliance for Financial Inclusion), Adeyemi John Omotoso (Alliance for Financial Inclusion), Camilo Tellez (UNCDF, Better Than Cash Alliance), Shruti Sharma (UNCDF, Better Than Cash Alliance), Asad Khan (Bank for International Settlements, Innovation Hub), Daniel Eidan (Bank for International Settlements, Innovation Hub), Federico Grinberg (International Monetary Fund), Gabriel Söderberg (International Monetary Fund), Habib Attia (Arab Monetary Fund) and Diego Ballon Ossio (Clifford Chance LLP).

Any questions or comments on this paper can be directed to: cbdc@stellar.org

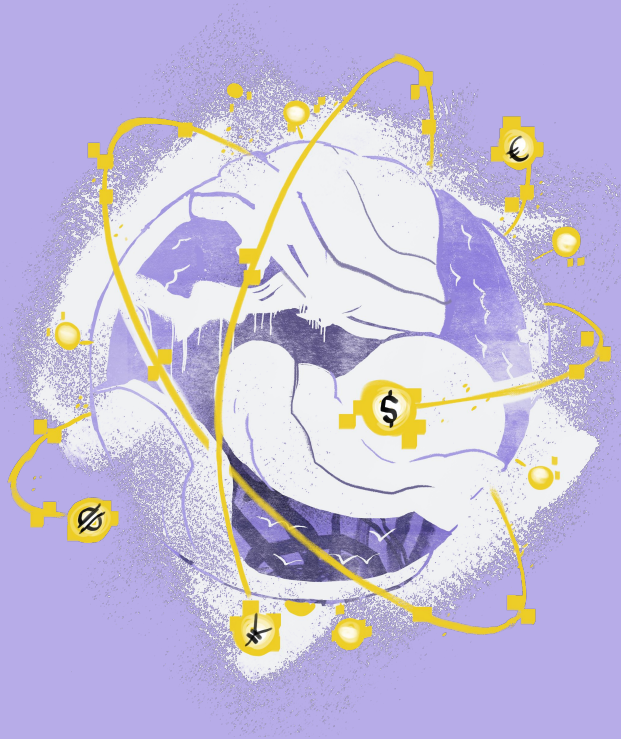
1. For further understanding on how Stellar works for CBDC, please see Stellar Development Foundation, Stellar for CBDCs, 2021.

THE STELLAR DEVELOPMENT FOUNDATION

The Stellar Development Foundation *is a non-profit organization that supports the development and growth of Stellar, an open-source network that connects the world's financial infrastructure.*

Founded in 2014, the Foundation helps maintain Stellar's codebase, supports the developer, fintech, and business communities building on the network, and serves as an independent industry voice to regulators and institutions.

The Foundation seeks to create equitable access to the global financial system, using the Stellar network to unlock the world's economic potential through blockchain technology.



INTRODUCTION

This paper aims to provide an overview of the policy and regulatory considerations for central banks to build and issue a Central Bank Digital Currency (CBDC) and highlights the benefits of open networks.

Unlike centralized and closed systems, an open network with asset control capabilities for issuers means robust and resilient infrastructure upon which anyone can build. Under an open system, regulators, public agencies, and regulated financial entities, from commercial banks to digital wallets, can design solutions and monetary policies using a ledger that possesses built-in capabilities to ensure security, certainty, and control - as with a centralized or closed ledger. At the same time, open systems foster competition and innovation by expanding the access and usage of more affordable financial services in addition to promoting financial inclusion.

First, the paper intends to briefly set out how individuals and Micro, Small and Medium Enterprises (MSMEs) would benefit from CDCs, hence why central banks should consider issuing a CBDC as a central bank public good, giving the private sector greater scope for impactful innovation. Second, the paper addresses an important question: Why should a CBDC be built on an open blockchain? Third, the paper highlights regulatory and policy considerations when issuing a CBDC and concludes with final thoughts. This paper is not focused on the technology aspect of the Stellar network. In order to understand the necessary steps for a central bank to build a CBDC on Stellar, please see Stellar for CBDCs.

> *CBDCs hold enormous potential for financial inclusion, and now is the time to ensure financial inclusion is embedded into design thinking. A precondition for success is all sectors working together under a common vision and framework"*

Dr. Alfred Hannig Executive Director, Alliance for Financial Inclusion (AFI), AFI Multi Stakeholder Dialogue on CBDCs and Financial Inclusion, 29 September 2021

> *Access to mobile wallets and digital payments must be as universal as access to cash"*

John A. Rolle Governor, Central Bank of the Bahamas, AFI Multi-Stakeholder Dialogue on CBDCs and Financial Inclusion, 29 September 2021

DIGITAL MONEY AS A CENTRAL BANK PUBLIC GOOD: WHY SHOULD A CENTRAL BANK CONSIDER A CBDC?

01. *An opportunity for everyone. Why Angelo and Antonietta's Caffè Pasticceria need a CBDC.*

For 35 years, siblings Angelo and Antonietta have run a small town Caffè Pasticceria in Umbria, Italy. Every morning, starting at 7am, they welcome many local residents who come to enjoy a good cappuccino with a cornetto. The Caffè only accepts cash, usually Euro coins, mainly due to the transaction costs involved when accepting digital payments. Angelo and Antonietta hold the cash throughout the month and then bring it to their nearest branch of a large Italian bank, about five kilometers away. But using only cash is less convenient for the business and its visitors, and presents a high risk of theft or loss.

