



Implementing a CBDC: Lessons Learnt and Key Insights Policy Report

Central Bank Digital Currencies
Working Group (CBDC WG)

October 2020

CEMLA FINTECH FORUM

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Central Bank Digital Currencies Working Group (CBDC WG)

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| | |
|-------------|----------------------------------------|
| Chairman | Jorge Ponce, Banco Central del Uruguay |
| Secretariat | Raúl Morales Reséndiz, CEMLA |

Members

| | |
|-------------------------------------------|-------------------|
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| | Björn Segendorff |
| Banco Central del Uruguay | Pablo Picardo |

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1. Introduction

In 2018, at the moment of launching the CEMLA Fintech Forum¹, general-purpose or retail Central Bank Digital Currency (CBDC) was not a top priority for central banks. Yet, the interest in better understanding their potential and implications led the Forum's members to set a task force to study the foundations and general features of CBDCs with very little experience at hand, by that time. Since then, several central banks are testing prototypes and others are keen on learning from the experience of their peers with retail CBDC, worldwide. Today, introducing a CBDC continue to be not in the highest consideration for many central banks, but its usefulness could not be discarded in several likely scenarios. For instance, events like the COVID-19 pandemic and the emergence of Global Stablecoins proposals like Libra by Facebook could imply opportunities for retail CBDC to gain traction.

While central banks from Ecuador, Uruguay and Ukraine already completed pilots² pondering design and technology with different approaches to meet their own institutional priorities, the list of central banks launching a retail CBDC pilot has nothing but increased over the last year. Central banks from Bahamas, China, Eastern Caribbean Currency Union, Korea, South Africa and Sweden are running or are closer to launch a pilot. Moreover, central banks from Brazil, Canada, Chile and Jamaica have recently established internal multidisciplinary groups to approach the subject with finer eyes. In all cases, a thorough and cautious analysis has taken place before embarking in an implementation/testing plan, especially as regards the motivations and the operationalization of such a project. In some cases, gaps in domestic payments infrastructure and financial inclusion goals served as policy majors. In other cases, the awareness of an economy becoming digital has pushed central banks to learn by doing with retail CBDC. In addition, retail CBDC has become fertile soil to test whether decentralized ledgers and new technologies could streamline traditional payment systems handled by central banks³ and the financial industry.

Against this backdrop, the Central Bank Digital Currencies Working Group (CBDC WG), made of ten central banks' experts, agreed on a Peer Review of CBDC pilots in Latin America and the Caribbean⁴ to draw lessons on what the technology and implementation plan implies when rehearsing a CBDC system in a controlled environment. The Peer Review is intended to go beyond public material, e.g. white papers, of the different CBDC projects, including the expert judgment of CBDC WG members.

¹ The Fintech Forum is an international initiative launched by CEMLA with the special collaboration of Banco de España, and it comprises 19 national central banks from Latin America and the Caribbean (including Spain). Further information of the mandate of the Forum can be found at: <https://www.cemla.org/fintech/english.html>.

² The Central Bank of Ecuador launched a retail CBDC project named BCE Dinero Electronico between 2014 and 2017. The Central Bank of Uruguay launched the e-Peso project between 2018 and 2019. The Central Bank of Ukraine launched the "e-hryvnia" project between 2016 and 2019.

³ As an example, the Bank of England recently published a policy paper discussing the opportunities and challenges of a retail CBDC just after a couple of years of a major reform of their RTGS system.

⁴ The Peer Review also comprised a special collaboration with the Sveriges Riksbank to Peer Review the e-Krona project.

This report summarizes the main findings of the Peer Review of pilots in Bahamas, Sweden and Uruguay. It is focused on lessons drawn with the expert judgment of CBDC WG members on retail CBDC pilots, especially in aspects of design (technological) and implementation (operational). The Peer Review carried out by the CBDC WG delivers several useful insights and lessons that are contained in this report. However, the results are limited to selected experiences from many around the world, like the Digital Currency Electronic Payment (DC/EP) in China. Hence, several aspects would need more research and empirical evidence. Moreover, design, operation and implementation options are unique in each project and thus the lessons learnt by the CBDC WG are a guiding reference but are not intended to serve as an universal approach.

It can be highlighted that, as a common feature, retail CBDC has been motivated and driven by a payments agenda explained by the need to: 1) improve contestability in retail payments system, and 2) to provide an alternative⁵ means of payments backed by the central bank⁶ with cash and safety properties in digital form. As such, one should expect retail CBDC to be convenient, resilient, widely accessible and interoperable, affordable and friendly. Moreover, it should allow for effective law enforcement, anonymity and consumer protection (BIS, 2020; Garratt and van Oordt, 2020). Furthermore, in emerging and developing economies (EMDE) like the Latin American and Caribbean countries, retail CBDC is regarded as a central bank policy to build an inclusive ecosystem responding to considerable gaps in financial access.

Relatedly, the CBDC WG found that the introduction of a CBDC would serve to strengthen the payment and financial systems relying on a balanced two-tier structure. This balance refers to an effective cooperation among central banks, payment service providers (PSP) and other related parties, to deploy digital fiat money as a means of payment, and to ensure that infrastructure gaps can be overcome without hampering competitive innovation by PSP when offering overlay services.

The potential of a retail CBDC to either, becoming a leading instrument in the retail payments system or provoking unintended consequences on (des)intermediation, competition and stability, requires deeper scrutiny and better understanding. The CBDC WG aims at contributing in this respect with an in-depth exploration of what has been done to design and test a retail CBDC pilot. For instance, to find out whether central banks can effectively design a CBDC in such a way that unintended consequences are circumvented or to detect if operationally, central banks would be ready to deploy a retail CBDC system on their own or in joint venture with relevant stakeholders.

The report contains a survey of recent academic and policy literature addressing relevant aspects of retail CBDC. The report also comprises a detailed examination of the CBDC Peer Review results and it provides a summary of lessons learnt and insights for central banks' policy makers. Section 2 outlines selected issues of retail CBDC that are discussed in relevant literature, to support the findings

⁵ In advanced economies like Sweden, retail CBDC are also designed as a central bank response to a situation in which payment means under use are mostly provided by the private sector and practically no public safe choice of fiat money is available for the population.

⁶ In practice, digital central bank money for wholesale users is offered by central banks through central bank reserves and Real-Time Gross Settlement (RTGS) systems.

of the CBDC WG. Section 3 introduces the Peer Review methodology and presents a summary report for each retail CBDC case. Section 4 discusses the lessons learnt and unexplored dimensions in the CBDC cases under study, emphasizing technology and implementation aspects from a policy perspective. Section 5 outlines conclusions that the CBDC WG found relevant to stress out for the consideration of the Latin American and Caribbean Central Banks' Governors. The full country reports of the Peer Review are found in the annex.