The banknotes and coins earned by many people just like Angelo and Antonietta could one day be replaced by a CBDC[2]. Angelo and Antonietta would have the security and comfort of instantly depositing payments received at the Caffè. In addition, it is not novel to say that small businesses struggle to access lending. By accepting a CBDC, the small business could automatically build a credit history that would allow the Caffè to potentially increase its access to credit[3] and buy a new coffee machine or create a financial safety net. It would also allow foreign customers (e.g. tourists and increasingly, working nomads), local merchants, and suppliers to make and accept affordable and efficient payments directly from their foreign or local digital wallets or bank accounts.

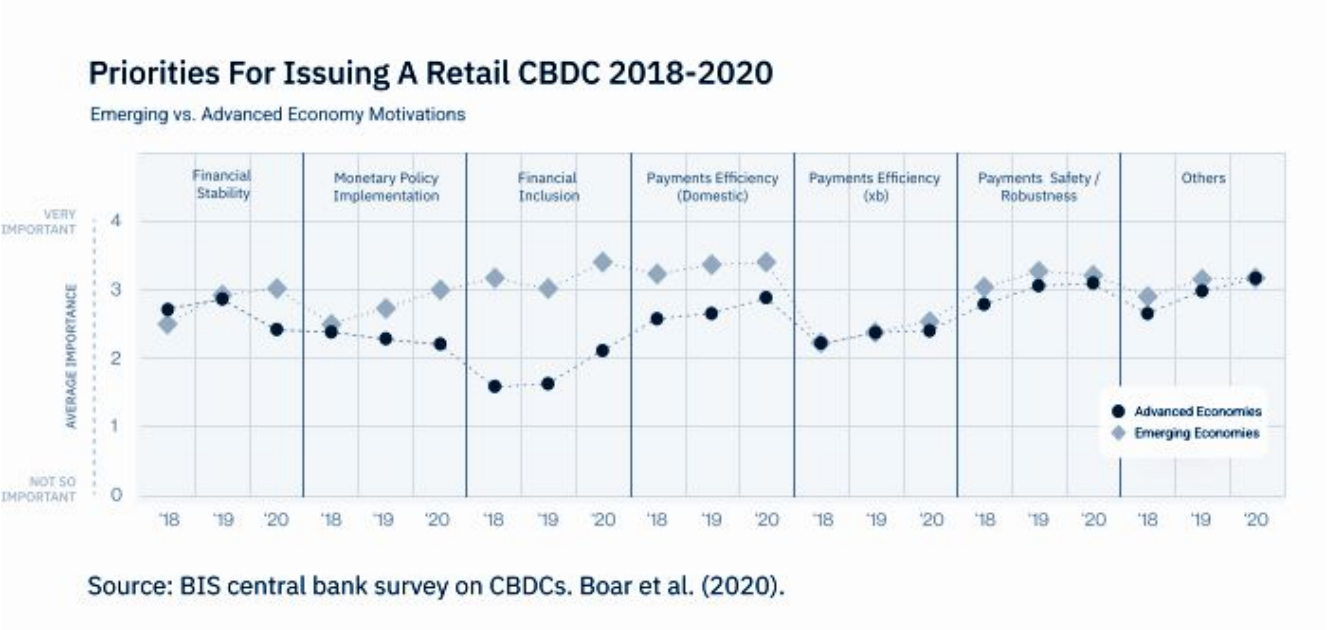
High transaction fees for foreign currencies would be avoided by merchants and tourists alike. While the small business run by Angelo and Antonietta is located in Italy, this scenario exists across the globe: in advanced and emerging economies, in urban and rural areas, in Europe, Asia, Africa, Middle East, and Latin America, wherever the use of cash remains high.

2. International Monetary Fund blog published by Tommaso Mancini-Griffoli in March 2021.
3 Around 80 percent of total MSMEs are informal (Global Partnership for Financial Inclusion (2018). These firms face a number of challenges that can negatively impact their operations and growth. According to the World Bank Enterprise Surveys, lack of access to finance is consistently reported as the biggest obstacle among these challenges. The potential demand for MSME finance in developing economies is estimated at US$ 8.9 trillion, compared to the current credit supply of US$ 3.7 trillion (G20 Policy Guide: Digitisation and Informality, Argentina International Finance Corporation (2018)). MSME Finance Gap Report. Washington DC

DIGITAL MONEY AS A CENTRAL BANK PUBLIC GOOD: WHY SHOULD A CENTRAL BANK CONSIDER A CBDC?

02. *Addressing financial inclusion and payments enhancement.*

The Bank for International Settlements (BIS) conducted a survey among central banks from advanced and emerging economies (65 in total for the last updated survey published in January 2021) regarding their engagement, motivations, and intentions with respect to CBDCs. Respondents represent close to 72% of the world's population and 91% of global economic output with 21 located in advanced economies and 44 in emerging economies. According to the latest data published by the BIS in January 2022, there are 28 pilots and 68 central banks have communicated publicly about their CBDC work.