2. A retail CBDC framework

In its 2019 Policy Report⁷, the CBDC WG outlines that central banks projects analyzing the feasibility of retail CBDC had in common the following features:

- 1) CBDC could serve as a public⁸ supplement payment means similar to cash but in digital form to be widely accessible;
- 2) CBDC design may comprise a public-private ecosystem supporting 24x7 availability and interoperable scope with other retail payment systems; and,
- 3) CBDC implementation relies heavily on technology and operational capacity at central banks, which imply an adequate internal assessment to fulfill and share this new form of (digital) money.

Since this report was released, the number of policy and academic works around retail CBDC has helped to better understand design aspects relating to its potential implications for payments, monetary and financial domains. The following subsections aims at summarizing the most relevant policy and conceptual developments that underpin the CBDC WG analytical framework for retail CBDC.

2.1 Foundations for retail CBDC

The international financial community, the academia and other relevant parties are increasingly working toward a CBDC analytical framework from an economic viewpoint, namely as a new form of (fiat) money. Filling this gap is relevant as it will lay the foundations to support policymaking for digital fiat money, just as experimentation is an important contribution.

Several authors⁹ discuss the complex relationship between cooperation and competition of the central bank and private payment service providers in the implementation and acceptance of CBDC services. For instance, in Adrian and Mancini-Griffoli (2019), cash and bank deposits compete with

⁷ The report provides an analytical framework to assess key CBDC features, namely, motivation, design, launching and expected effects; see <https://www.cemla.org/fintech/docs/2019-06-KeyAspectsAroundBankDigitalCurrencies.pdf>.

⁸ It was specifically noticed that the alternative of a “free-of-risk” payment means, could be a task for central banks to be fulfilled.

⁹ Adrian and Mancini-Griffoli (2019), Auer and Bhöme (2020), Bech and Garrat, Bindseil (2020), Brunermeier et.al. (2019), Dyson and Hodgson (2017), Kahn et.al. (2018), Kiff et.al. (2020), Kumhof and Noone (2019), among others.

new digital forms of money, mainly e-money and a synthetic retail CBDC. Such forms of money differ from retail CBDC given they are claims not issued by a central bank, but are fiat pegged. E-money developments took place in early 2000's¹⁰, but Adrian and Mancini-Grifolli argue that e-money services providers, as other payment service providers (PSP) could have access to central bank reserves, though under strict conditions, to issue a "synthetic CBDC".

Auer and Bohme (2020) discuss the definition of retail CBDC from three angles. They consider retail CBDC where the central bank is the sole issuer and service provider with no intervention of PSP to support the rolling out. While this model is unlikely in practice, they suggest two similar models, indirect- and hybrid- retail CBDC which main differences relates to the structure of the legal claim, and main common feature is the establishment of a two-tiered system in which core issuing functions remains at central bank and deployment and usability is fostered by authorized PSP. Two-tiered systems are not new in payments and it is worth noting that retail CBDC design choices could led to multiple results in how such system works. It can be underscored that in such a division of work, it is foreseeable to have coexistence (i.e. an ecosystem) of public and private stakeholders where legal definitions on the backstopping of money holdings will yield the most significant differences from one model to another, including whether they can be named retail CBDC.

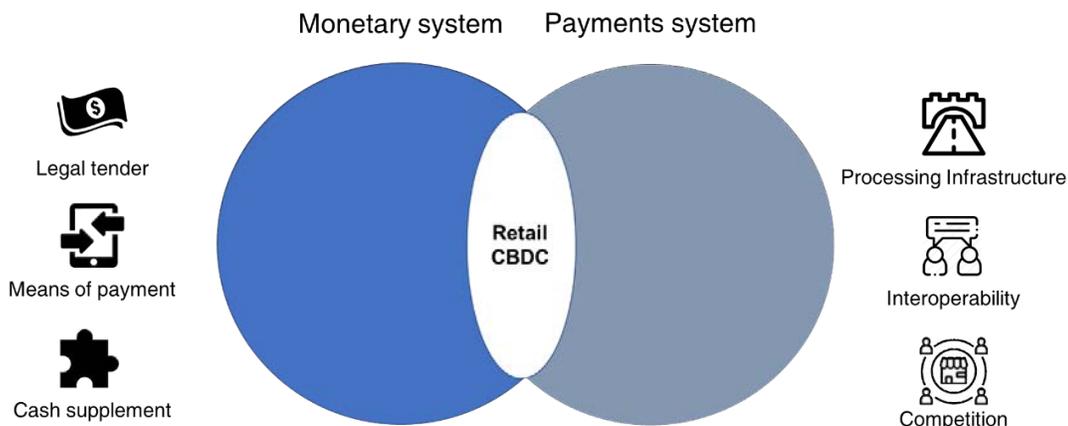
Relatedly, Ayuso and Conesa (2020) contribute by showing that behind retail CBDC the most relevant aspects to consider are: 1) how central bank digital money can be widely available (like cash), and 2) how necessary is the engagement of private sector (PSP) to roll out digital cash.

The CBDC WG proposes a definition of retail CBDC involving two key features of money and payments, respectively. On the money side, retail CBDC is a digital representation of fiat money¹¹. On the payments side, a retail CBDC relies on a supporting infrastructure.

¹⁰ E-money solutions have been available since early 2000's, but they increased the attention of policymakers worldwide after 2007, when the M-Pesa model gained a space as a mean of payment in Africa. A similar phenomenon took place in Latin America and the Caribbean with Tigo Money that started to operate around ten years ago in Central American countries and few South American jurisdictions. Both shared a common feature, they were not initially licensed or regulated by central banks but were rapidly adopted by a population lacking adequate retail payments infrastructure, leading the central bank and financial authorities to work toward a regulatory framework. In other words, they became to what Adrian and Mancini-Grifolli (2019) denominated b-money, but without serving as traditional bank accounts.

¹¹ Kiff et al. (2020) coincide in underlining the importance of having a monetary authority issuing retail CBDC as a claim hold by the public.

Figure 1: Retail CBDC foundations



Source: Own elaboration based on Bank of England (2019)¹².

An important aspect to stress out is that in a retail CBDC either hybrid, synthetic or the like, central banks must work to design a system that consistently ensures the confidence in central bank and fiat money and a reliable and robust operational architecture independently on design choices, whereas PSP attain financial regulation to achieve their trustworthiness. In effect, the design and related attributes of a CBDC compared to other existing forms of money continue to be one of the most relevant issues under debate by the international community. Therefore, an approach like the one explained above might consolidate as a viable avenue to continue exploring this new form of fiat money.

2.2 Risks and opportunities with retail CBDC

Central banks can help improving payment services by safeguarding the well-functioning of domestic payments infrastructure as operators, overseers and catalyzers.¹³ Moreover, central banks are well positioned to overcome coordination problems found in the retail payments system by introducing retail CBDC, as discussed in Ponce (2020). Network effects in retail payments have now become vital in a digital environment for payments and money, thus unveiling the need for public intervention. Nowadays, a number of central banks are considering issuance of retail CBDC as a complementary mean of payment to address (retail) payments market shortcomings.

¹² Recently, the Bank of England (BoE) presented a conceptual platform model of retail CBDC designed to enable households and businesses to make payments and store value. In the proposed 'platform' model, the BoE would provide a fast, highly secure and resilient technology infrastructure, which could sit alongside the Bank's Real-Time Gross Settlement (RTGS) system, and provide the minimum necessary functionality for retail CBDC payments. This could serve as the platform to which private sector, namely PSP, would connect in order to provide customer-facing CBDC payment services. In this platform model, PSP could also build overlay services –additional functionality that is not part of the Bank's core infrastructure, but which might be provided as a value-added service for some or all of their users.

¹³ BIS, 2020.

Retail CBDC presents both opportunities and challenges. Central banks around the world are exploring the concept of general purpose CBDC, even if there is no decision on whether to introduce it.¹⁴ Moreover, crypto-assets¹⁵ and Global Stablecoins (GSC) are also relatively recent initiatives from the private sector of digital money drawing significant attention but lacking a regulatory acknowledgement as a means of payment. In effect, GSC have reinforced the interest from the international central banking community to ensure public provision of payment means are available worldwide, impeding that non-regulated store of value claims replaced fiat money, especially in EMDE. Retail CBDC are thus a central bank initiative combining both, the digital nature of regulated and unregulated digital monies, and more importantly the trust and institutional support of a monetary authority that, if well designed, could fill gaps relative to population's payment needs without hampering financial intermediation.

As a matter of fact, the COVID-19 pandemic accelerated the interest in retail CBDC as a potential contingency tool to deploy public resources to households and businesses. Amid this context, it became evident that having a universal widely accessible payment means like digital cash, could be useful in many circumstances during an economic lockdown. According to the previous CBDC WG' report, a successful retail CBDC would need to provide a resilient and inclusive digital complement to physical cash. As such, a CBDC must have all the features and more that make cash so attractive. The basic elements are trust in the issuing entity, legal tender status, guaranteed real-time finality and wide availability. But a CBDC must also be equivalent to cash in other dimensions like being user-friendly, be highly resilient to infrastructure outages and cyber-attacks and guarantee the safety and integrity of payments. As per the 2020 BIS Quarterly report, the bar for a CBDC technical design is high.

Ayuso and Conesa (2020) argue that although some central banks consider issuing CBDC to address domestic issues, it is worth mentioning that CBDC is not the only solution to many of them. Policy choices are available, including fast payments, regulatory changes to enable fintech companies to fill the gaps, or to just "laissez-faire" the retail payments market. The existence of alternatives therefore requires considering retail CBDC ability to overcome an eventual problem, and also its degree of effectiveness against other alternative policy choices. Adrian and Mancini-Grifolli (2019) argue that the impact of introducing a retail CBDC would hinge on its design and country-specific characteristics, and more importantly, its adoption will not necessarily be very high and will depend on the attractiveness of alternative forms of money. They, and many others, also argue that there are other payment solutions to help central banks achieving their payments and money goals.

As it is explained in Section 4, retail CBDC pilots should be designed and implemented with an in-depth analysis of the operational architecture that would better perform to achieve the expected cash-like features. In sum, it is still too early to draw conclusions on the net benefits and costs of

¹⁴ For instance, some major central banks like the Bank of England (BoE) and the Federal Reserve System are in this group.

¹⁵ A crypto-assets can be broadly defined as a private assets issued digitally using cryptographic technology. Some crypto-assets, besides being subject as a medium of exchange on exchanges and trading platforms, but lack the features of unit of account and centra bank stopping.

According to the FSB, a Global Stablecoin comprises an arrangement that combines a range of functions (and the related specific activities) to provide an instrument that purports to be used as a means of payment and/or store of value. It relies on a crypto-asset that aims to maintain a stable value relative to a specified asset, or a pool or basket of assets.

retail CBDC and further analysis of technological feasibility, operational costs and design choices are the missing link.

2.3 Technology issues for retail CBDC

Central banks worldwide started monitoring decentralized technologies in finance with the emergence of Bitcoin. Blockchain platforms underpinning financial market infrastructures are indeed a topic of growing interest and experimentation. Several projects testing decentralized technologies to enable wholesale payments have been documented: Jasper, Stella and Ubin are just a few of them.

Nevertheless, conventional centrally operated payment infrastructures have crossed over several reforms during the last twenty years, and continue to modernize on an ongoing basis. Both the industry players and the central banks have been pushed to ensure their platforms are able to safely face larger streams of real-time payment transactions. Apart from technology capability, there have been market issues not fully addressed by conventional payment infrastructures, especially in emerging and developing economies¹⁶. This has reinforced the interest about what decentralized technologies can do to enhance payments rails.

There are numerous issues associated with technology for retail CBDC that are naturally pegged to any design choice, but some of them deserve special attention by policymakers. To illustrate these issues and why technology is a key area for retail CBDC deployment, Auer and Böhme (2020) propose a couple of high-level questions for the operational architecture of the retail CBDC system. First, given the importance of featuring cash-like safety, a retail CBDC system can be one where the central bank offers directly the claims (CBDC holdings) to end-users or alternatively one where the claim is indirect via PSP. Second, in light of the (national) wide scope of a retail CBDC, the platform may be one where the central bank handles only core strategic roles like minting (i.e. issuing digital banknotes and coins) and data management (i.e. up keeping the identity of each spent digital banknote in circulation, safeguarding end-users privacy and anonymity), instead of centralizing all daily operation of such a system¹⁷.

The above can be unfold in a choice question between underpinning the retail CBDC system on conventional database or on decentralized protocols, or a combination of both. Existing centrally operated infrastructures and new ones relying on Distributed Ledger Technologies (DLT) differ in their setup, but experience with decentralized technologies is not as ripe as with conventional systems. In light of this, policymakers have much more to decide about technology and its implications for design features than expected, to ensure that a retail CBDC runs safely, efficiently and on a nationwide basis (just like with cash). As argued by Townsend et al. (2019), any single choice of technology may imply

¹⁶ There is a considerable gap in financial access in emerging market and developing economies. This financial inclusion concern is of special relevance in Latin America and the Caribbean (LAC). According with the World Bank Global Findex, barely 20% of the poorest population in LAC holds and use a debit card, while this percentage for advanced economies surpasses 80%. Moreover, only 10% of the population in LAC have accessed their accounts using mobile phone or internet and around 5% have a mobile money account. Likewise, only one third of the population in LAC made (sending/receiving) digital payments throughout the year, while the percentage rises 90% in AE.