Financial inclusion emerges as a main factor across emerging economies and remains a top priority for CBDC development. Payment-related issues, such as domestic payments efficiency and payments safety, remain priorities of both advanced and emerging economies' motivations for issuing a general purpose CBDC. The survey also shows that financial stability and monetary policy have become more important motivations for emerging economies.[5]

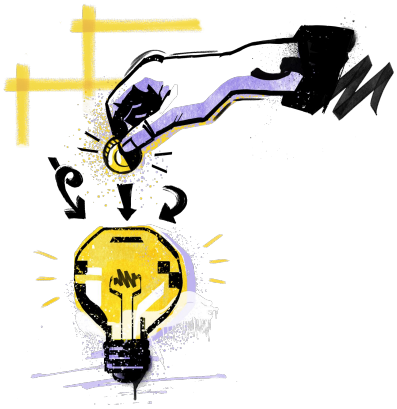
Central banks and policymakers have revealed additional motivations. For instance, the European Union Commission (EC) has highlighted the contribution that a CBDC could make to

4. Bank for International Settlements, Rise of central bank digital currencies: drivers, approaches and technologies, Updated dataset, January 2022.
5 Bank for International Settlements, Ready, steady, go? – Results of the third BIS survey on central bank digital currency, January 2021

green inclusive sustainable growth, social inclusion, and social sustainability. The EC argues that social and environmental values can support economic growth through collaborative finance, to which a CBDC is very well-suited. In response to a decline in the use of cash, a CBDC could be introduced as an additional form of public money and means of payment. In this sense, a CBDC could be inexpensive and easy to use, secure, safety-enhancing, and enable fast payments.

03. *CBDC as a central bank public good – giving the private sector greater scope for impactful innovation for everyone's benefit.*

Building on Paul Samuelson's 1954 work[6], a public good in economics is one that is non-excludable and non-rivalrous, where anyone can use it and the use by one does not diminish its availability to others. Our current monetary system is founded on sustaining trust in national currencies, which are public goods. In a December 2019 lecture on the future of money and the payment system at Princeton University, Agustin Carstens, General Manager of BIS, referred to this as central bank public goods. While stressing the importance of central bank public goods, Carstens also highlighted that central banks need to give the private sector the scope to innovate in this area, for everyone's benefit.



Today's technological advances can certainly help in building a more efficient and more inclusive financial system, and central banks need to embrace such innovation, including CBDCs.[7] As the world becomes increasingly digitized, there is a growing reliance on digital money that is not issued or directly backed by central banks (and not equally available to all). Therefore, in order to continue playing the role of offering trusted money and a public good that is available to all, central banks should explore the possibility of issuing a CBDC. The private sector could provide innovative solutions in terms of financial infrastructure and products that will allow central banks to deepen the provision of public goods. For instance, in many countries, private entities have taken the lead in digitizing national ID numbers, which is an example of the private provision of apublic good.

6. Samuelson, Paul, The Pure Theory of Public Expenditure, Review of Economics and Statistics, 36, 387-9, 1954
7. ank for International Settlements, The future of money and the payment system: what role for central banks? Lecture by Agustín Carstens, General Manager at Princeton University, December 2019..

04. *Public-private partnership CBDC design approach is the preferable option.*

There are three CBDC design models: a public CBDC, a synthetic CBDC, and a public-private partnership CBDC. In a public CBDC, a central bank would be responsible for all aspects of the CBDC: issuance, distribution, compliance, customer service, anti-money laundering and countering the financing of terrorism (AML/CFT), and privacy. Central banks are not required to conduct all these activities now. This is why there is consensus in the international community that the public CBDC option is not preferred.

A second option is a synthetic CBDC. This option would involve a private entity issuing a CBDC which is backed by fiat currency and governing both the currency and technology aspects of it. Due to the control at the currency level, there is also a common understanding and consensus in the international community that this is undesirable. The third, and most preferred option involves dividing the aspects of a CBDC between public and private stakeholders in much the same way current two-tiered systems do.

Central banks would be responsible for the currency by governing and controlling the monetary aspect of a CBDC, while the private sector would lead efforts on the technological side by providing appropriate financial infrastructure and innovative end consumer products such as digital wallets[8] and remain responsible for applicable compliance obligations. Under this option, an open network could provide the infrastructure to build a CBDC giving the appropriate control and certainty of a centralized system but leveraging the possibility to innovate in a competitive environment as consumer needs evolve.

INNOVATION BY OTHERS: WHY SHOULD A CBDC BE BUILT ON AN OPEN BLOCKCHAIN?

05. *Open technology supports competition, resilience, and innovation.*

Blockchain technology[9] reduces the need for intermediaries and centralized processes in the offering of financial services. Decentralizing a system also limits the reliance on any one authority that increases risks due to internal reasons such as malfunctioning of part of the system or external reasons such as a cyberattack. Open blockchain networks provide the possibility to develop an ecosystem where regulators, policymakers, financial entities, developers, monetary policies, governance strategies, and reward systems all interact to foster innovation and competition.

8. Welcome remarks from Agustin Carstens, General Manager for the BIS, Jerome Powell, Chair of the United States Federal Reserve, and Jens Weidmann, Governor of the Bundesbank at the BIS Innovation Hub Summit of 2021.
9. For the purpose of this paper, blockchain technology means a method for keeping data synchronized across multiple, independent stakeholders. Where a traditional database may be perfect for tracking records for a single entity, blockchain allows a group of entities, regardless of their relationship or level of trust, to agree on and maintain a single dataset.