¹⁷ See Garratt (2020), Huynh (2020), and Kahn et al. (2018).

legal aspects that vary on a country-by-country basis, thus retail CBDC design and operational architecture arrangements will heavily depend on this aspect as well. Furthermore, the economic, financial and institutional setup in each jurisdiction will also have influence on the use of such technology. This is of special significance to ensure that onboarding and operational risks has to be properly anticipated at the cost of encountering unknown fraud, cyber threats, outages or natural disasters, to name a few.

Many have argued that DLT would tend to perform negatively and that interoperable arrangements to support a hybrid/synthetic CBDC are not yet achievable. Thus, understanding how to implement such a payments infrastructure either with conventional or decentralized technology will be key in looking ahead. DLT are rapidly evolving and issues related to scalability and privacy that were previously questioned are already addressed by enhanced consensus algorithms and are under test by some CBDC pilots. Yet, the discussion and developments in DLT fall beyond the scope of this Report. Given the complexity of the subject, the CBDC WG deem relevant to underline that technology novelties should be properly studied looking forward.

3. Peer Review

The CBDC WG's 2019 Policy Report stressed that there is no one-size-fits-all retail CBDC solution; every case has its own motivation and it will face a very specific institutional set up. Besides an in-depth analysis of the implications and design issues preceding a retail CBDC pilot case, central banks must address potential operational, reputational and financial concerns. Moreover, as it is also seen in several jurisdictions, central banks may wish to analyze alternative choices, such as fast payments scheme or full privately run e-money ecosystem.

The focus of this Report is to get deeper in CBDC pilots of the Bahamas, Sweden and Uruguay. The CBDC WG set a Peer Review experts' group for each CBDC pilot with the main objective of addressing design (technology) and implementation (operation) aspects of such projects. The Peer Review is intended to go beyond public material, e.g. white papers, of the different CBDC projects, including the expert judgment of CBDC WG members. The following subsections briefly describe the methodology and main results of the reviews made between central banks' peers.

3.1 Methodology

The Peer Review consists of a series of interviews and exchanges by mail, conference calls and videoconferences, per each CBDC project. CEMLA hosted the Secretariat of the Peer Review to support and streamline the process.

Peer reviewers followed a methodology based in their own experience of CBDC piloting. Each CBDC project had an interviewee central bank and a group of (2-3) interviewers as seen below. CEMLA representatives were present as interviewers in all cases.

Table 1. Peer Review roles of CBDC projects

| Interviewees | Interviewers |
|--------------|--------------------------------|
| Bahamas | Peru and Uruguay |
| Sweden | Bahamas, Chile and Ecuador |
| Uruguay | Colombia and Eastern Caribbean |

Peer Reviews' full reports can be found as Annex of this Report. They contain detailed findings that peer reviewers discussed with the interviewees, respectively.

3.2 Summary of results

Given the particular characteristics of each CBDC pilot, the main results of the Peer Review are presented in a country basis.

3.2.1 *The Sand Dollar*

The Central Bank of The Bahamas (CBOTB) implemented a digital version of the Bahamian dollar, i.e. a retail CBDC. The initiative denominated Sand Dollar started in December 2019 with a pilot in Exuma (one of the Bahamian islands) and then it continued to Abaco (another island). The main targets of this CBDC were improving the domestic payments infrastructure and ultimately broadening financial access. In terms of design, the Sand Dollar is token-based and is minted by the CBOB solely. The Sand Dollar is a real-time, retail, digital cash-transactions system, featuring 24x7 availability. Interoperability is guaranteed through supervised financial institutions (SFI): commercial banks, PSP and money transmission businesses integrated via API connectivity to the Sand Dollar network. Furthermore, the system has a built-in proprietary resilience network that allows users to connect to the Sand Dollar network without data and internet connectivity. Regarding the distribution of Sand Dollars, only SFIs can handle it. For that purpose, SFIs have Sand Dollar Accounts at the central bank. In terms of financial intermediation, there are no possible trade-offs between deposits (held at SFI) and CBDC, as the Sand Dollar currently do not bear interest and is designed to only cash-in/Sand Dollar-out and vice versa for now. Moreover, the CBOB is working with SFI to link the Sand Dollar wallets directly to bank accounts, and with that bringing unbanked into the formal financial sector.

The CBOB undertook a process to select one technology solutions provider for the retail CBDC design and implementation and more than 30 entities submitted a bid. An evaluation committee was appointed to evaluate the vendors based on a white paper and live demonstration. The cost of the Bahamian pilot was being borne by CBOB. Moreover, it offers a virtually costless service, which is free of charge for final users.

More recently, the project has been re-strategized to respond better the COVID-19 effects in the implementation of the pilot, with the central bank and the key stakeholders fine-tuning their various roles and with that meet properly the economic and social new needs brought by the pandemic.

Looking ahead, the Sand Dollar operation may generate a nominal fee for the upkeep of the service which may be shared amongst all the beneficiaries of the system.

3.2.2 *The e-Krona*

The e-Krona project started mainly as an analytical endeavor of the Sveriges Riksbank to respond to a lasting dynamic of marginalization of cash in Sweden, and by the release of this Report, it was ready for a Proof of Concept (PoC). Indeed, the Riksbank acknowledge that new digital payment products such as Swish (a domestic e-money solution) and global stablecoins like Libra can potentially pose a threat to the sovereignty of the central bank authority to issue fiat money. In other words, a retail CBDC in Sweden would be explained by the central bank concerned to ensure access to fiat money to the general public.

In the e-Krona project, there is not yet an available high-level workflow on the intended platform and technology for minting and rolling out the retail CBDC. Therefore, it is not possible yet to have a substantial evaluation of the similarities or differences between the physical issuance and its possible version in a digital form. In turn, the Peer Review found out that the likelihood of establishing a direct distribution channel through banks and authorized payment service providers, with limited features and thresholds in comparison with traditional bank accounts, is very high. In addition, just as with cash, the Riksbank would be responsible for issuance and supply management of the e-Krona claims, while PSP would manage the roll out and management of e-Krona wallets/accounts.

In this context and given the early phases of the PoC, which could be underpinned with DLT technology, it can be only speculation that the e-Kronas would be minted by Riksbank in some very particular e-Krona nodes and then distributed to other e-Krona nodes through a private decentralized network.

Overall, there will be major legal and operational steps to be taken if the Riksbank decides to get the e-Krona into production. It can be also expected that design features must be carefully address, given the borderless tendency in the European retail payments market. Despite the fact that Sweden is not a country member of the Eurosystem, cross-border payments take place on a daily basis, thus accessibility and usage of e-Kronas will demand special attention by the central bank, among other potential domestic considerations.

3.2.3 *The e-Peso*

In Uruguay a retail CBDC pilot, called e-Peso, was run by the Banco Central del Uruguay (BCU), between November 2017 and April 2018. Digital issuance of this legal tender currency was framed by a pilot plan led by the BCU. The e-Peso was motivated to evaluate several aspects of new technologies relative to CBDC and central bank business model. The pilot intended to determine a possible design for a retail CBDC adapted to Uruguay in case policymakers decide to take it over definitively. Other key aspects were taken into consideration, for example, whether the CBDC could

help meeting public policy goals like improving safety and efficiency in payment systems, financial inclusion, security, and the provision of a level playing field for financial innovation.

In terms of design, the e-Peso was intended to be another representation, i.e. digital, of the legal tender currency of Uruguay. Since it aimed to replicate the same features of physical cash, it did not bear interest. Also, it does not allow opening accounts to the general public at the central bank, e-Pesos are designed as tokens. The e-Peso provides instantaneous payment. The core e-Peso system had two layers. First, a core “digital mint”, which were owned by the BCU, to print e-Peso notes. The core used cryptography technology to provide a balance of security, traceability and anonymity. The second layer was made of an entire ecosystem including a central digital vault, ran by a third party, e-Peso account managers, and PSP; this allows the BCU to have a roll-out and validation system, which besides hold e-Pesos in individual and anonymous digital vault that are linked one-to-one with final users’ digital wallets. Important noting that the BCU found as a design issue whether the e-Peso central digital vault should also be a component directly managed by the central bank.

With the e-Peso, final users access their digital wallet system supported by the mobile phone infrastructure provided by the state-owned telecom company. For the implementation process, the e-Peso pilot was limited in size in order to keep risks under control. During the pilot there were not technical incidents. According to preliminary technical evaluation, scalability could be done without technical issues. As regards the last mile, during the pilot, the e-Peso was advertised through the media, e.g. television. A system of incentives was also in place: first users gained automatically an amount of money and there were monthly prizes of money to the most active users.

4. Lessons and key insights

This section summarizes the most important lessons and key insights of the Peer Review process. First, an overview of the main insights related to the retail CBDC pilots. This is followed by the lessons regarding the design of the CBDC, a number of lessons about the operation, and the lessons learnt from the implementation of retail CBDC systems.

4.1 Key insights

The following are the most relevant elements that have been found in each retail CBDC project studied in the Peer Review. In the case of Bahamas, a preliminary assessment indicates that the Sand Dollar set high requirements to deliver a solution that was robust against international regulatory standards, including technological solutions which are scalable and trustable. Regarding design lessons of this experience, as it offers real time retail transactions, SFIs have no control over the transmission and settlement. Moreover, the envisioned ecosystem provides room for the private sector to play different roles, while the central bank maintains control of the most strategic ones (i.e. minting and data protection). Furthermore, there are no relevant differences between CBDC access

channels, either mobile- or card-based account options and there is no direct cost for the final user. In terms of data protection, whether there is a need to investigate nefarious activity or not, SFIs are always able to request information on a particular transaction. In relation to the balance sheet of the CBOB, the issuance of a CBDC will become a liability of the Central bank (same as fiat), but as the current pilot only represents a controlled issuance of Sand Dollars, this not necessarily inflate the monetary base, nor have other policy implications.

Importantly, starting the project in one of the Bahama islands was a crucial decision in order to eventually include the rest of the population. A national survey on spending habits was a necessary practice as part of the preliminary development of the project. Coordination with private sector is crucial as well; not only with financial institutions but also with payment providers, technological platforms, fintech, other authorities, etc.

Regarding operational issues, potential disintermediation risks are controlled through limits to the amount of Sand Dollars that customers can hold. In relation to that, the CBOB has a dashboard that allows overseeing the circulation of Sand Dollars daily.

Finally, the COVID-19 pandemic led the CBOB to strategize with wider stakeholder groups on various community-building initiatives and to further refine its current solutions in order to meet the future needs of changing economic and social norms stemming from the pandemic.

In the case of Uruguay, future steps of the e-Peso are under consideration by the central bank. Hence, it is not possible to forecast how the e-Peso could be adopted. For instance, if the vendor solution that was used for the pilot is likely to be used on a CBDC system for national scope, it could bring scalability challenges. This could be a red flag for central banks when dealing with vendors and solutions providers to ensure the design of a CBDC can be met by third parties playing a role in such a “payments system”. Above all, it has been an enriching experience since it has involved great effort by an interdisciplinary team inside the BCU, in collaboration with external technological companies. Several technological aspects have been tested and several other questions were raised and are under evaluation thanks to the pilot. One can underscore that critical concerns that should be managed ex-ante by the central bank, comprise: safety policy and rules, market structure and industry dialogue.

A very preliminary assessment indicates that there will not be major disruptive effects in the financial intermediation activity, nor in the transmission mechanisms of monetary policy. Importantly, such effects will depend on the design and parameterization of the CBDC system, e.g. on their cases of use, limits to transactions and cash holding in digital wallets, etc. Nevertheless, aspects like the velocity of circulation, the stability of the money multiplier and the willingness of final users to use cash could be altered.

In terms of business continuity, the pilot comprised existing contingency plans to keep the system running. In that respect, the e-Peso system uses internet as the principal channel and the USSD telecom protocol as secondary and contingency channel. The e-Peso pilot did not feature off-line transactions but without internet transactions were processed on-line via the USSD protocol.

In any case, both central banks and commercial banks and other payment services providers would have to make considerable investments to set up a suitable infrastructure for this new product, redesign networks and integrate it with current existing technologies and services. Issues such as how to remunerate private intermediaries for performing those functions will require a thorough analysis. It would also be expected that the banking sector and other financial entities, with the capacity and expertise to intermediate, would continue to offer value-added services, such as overdrafts and loans and mortgages, while competing against CBDC for transactional services.

Some of the most relevant general lessons of the retail CBDC pilots can be summarized as follows:

- Central banks should address domestic concerns ex-ante. This involves: reviewing market structure, ensuring industry dialogue, fostering that safe and efficient payments are underpinned by an appropriate policy framework.
- Central banks should proceed with a reliable analysis using data on payment habits to understand exactly how a CBDC could fill the gaps both in normal times and in extreme situations (e.g. during the COVID-19 pandemic).
- Central banks should set the highest technological and operational requirements to deliver a solution that is likely to become scalable, interoperable and trustable.
- Central banks should retain strategic roles no matter other design choices. But, they should also examine how to design an ecosystem with the private sector bringing their expertise and market abilities.