06. *Various degrees of decentralization are possible.*

The degrees of decentralization allowed by blockchain technology vary from open systems that are accessible to all users to closed systems where a limited consortium of users are able to read and/or write to a ledger. The Financial Stability Board (FSB) has highlighted that new forms of concentration risk may arise in permissioned decentralized systems since many activities (e.g. ownership of the assets, control over source code, operation of the infrastructure, crypto-assets mining, and code development) remain concentrated in a relatively small set of persons (e.g. software developers) or entities.[10]

Although the FSB highlights challenges of decentralized systems in terms of consumer and data protection, determination of legal liability, resolution and recovery of assets, it has also pointed out that the application of decentralized financial technologies – and the more decentralized financial system to which they may give rise – could benefit financial stability. It may also lead to greater competition and diversity in the financial system and reduce the systemic importance of some existing entities.[11]

***Table 1**: Comparison of centralized and closed/open decentralized systems.*

	Centralized (current payments infrastructure)	**Closed Decentralized** (e.g., Corda, Hyperledger Fabric, Quorum)	**Open Decentralized** (e.g., Stellar)
Innovation and competition (Efficiency and affordability)	**User Cost** remains high for merchants accepting retail payments and for remittances and B2B cross-border payments due to multiple intermediaries involved in a transaction, among other factors.	**User Cost** is determined by the system, and will be higher depending on the number of intermediaries involved in a single transaction.	Cost to move value on Stellar is near zero. Total **User Cost** would be determined based on whether there are fee-collecting intermediaries facilitating the cross-border transactions and if there is currency conversion cost beyond the blockchain portion.
	Settlement Speed – still a challenge in real-time retail payments and takes hours or days to settle cross-border payments	**Settlement Speed** – varies by network. Complete payment processing averages 5-10 seconds	**Settlement Speed** – varies by network. On Stellar, transactions are finalized in an average of 5-10 seconds

10 Financial Stability Board, Decentralised financial technologies. Report on financial stability, regulatory and governance implications, 2019; and FinTech and market structure in financial services: Market developments and potential financial stability implications, 2019, pp. 1, 4 and 17 for a discussion of the impact of technology on competition and financial stability.
11. Ibid

***Table 1**: Cont.*

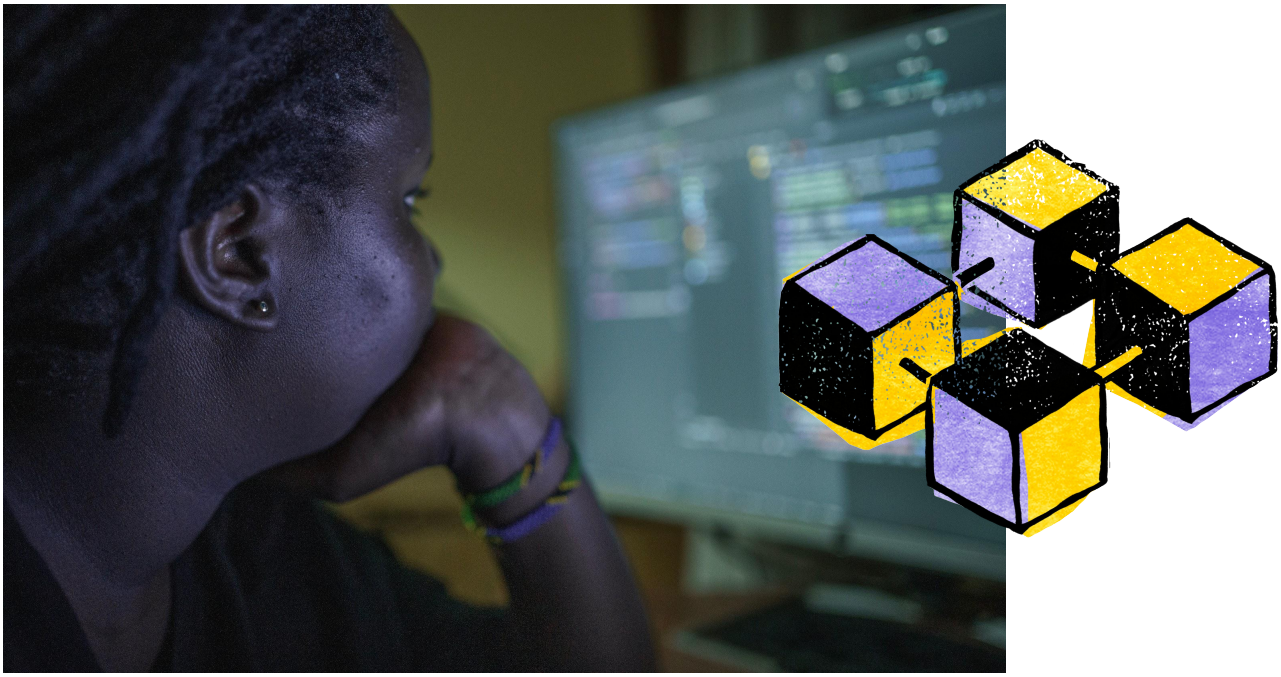
	Centralized (current payments infrastructure)	**Closed Decentralized** (e.g., Corda, Hyperledger Fabric, Quorum)	**Open Decentralized** (e.g., Stellar)
	Innovative solutions and entities still face challenges and barriers to competition	Need permission to be granted to build a product – precludes innovation and competition	Anyone can participate and build solutions on the Stellar network, which creates a free-entry market that enables innovation.
Interoperability	There are still challenges for innovative products (i.e. digital wallets) to connect with traditional financial services (i.e. bank accounts)	Usually referred to as closed systems. Challenges around integration	Financial services and products can connect with each other and with solutions designed in the current payment system
Resilience and security	Subject to higher risk of cybersecurity issues since information is concentrated in a single authority	A small section of a closed system can work together to modify the data stored within the network. In this way, the integrity of the network could be compromised	Open systems can be more resilient to cyber risk than highly centralized or closed decentralized systems, particularly in terms of the integrity of their record-keeping and service availability because there is no single point of failure
Sustainability	Energy consumption of Visa network amounts to 0.00092 kWh per transaction	No public information available	Varies – Preliminary results on energy consumption of the Stellar network amounts to 0.00022 kWh per transaction. This is significantly lower than other open networks such as Ethereum (107.75 kWh) or Bitcoin (1 575.93 kWh)[12]

12 Wanecek, Wilhelm, Estimating the electricity consumption of the Stellar payment network, Lund University, Department of Electrical and Information Technology, 2021; . https://lup.lub.lu.se/student papers/search/ publication/9059429.