Overall, the design of a CBDC should be one that meets the above if no other solution is at hand (e.g. a fast payments scheme). And more importantly, central banks must pay special attention to financial and monetary potential implications that will be attained to a selected design choice.

4.2 Lessons regarding design

A retail CBDC would be innovative in both the form of (digital) money provided to the public and the payments infrastructure on which retail digital transactions can be made. Unlike banknotes and coins, CBDC would be electronic, and unlike reserves, retail CBDC would be available to households and businesses. Retail CBDC would therefore allow households and businesses to directly make payments and store value using a digital form of central bank money. Retail CBDC is thus a cash equivalent, although in practice it may have other features depending on its design as it has been learnt through the peer review process.¹⁸

As a result, CBDC pilots are a source of knowledge on how design is relevant to reap the innovation bonus to fulfill gaps found by central bank policymakers without dislocating current financial and monetary arrangements.

The Peer Review shows that retail CBDC pilot projects are mainly motivated for payment infrastructures lags, financial inclusion concerns or cash related issues. Against this, central banks

¹⁸ See also Bank of England (2020) for a discussion on other potential features of CBDCs

advocated retail CBDC as a potential response to fill such gaps, yet deploying general-purpose CBDC could have undesirable consequences if, for instance, it impacts negatively the structure of the banking system and the way that central banks achieve their primary objectives to maintain monetary and financial stability.

There are potential benefits and risks of CBDC for monetary policy. For instance, if retail CBDC is introduced on a wide basis and bear interest, it may support more effective transmission of monetary policy through some channels. But these benefits would have to be weighed against risks, such as the potential effects of disintermediation of the banking sector on credit provision. Design issues such as monthly limits for retail CBDC holdings and interest-bearing are some of the most relevant policy making aspect central banks must take care, preceding a CBDC pilot project. The Peer Review allows to conclude that such a design needs some experimentation to learn on the best approach to be taken for a full-fledged implementation.

Several central banks and national authorities around the world share the same kind of motivation to assess CBDC: remoteness of communities outside of a cost-effective range of physical banking services, weak payments' interoperability and arrangements as well as limited availability of payment means, besides cash and traditional bank accounts. These reasons comprise strong motivations to design a retail CBDC aimed at addressing such market failures and ensuring all individuals and businesses, and the government, are able to access fiat money in electronic format.

An important design feature present at CBDC pilots reviewed by the CBDC WG relates to quick and effective universal access to instant payments at little or no cost for final users (alike cash), but without invading the space of intermediation financial services, which is a critical decision to avoid negative effects in banks' balance sheets, and with that mitigate unintended effects on financial stability. The links of a CBDC system with financial intermediation, including the possible waterfall with bank accounts, is an important aspect that needs careful design. The scope of the pilots that were assessed for this report does not allow to extract definitive conclusions on this issue.

Another major design consideration that has been found relevant by the CBDC WG relates to the wallet structure either for PSP or end-users. Custodian special wallets (i.e. wholesale CBDC accounts at the central bank) for authorized PSP and customizable wallet solutions (i.e. devices to access retail CBDC by end-users) must be designed in such a way that they fit and run seamlessly in the payments chain. Custodian wallets have to be able to interoperate and communicate with the core payments infrastructure and, possibly, with other retail payments infrastructures, and also having appropriate risk management controls to avoid fraud risk, for instance. Individual wallet solutions offered by PSP should be friendly, workable and reliable to ensure that the experience of end-users is frictionless but, more importantly, free of cyber risk as much as possible.

Some of the most relevant lessons from the design of the retail CBDC pilots, can be summarized as follows:

- Framing the scope of the retail CBDC, a digital form of fiat money to be widely available on a safe and reliable basis, like cash.

- Reviewing the legal framework and, where necessary, adapting it to run a pilot. Afterwards, possible regulatory amendments may be required, depending on the jurisdictions.
- Establishing thresholds, usability and capability features of CBDC wallets to keep risks under control, and to circumvent any material concern on bank runs and fly-to-quality risks.
- Developing an ecosystem with industry players to deploy retail CBDC widely, thus establishing adequate coordination of roles.
- Establishing a compliance and interoperability framework at PSP-level to ensure retail CBDC onboarding a seamlessly process.
- Ensuring a resilient and reliable environment for PSP, access points, other parties, and the population, including operational capacity, penetration testing and data management systems.

It is worth underlining that given the scale of the retail CBDC pilots, there were design issues that were not possible to assess, nor to test. Full privacy, in particular anonymity and wide accessibility are perhaps some of the most salient design features that are not yet enough tested. Besides, they are crucial to determine the adoption from end-users and merchants. This limitation will merit further study, as it has been demonstrated as a key challenge for new payment instruments.

4.3 Lessons regarding operation

As mentioned earlier, there is no one-size-fits-all design for retail CBDC. Nonetheless, there is already enough empirical evidence with CBDC pilots, telling that at least an efficient operation configuration of a retail CBDC is one where the central bank mint and distribute it -possibly on a wholesale basis- through banks and PSP. In this business model, the main operation of onboarding, rolling out and clearing transactions will be handled by authorized PSP and banks, which certainly have the expertise and channels network to ensure business continuity and robustness of the system at a larger scale. Furthermore, central banks would need to ensure that the retail CBDC system does not misplace expertise and long-established capacity of banks and PSP. In other words, as suggested in the BIS Annual Economic Report 2020, retail CBDC pilots are basically set in motion as traditional two-tier payment systems provided by the central bank together with PSP. The central bank ensures safe and efficient payment options, trusted money, while the private sector competes to meet the last mile.

Importantly, the operation of retail CBDC systems in pilots reviewed by the CBDC WG have benefited from reliable designed centralized and decentralized platforms. Technologies underpinning the core and related layers in the CBDC systems have been useful for validation and settlement processes. Interestingly, some of the CBDC pilots revised are based on proprietary software (e.g. e-Peso), while others are mostly DLT-based (e.g. Sand dollar). Given the permissioned (closed) networks that are built to support the core system, central banks have achieved a high degree of operational reliability as stated in the Peer Reviews of the Bahamas and Uruguay. For instance, preventing double-spending or fraud is a feature that these retail CBDC pilots have undertaken seriously given available new cryptographic developments of decentralized technologies. It is worth mentioning that the limited

scale of the CBDC pilots have shown that, in effect, specific design choices for digital fiat money can largely benefit from DLT, but it will be required a broader implementation to confirm how effective these technologies could be to deal with large streams of transactions in peak demand.