***Table 1**: Cont.*

	Centralized (current payments infrastructure)	**Closed Decentralized** (e.g., Corda, Hyperledger Fabric, Quorum)	**Open Decentralized** (e.g., Stellar)
Programmability	Limited to direct debits or standing orders	Usually, smart contracts are used	AML/CFT, monetary policy tools, emergency cash transfer relief, MSME lending features, payments to specific individuals, among others

A recent Financial Stability Board report points out that decentralized financial technologies and systems could improve financial stability.



07. *An open network allows for innovation and competition which fosters financial inclusion.*

Anyone can participate and build applications in an open network, which creates a free-entry market that enables competition.[13] Furthermore, rules are set and maintained by the validators of the system, not by a coalition of companies or other large market participants, which guards against entrenched forces driving out competition. For example, the European Central Bank has considered that offline private payments would be an attractive feature that the Eurosystem could provide, mirroring services that could be offered by some stablecoin issuers and wallet providers.[14]

An open system would incentivize the development of offline and restricted or limited connectivity solutions by financial entities and developers in a competitive and secure environment. Anyone with a standard computer could create offline, or restricted or limited connectivity tools that could then be integrated and offered to consumers. Therefore, an open network could be the best approach for achieving availability and fostering a competitive environment, which is aligned with Principles 5, 9, and 10 of the G7 Public Policy Principles for Retail Central Bank Digital Currencies.[15] More importantly, an open network fosters financial inclusion by allowing innovation and competition, which improves welfare and boosts economic participation

08. *An open system could strengthen interoperability and interoperability between CBDCs, non-CBDC tools, and any other currency.*

An open system could provide instant real-time payments in central bank money, so payees (including merchants) could receive funds instantly. The core ledger could be built with relatively simple functionality, so that it would be as efficient and cost-effective as possible, expanding the offering of financial services. It could also ensure that any CBDC account would be able to pay any other CBDC account, regardless of the financial entity associated with each account, allowing for interoperability. These solutions and products can be built on an open system to enable a CBDC to meet payment needs as they evolve. This design model is what the Bank of England referred to as the 'platform model'.[16] A CBDC should also be interoperable with other currencies for the purpose of cross-border payments.

13 When one role in a distributed system may be played by many independent authorities, each serving only a small subset of the total user population, trust is dispersed among these authorities. The dispersal of a nation's governmental powers across many regional and local governments, each having jurisdiction mainly only over its own residents and territorial domains, is a classic pre-digital example of this form of decentralization. For further details on this, please see: The Brookings Institution, Design choices for Central Bank Digital Currency, Policy and Technical Considerations, 2020.
14 European Central Bank, Report on a digital euro, 2020.
15 G7, Public Policy Principles for Retail Central Bank Digital Currencies, October 2021.
16. Ibid

Specifically on cross-border payments, the Bank of Japan has pointed out that in considering a CBDC, it is also desirable to ensure that it could be used for transferring funds across countries - not only for domestic payments - while thoroughly monitoring developments in each central bank, in order to respond flexibly to developments in relation to interoperability.[17] Central banks are also working together on initiatives to make cross-border payments more efficient.[18]

These initiatives are relevant to minimize the risk that the implementation of CBDCs utilizing different networks would not address the affordability element due to the need for several intermediaries to process, settle, and clear transactions across borders. Open networks enable cross-border payments including remittances and business-to-business payments that finalize in seconds and cost fractions of a cent, mainly due to the reduction of intermediation. Open networks also enable financial services and products built on them to connect with each other and with solutions designed in the current payment system.

17 Bank of Japan, The Bank of Japan's Approach to Central Bank Digital Currency, 2021.
18 The Bank of Thailand (BOT) and the Hong Kong Monetary Authority (HKMA) have explored the application of blockchain to increase efficiency in cross-border funds transfers in . In addition, the BOT and the Monetary Authority of Singapore have worked to promote cross-border payments through a mobile phone across countries; . project Inthanon-LionRock https://www.mas.gov.sg/news/media-releases/2021/singapore-and-thailand-launchworlds-first-linkage-of-real-time-payment-systems

INTERNET AND OPEN BANKING REGIMES AS AN EXAMPLES OF INTEROPERABILITY

There is a common understanding of the relevance of the power of systems built on common infrastructure: the internet is common infrastructure that has made information and data more interoperable than ever before. Money and payments, in contrast, remain siloed, largely operating on disconnected systems. Issuing money on common infrastructure has the potential to make sending money almost as easy as sending an email. Open banking is a further example of the interoperability between entities in terms of data sharing. It could be deemed as the first step for the responsible use and sharing of data to expand the access to financial services. Making further information available allows the development of a more diverse financial services ecosystem for consumers and MSMEs.

Open banking offers many advantages for people with low incomes. If properly structured and with the right market conditions, the exchange of data that results from open banking supports financial resilience and financial inclusion in several ways. The international experience evidences that open banking benefits customers who would own and have control of their data. Open banking is progressing in Australia, United Kingdom, Canada, Mexico, and Brazil, among other countries. This could then be expanded to utilities and telecommunication companies, among others, expanding the scope of open banking to what is referred to as open data: financial data supplied from a wide spectrum of sources.

The open nature of common infrastructure means anyone who wants to can connect to it and innovate. While this provides exciting opportunities for financial inclusion and innovation, it also creates concerns around the ability to keep the asset safe and reliable that must be addressed. As central banks around the world consider CBDCs, they are grappling with how to get comfortable that an asset issued on an open network can be safe and secure enough.[19]

19 For further detail on how Stellar provides safety and security, please see: Stellar Development Foundation, Stellar for CBDC, 2021

09. *An open network for a robust and resilient infrastructure.*

CBDC could enhance financial stability by contributing to resilience in payments and providing core payment services outside of the commercial banking system. By providing a complementary way to make payments, it would diversify the range of payment options, particularly for e-commerce (where cash cannot be used). The structure of the CBDC ecosystem could also be designed to avoid some of the vulnerabilities in payment systems that have evolved over time, complementing ongoing work to enhance resilience in existing payment systems. Differences in geographical locations, and approaches to implementation can create more diversity in the system as a whole, which means that problems that affect one type of hardware, or one software version, are unlikely to affect all parts of the network simultaneously.[20]

10. *Open systems bring security.*

The use of decentralized financial technologies may also decrease the nature and significance of operational risks. Decentralized systems may – if appropriately secured – be more resilient to cyber risk than highly centralized systems, particularly in terms of the integrity of their record-keeping and service availability. This is due to how they distribute the recording of information, rather than concentrating it within a single node or system. Furthermore, the use of multi-party consensus could make a system more secure against attackers that are attempting to manipulate data, for example to steal funds.[21] This is aligned with Principle 4 of the G7 Public Policy Principles for Retail Central Bank Digital Currencies.[22]

11. *Enabling programmable money.*

Blockchain provides the possibility of creating 'programmable money' as highlighted in a recent report by the Bank of England.[23] An example would be automatically initiated payments on the confirmed receipt of goods, or routing tax payments directly to the tax authorities at point of sale. Several central banks have expressed their support for programmability. The People's Bank of China stated that under the premise of security and compliance, this feature enables self-executing payments according to predefined conditions or terms agreed between two sides, so as to facilitate business model innovation.[24] The Bank of Canada said the ability to

20. Bank of England, Discussion Paper: Central Bank Digital Currency, March 2020
21.Bank of England, Discussion Paper: Central Bank Digital Currency, March 2020.
22. G7, Public Policy Principles for Retail Central Bank Digital Currencies, October 2021.
23 Bank of England, Discussion Paper: Central Bank Digital Currency, March 2020.
24 People Bank of China, Progress of Research & Development of E-CNY in China, 2021. .

implement the complex logic of programmability is quite limited with today's payment arrangements and infrastructure. Traditional payment systems do not have the technical capability to integrate this function into payment processes. Direct debits or standing orders can carry out simple forms of programmable payments; however, these existing instruments are very limited in terms of use cases. Innovative solutions are therefore needed to execute on the value of these new use cases.[25]

Programmability v. smart contracts

Smart contracts are computer programs that can automatically execute an agreement based on programmed logic. The concept of integrating technology and legal contracts dates back to the 1950s when scholars built computational methods that could enforce legal rules without involving traditional legal processes. Smart contracts were formally defined by Nick Szabo in 1997: Smart contracts combine protocols with user interfaces to formalize and secure relationships over computer networks. Objectives and principles for the design of these systems are derived from legal principles, economic theory, and theories of reliable and secure protocols. In recent years, blockchain technology has enabled a new breed of smart contracts with immutable storage of agreement terms, cryptographic authorization, and integrated transfers of value. For some open networks (such as Stellar), programmability is achieved without the use of smart contracts. Stellar is purposebuilt for payments and has programmability built in for payment related and token issuance use cases. Programmability is expressed as compositions of transactions that are connected and executed using various constraints. The following are examples of programmability that can be considered and implemented on Stellar:

A. AML/CFT related features: A retail CBDC could be programmed to prevent the execution of transactions with sanctioned parties, or automatically report transactions that meet certain regulatory criteria, such as amount thresholds, association with 'dark web' activity, and other red flags. The programmable nature allows a flexible balancing of AML / CFT requirements, privacy protections, and cybersecurity controls with more sophistication than currently possible.

B. Monetary policy tools: A feature could be programmed to encourage saving or spending in inflation sensitive economies. For instance, a fee could be imposed in the event that money is spent in a certain timeframe or with a specific purpose. Similarly, a fee could be applied to positive balances after some time the account is idle, for example one year, to encourage spending. These could complement the current monetary policy tools that central banks usually utilize such as the possibility to change interest rates. These further programmable monetary policy mechanisms could be built in an open system and could act as incentives to boost economies.

25 Bank of Canada, The Positive Case for a CBDC, 2021.

C. Emergency cash transfer relief: A feature that would allow stimulus payments to targeted groups in order to boost local economies or specific sectors - e.g. tourism. This feature could support the covid-19 recovery of advanced and emerging economies, or disaster relief use cases, and could foster transparency as well.

D. MSME lending: A feature that provides a small amount of recurring lending based on a user's credit history and other relevant parameters. This could be targeted to MSMEs and could potentially be a tool to expand access to credit.

12. *An open system to create truly token-based money (cash-like design).*

Two main models to consider for design of CBDCs are token-based or account-based. With truly token-based money, a cashlike[26] design, individual users access the CBDC based on a password-like digital signature using private-public key cryptography, without requiring personal identification. On the other hand, an account-based model is built on verifying users' identity when using a CBDC such as it occurs now when using the payments card network, e-money, or a bank account.