The CBDC WG Peer Review also helped to identify that in connection with design, an implementation plan is decisive to nail down an operable strategy. In other words, a step-by-step approach to understand which elements should be achieved first when making operative the retail CBDC system.

As regards the operational architecture, the Peer Review help to confirm that a multilayer infrastructure is being developed to ensure the central bank retains a core layer that serves strategic roles such as issuance and redemption of retail CBDC claims, while PSP (and other third parties) handles daily transactions and accounts' management in separate but connected layers.¹⁹ As found in the retail CBDC pilot of Uruguay, such fragmentation of roles allows the central bank to provide the general public with the certainty that the information on their transactions and their privacy remains untouched.

The ecosystem that results from establishing an operational architecture for retail CBDC can be complex, as the CBDC WG have been able to check in the Peer Review. And while the new landscape of retail payments is a complex one, with Open Banking²⁰, payment aggregators and other new players, central banks considering a retail CBDC must be aware of how roles are assigned and monitored. In special, under such a partitioned ecosystem, central banks may need to carefully design how third-party service providers can support tasks like data storage and validation, without endangering safety or efficiency of the overall system and its end-users. This is one of the features that both conventional and decentralized infrastructures will require to address with a risk management framework. The central banks worldwide have a long-lasting experience in providing such a framework. In fact, central banks could take further steps in measuring how strong could be the CBDC system before the implementation plan is activated.

To illustrate the above, and despite the e-Krona is not yet in a pilot phase, its Peer Review comprised an assessment against the CPMI-IOSCO Principles for Financial Market Infrastructures (PFMI)²¹ as a way to measure the governance, financial and operational ability of the envisioned CBDC pilot. In this respect, it can be underscored that the PFMI assessment of the retail CBDC system of the e-Krona found that recommendations relating to payment systems operation should be applied when assessing and operationalizing the e-Krona. At earlier stages, it will be necessary to identify whether there is a sound legal basis, governance, risk management framework, settlement finality, operational

¹⁹ See Kahn et al. (2018) and Kumhof (2018).

²⁰ According to the Basel Committee for Banking Supervision, Open Banking consists of the sharing and leveraging of customer-permissioned data by banks with third parties to build applications and services. Some Open Banking developments are aimed at providing real-time payments, greater financial transparency options for account holders, and marketing and cross-selling opportunities.

²¹ The Principles for Financial Market Infrastructures are the international standards for financial market infrastructures (i.e. payment systems, central securities depositories, securities settlement systems, central counterparties and trade repositories). The PFMI were issued by the Committee on Payments and Market Infrastructures (CPMI) and the International Organization of Securities Commissions (IOSCO) in 2012, and they entail 24 Principles aimed at strengthening financial market infrastructures to support the financial stability.

risk, access and participation and communication procedures and standards. Finally, it was also found that for the e-Krona assessment of the PFMI, aspects and recommendation related to financial risk and general business were less relevant. This is an approach that the CBDC WG find recommendable as a best practice for policymakers studying the subject.

Another important feature of the operational architecture is the interoperability provided by a retail CBDC system. Unfortunately, given the limitations provided by the scope of the CBDC pilots is not possible to confirm whether a CBDC system can interact with other retail payments infrastructures. This will ensure that PSP and other market players have incentives to overlay additional services to retail CBDC transactions. Concerning the Peer Review, it is possible to remark that a high degree of standardization with the telecommunications, physical and related infrastructure of a country, was a pre-requisite to deploy the retail CBDC system, which could ease interoperability with other existing payment infrastructures, at least domestically.

Some of the most important lessons from the operation of the retail CBDC pilots, can be summarized as follows:

- Leveraging on both central banks' experts and technology specialized firms to build-in the layers and platform to run the retail CBDC pilot, based on selected CBDC features, namely, token-based, 24x7, instant settlement and offline availability.
- Relying on a multi-layer operational architecture -using or not, decentralized technologies- to improve minting, data management, settlement and other processing features of the CBDC system.
- Assessing the proposed CBDC architecture against the Principles for Financial Market Infrastructures (PFMI) as a way to measure the governance, financial and operational ability of the envisioned CBDC pilot.
- Establishing a risk management framework to ensure a resilient and robust operation is critical for a nascent payments infrastructure to achieve confidence by end-users, particularly in aspects like cyber security and privacy of the information.

It is worth underlining that given the scale of the retail CBDC pilots, there were operational issues that were not possible to assess, nor to test. Scalability, operational capacity and cyber security can be underlined as some of the most relevant ones in this category. Moreover, interoperability features may be further analyzed in the advent of payments innovations and a greater digitization of the economy.

4.4 Lessons regarding the implementation process

The implementation of retail CBDC pilots shed light on aspects that cannot be covered by discussion and policy analysis. Hands-on experience is therefore a rich source of lessons for the international community of central banks about the future of new forms of (digital) money, including general-purpose CBDC.

Before presenting an overview of the key insights of the Peer Review carried out by the CBDC WG, there are some lessons on the implementation process that deserves to be mentioned.

Introducing new payment instruments is not a minor, nor a negligible task. Many fintech endeavors have seen the light fleetingly, and just a few of them have succeeded. Retail CBDC combines several roles already played by central banks in payments, that requires a clear strategy on how to remain effective executors of each role. For instance, as overseers, central banks could find retail CBDC as a catalyzer of competition and efficiency; as regulators, it can serve as a mechanism to introduce moral suasion and greater interoperability; lastly, as operators, central banks will have a major test with the introduction of a retail CBDC as a payment infrastructure demanding greater operational requirements than a fast payment scheme. Overall, implementing a retail CBDC as a payments-driven response to market failures calls for the central bank to adequately combine these roles in joint with key industry players to avoid crumbling a well-designed plan with a poor implementation strategy.

The CBDC WG Peer Review showed that retail CBDC pilots' implementation plan have followed an akin roadmap, but not surprisingly they differ considerably relative on how the systems are being operationalized. A key lesson to draw is the design and selection of the environment where the retail CBDC will be available. In this respect, a wise approach in CBDC pilots relates to engage relevant PSP with significant presence in the current payments market and also to bring together "super" merchants who can provide a wide range of access points for end-users to make payments with retail CBDC. With such an approach, adoption by end-users could be smoother. Each CBDC pilot differed in terms of how many PSP and, in general, how the environment was set. To promote early adoption and a growing usability of retail CBDC, it will be convenient to make that large and recurrent stream of payments, such as government payments and transfers, and public transportation can be paid with retail CBDC holdings.²²

On another subject, financial education and incentives for adoption as part of the implementation strategy has been key for onboarding and usage of retail CBDC devices. Retail CBDC pilots under review displayed substantial differences on how the central bank catalyze and promote the new payment infrastructure. This could be explained by the operational costs behind the pilot and the expected endurance of the testing. Spending resources on education campaigns and granting bonuses or incentives in limited groups and for a small amount of time may be feasible, but it could be not sustainable in large economies or in jurisdictions where the CBDC pilot will be followed by a national implementation. The pricing structure is a noteworthy feature of the CBDC pilots that were not reviewed, nor available in any case. Nevertheless, this is a key issue regarding how the central banks decides to share the responsibility of deploying a retail CBDC system in cooperation with the private sector.