The design choice is intimately tied to broader policy debates on data governance and privacy.2[7] Under a token-based money approach, CBDC would be treated exactly like physical cash, providing households and businesses with a new form of central bank money and a new way to make payments.[28] It could ensure that the public has continued access to a low-risk form of money issued by the central bank, which may be especially important in the future as cash use declines and new forms of privately issued money become more widely used in payments. In line with this thinking, the European Central Bank has pointed out that ideally, a CBDC should allow citizens to continue to make their payments much as they do today with cash.[29]

26. Cash means physical banknotes (issued by a central bank) and coins.
27 Bank for International Settlements, The technology of retail central bank digital currency, March 2020.
28 Mark Carney's foreword on Bank of England, Discussion Paper: Central Bank Digital Currency, March 2020.
29 European Central Bank, Report on a digital euro, 2020.

13. *Using an open network, the CBDC remains under central bank monetary control, but anyone can join and participate in the system.*

In a centralized or semi-centralized ledger design, a small number of servers is usually sufficient. This small number is relatively easy to coordinate and to achieve good performance. However, in a fully or semi-centralized design in which the choice of validators and their operation are all under direct control of one authority such as the central bank itself, that authority – or a malicious insider- can potentially change the rules at will, roll back system state or rewrite history, and censor or delay transactions.

Using an open network, the CBDC is under centralized monetary control (central banks would manage the currency they issued and the programmability rules they created), but anyone can join and participate in the system. Although validators can still change the system rules or "fork", attacking the CBDC would mean compromising the validators of some number of reputable entities chosen by the central bank as a validator, which would be very difficult given their sophistication and scale.

Open networks have also demonstrated unprecedented robustness and can have the ability to issue digital currencies with a feature enabling a "clawback" or reversal of transactions in case of fraud or errors.

The possibility to clawback a transaction Revoking authorization of access to an asset gives important controls to an issuer, but it is very important as well that a network provides the possibility for an issuer to recover funds that were used in a fraudulent transaction. An asset such as a CBDC can also be issued with a clawback flag on Stellar. When this flag is enabled, the issuer can recover or "clawback" the asset that was fraudulently obtained.

This flag is not just useful in circumstances of fraud, but can also be useful to help an identity-proven person to recover an asset after theft or the loss of a private key. Asset holders are clearly made aware of the designation when they use the asset, and the flag cannot be applied retroactively. For further details about how the clawback feature works on Stellar, please see Stellar for CBDCs (https://resources.stellar.org/stellar-for-cbdcs)

POLICY AND REGULATORY CONSIDERATIONS

14. *AML and CFT: Blockchain analytics.*

An effective way for open networks to ensure compliance with AML and CFT is to require that regulated financial entities integrated with their network conduct the appropriate customer due diligence and KYC requirements. A further useful tool to identify behavior patterns on the network is the use of blockchain analytics. Blockchains offer a granular view of information to authorities who can cross-reference transaction data with confidential investigative and intelligence information to more effectively identify, disrupt, and dismantle illicit financial networks. This could also be complemented with programmability.

The European Commission through the EU Blockchain Observatory and Forum highlighted that a digital euro could be programmed to prevent the execution of transactions with sanctioned parties, or automatically report transactions that meet certain regulatory criteria, such as monetary thresholds, association with 'dark web' activity, and other red flags. The programmable nature of an open network permits a more nuanced and flexible balancing of AML and CFT requirements, privacy protections, and cybersecurity controls than currently possible. It would also permit a more efficient allocation of resources to combat illicit financial activity.

Law enforcement authorities and regulators would no longer have to expend scarce resources ensuring regulatory compliance that would be better spent directly detecting, investigating, and preventing illicit financial activity. Governments would no longer have to spend constrained budgets re-analyzing noisy data and could instead redeploy their resources to directly analyzing blockchain data to more effectively detect illicit financial activity, prosecute illicit actors, forfeit illicit proceeds, and dismantle illicit financial networks. [30]

15. *Sustainability.*

The technological design choice of the issuance of a retail CBDC should also consider sustainability. The EC has highlighted that the design of the digital euro should be based on technological solutions that minimize its ecological footprint and improve that of the current payments ecosystem.[31] The energy consumption across blockchains vary based on the asset issuance and governance models that are used. For example, preliminary results on energy consumption of the Stellar network were published in 2021.[32]

30 EU Blockchain Observatory and Forum, Central Bank Digital Currencies and a Euro for the Future, 2021
31 Ibid.
32 Wanecek, Wilhelm, Estimating the electricity consumption of the Stellar payment network, Lund University, Department of Electrical and Information Technology, 2021;
. http://lup.lub.lu.se/student-papers/ record/9059429.

The study aimed to obtain a generalized estimate of the electricity consumption of the Stellar network. The generalized estimate of the electricity required for a single transaction amounts to 0.222 Wh, which turns out to be less than that of Bitcoin by a factor of 10^7, and similar to that of VISA. This is aligned with the Principle 8 of the G7 Public Policy Principles for Retail Central Bank Digital Currencies.[33]

Table 2: Comparison of electricity consumption per transaction between Bitcoin, Ethereum, VISA and the corresponding value derived for the Stellar network.

System	*Electricity Consumption Per Transaction*	
Bitcoin	1575.93	kWh
Ethereum	107.75	kWh
Visa	0.00092	kWh
Stellar	0.00022	kWh

16. *Open decentralized approaches to privacy protection allow a middle ground between transparency and privacy, and foster trust dispersal.*

The design of blockchain technology offers a number of options to address privacy for users and transparency for regulatory authorities. One feasible option is to design a CBDC in a way that transactions are transparent and fully visible to authorities – central banks, anti-money laundering regulators, tax collection authorities, and others. On the other extreme, a CBDC could be designed providing full privacy replicating the structure of a cash transaction today. A balance between these two approaches should be struck. CBDC could be designed to protect privacy and give users control over who they share data with, even if CBDC transactions are not truly anonymous or secret.

For example, a user may legitimately want to make a payment to a supermarket without sharing their identity, as this would allow the supermarket to build a picture of their shopping habits. Open networks provide the possibility for all personally identifiable information to be stored in a private database that only the financial entities building solutions and offering financial services, such as commercial banks or digital wallets, or external KYC providers could access.

This is the same model that traditional banks use, and is well proven Access is configurable in order to provide further intermediaries permission to access information related to the portion

33 G7, Public Policy Principles for Retail Central Bank Digital Currencies, October 2021.

of the program that they administer. What is public? Transactional data on balances and payment amounts are public, but they are not associated with names or any other identifying information. Having access to this publicly available data would allow central banks to analyse insights to mitigate AML and CFT risks and for monetary policy and macroeconomic purposes.

17. Implications for monetary policy.

Policymakers and regulators are debating whether a CBDC could be remunerated.[34] This would be a further feature that could be programmed on an open network. A remunerated CBDC, which would be a closer substitute for bank deposits, could lead to faster and fuller transmission of monetary policy to deposit rates. The rate paid on a remunerated CBDC could set the lower limit of the return households and businesses were prepared to accept on their money holdings.

A remunerated CBDC would also mean the public received interest on their CBDC balances. This would increase the proportion of money linked directly to monetary policy choices, and have an impact on the monetary transmission mechanism. As interest rates change, the effect on the interest income received by deposit and CBDC holders would be more pronounced (an effect known as the 'cash-flow' channel). Ultimately, the impact would depend on the relative changes to interest rates on both saving and borrowing.

On the other hand, remuneration increases the potential for greater disintermediation of the banking system by increasing the incentive for households and businesses to shift larger amounts of money into CBDC.[35] In addition, an open blockchain allows central banks to understand how money is being used by analyzing transactional data. This would permit policymakers and central bankers to design monetary policy tools accordingly.

18. Legal authority to issue a CBDC.

The issuance of a retail CBDC would generally involve adapting the legal and regulatory framework to ensure all the aspects of a retail CBDC are covered. The Riksbank has highlighted that the question of digital central bank money being available to the general public is relatively new and has only become relevant in recent years, both in Sweden and abroad. Therefore, neither legislation nor any advisory examples exist in this field.

Issuing an e-krona would most probably require some new legislation, regardless of the model, design and technical solution used.[36] The European Central Bank also concluded that legal risks could arise if there was uncertainty about the legal basis for issuing the digital euro.[37]

34 The Bank of England and the EUC, among others, have assessed the implications of a remunerated CBDC; Bank of England, , March 2020, and European Central Bank, Discussion Paper: Central Bank Digital Currency Report on a digital euro, 2020
35 Bank of England, Discussion Paper: Central Bank Digital Currency, March 2020.
36. Riksbank,e-krona pilot phase 1 , 2021
37. European Central Bank, Report on a digital Euro, 2020.

Ukraine: Authority granted to the National Bank of Ukraine to issue a national digital currency

A challenge for the development of a CBDC is whether the central bank has the authority to issue it. The National Bank of Ukraine has been exploring the issuance of a national digital currency for the last few years. The Ukrainian parliament passed legislation formally authorizing the National Bank of Ukraine to issue a national digital currency. A draft law legalizing and regulating virtual assets like tokens, including the possibility by the National Bank of Ukraine to issue a national digital currency, passed parliament in September 2021.

CONCLUSION

Digitization has transformed the way that individuals and MSMEs access and use financial services. It brings benefits such as affordability, efficiency, and financial inclusion but it also comes with challenges in terms of data protection, AML, financial and digital literacy, and access to infrastructure. Our current monetary system is founded on sustaining trust in the currency. Trusted money, such as bank notes and coins issued by a central bank, is a public good. Digitization makes the issuance of money through a CBDC possible, which could be deemed as a central bank public good.

The role of the private sector is to provide innovative solutions in terms of financial infrastructure and products that will allow central banks to deepen the provision of public goods. There are many benefits for a CBDC to be built on an open system with asset control capabilities for issuers such as Stellar. Open technology supports competition, resiliency, and innovation. An open system allows for the development of new financial services and products for the benefit of all, even as consumer needs and the market evolve.

An open network fosters the 'innovation by others' approach that provides the appropriate infrastructure for the design of tools and solutions with a customer-centric approach. An open system could strengthen interoperability and interoperability between CBDCs, non-CBDC tools, and any other currencies, allowing for faster, more efficient payments and extensible capability, such as the internet and open banking regimes have done in the past.

An open network brings security by minimizing the risk of cyber attack. It also enables programmable money for emergency cash transfers, relief programs, and AML/CFT, among others. Some open systems have also proven to be sustainable in terms of energy consumption.

Open networks also allow central banks to understand how money is being used by analyzing transactional data for monetary policy. Finally, in an open design, the CBDC is under centralized monetary control, with the currency owned by central banks, but anyone can join and participate in a safe, robust, and secure system. Even more importantly, a CBDC could play an important role in expanding the access and usage of central bank money.

An open system allows for the issuance of a CBDC in a secure, transparent, innovative, and competitive environment. This promotes financial inclusion, improves welfare, and boosts job creation and economic participation, both for individuals and MSMEs, such as the Caffè Pasticceria run by Angelo and Antonietta in Italy, and the myriad of other small businesses with similar challenges around the world.