It can be also underlined how risk management has been pursued by central banks. In general, the CBDC WG found that Know Your Customer (KYC) and Customer Due Diligence (CDD) procedures were in place at PSP-level that enabled the central bank to moderately discharged fraud detection

²² The Payment Aspects of Financial Inclusion framework was published by the Committee on Payments and Market Infrastructures (CPMI) in April 2016. It sets a Guiding Principle on fostering electronic and digital payments by means of using them to pay large and recurrent payment streams, such as government payments, remittances and public transportation. These are daily expenses that individuals, businesses and the Government regularly run on cash.

and payment anomalies. This is a key element when designing an implementation strategy as it also comprises a foundation of confidence in payments, including retail CBDC. A central bank declared that a potential result of retail CBDC pilot could be the establishment of a KYC registry of retail CBDC users to foster each PSP contribute to the central registry as a data input for them to use for overlaying services, and ultimately support prudential requirements to be met when onboarding end-users.

It is relevant to note that with the unexpected global contingent frictions concerning the COVID-19 and the resulting 2020 Great Lockdown, central banks have been showing a stronger intention to study, explore and pilot CBDC projects. Even some central banks have showed some readiness to start soon a more robust developmental work or initial deployments in order to ensure that on-the-ground implementation can be supported.²³ In particular, the new social frictions concerning social detachment give incentives to improve the onboarding process with digital payments and eventually, with retail CBDC transactions. For instance, being able to enhance (or enable) contactless payment channels and devices would be relevant to attain social distancing measures, instead of relying fully on physical infrastructure.

Some of the most relevant lessons from the operation of the retail CBDC pilots, can be summarized as follows:

- Implementing retail CBDC as a payments-driven response to market failures calls for the central bank to adequately combine its roles as regulator, operator and catalyzer in joint with key industry.
- Engaging relevant PSP with significant presence in the current payments market, government payments and transfers, public transportation, and also "super" merchants who can provide a wide range of access points for end-users.
- The COVID-19 is an unusual test for retail CBDC pilots, proving that central banks should be ready to face unexpected frictions when the implementation of a pilot or full CBDC deployment takes place. Central banks need to carefully redirect industry and its own efforts to minimize negative effects in access and adoption of retail CBDC by understanding how to meet the needs posed by such a challenging context.
- Onboarding through financial education and incentives for adoption as part of the implementation strategy has been key for usage of retail CBDC devices.
- Enhancing confidence in payments through risk management. In general, the CBDC WG found that KYC and CDD procedures were in place at PSP-level that enabled the central bank to moderately discharged fraud detection and payment anomalies.

²³ This is, for instance, the case of The Sand Dollar in The Bahamas.

5. Conclusions

Retail CBDC is a matter of snowballing interest for several central banks worldwide, but it is a development in a state of flux. Its current analysis is undesirably limited to the available research and few proofs-of-concept and even less pilots. The CBDC WG finds that it is necessary to “wait and see” how retail CBDC evolves conceptually and in practice. Relatedly, unexpected frictions when designing, implementing and operating a CBDC should be addressed by central banks with a knowledgeable strategy that needs to come first the decision to advance in practical aspects. Thus, cooperation, information and experiences sharing among the central banking community will be desirable ahead.

As introduced in earlier sections, motivations for introducing a retail CBDC could range from a rapid decline in the use of physical cash (and the need to ensure that digital alternatives are available, i.e. payments as a public good) to an underdeveloped retail payments market (and the need to foster efficiency and competition, as well as to development opportunities in the payments industry). Once the rationale is identified, a retail CBDC proposal needs to be carefully designed as a cash equivalent. A roadmap for the design process will minimally comprise framing the scope of the retail CBDC, reviewing the legal framework, establishing appropriate risk management measures, and developing an ecosystem with industry players. Central banks should pay special attention to retail CBDC usability and acceptance. In this regard, features like thresholds, compliance controls, off-line servicing, no-surcharging rules and other measures could help minimizing a major risk for its adoption, and also minimize potential negative effects on the overall model of financial intermediation. Moreover, central banks embarking in retail CBDC may wish to consider the PFMI as a reliable basis to both guiding the risk management framework to govern the system and supporting a measurable assessment and monitoring of robustness of such a brand-new payments infrastructure.

For central banks moving to the next stage, displaying a retail CBDC system will require a significant amount of coordination and operation efforts, before and during the implementation. Firstly, the central bank should adequately identify its roles as regulator, operator and catalyzer of the retail CBDC system, implying that key industry players are embarked to build a comprehensive and workable ecosystem, since the very beginning. Secondly, the central bank will have to effort making that such ecosystem must minimally encompass both an interoperable, scalable and reliable operational infrastructure (either conventional- or DLT- based) with the highest requirements and standards, as well as a tiered structure in which the ecosystem main players (i.e. private PSP) compete fairly to serve final users and the central bank remain as the sole operator of core strategic activities (e.g. minting of tokens). Thirdly, the central bank should analyze and decide a sustainable costs’ structure for the implementation, operation and maintenance of the related systems; as a public good, it should be envisaged that a fraction of the costs may be borne by the central bank. And fourthly, the central bank must establish a risk management framework able to embrace the complex architecture of retail CBDC, that bring together wide-nation final users and private and public payment infrastructure, all subject to an intensive technology-based novel platform, where cyber security, privacy, KYC, AML/FT concerns must have the highest attention possible.

There are aspects of the implementation and operation that should be expected as indeterminate, however central banks must be the best prepared to appropriately respond. One of them is to anticipate frictions regarding adoption given the competition of retail CBDC with other existing payment instruments. This is not trivial and deserves that the central bank equips with accurate information on payment habits (Jiang, 2020; Huynh, 2020) to understand how the retail CBDC must insert without becoming a niche solution or a failed attempt to fulfill specific goals set by the own central bank. Relatedly, information from retail CBDC users' experience will become an important source of information to improve retail CBDC pace of adoption.

Other important aspect when making the retail CBDC operable, concerns unexpected events like the COVID-19 pandemic and its devastating effects for the economic activity. Certainly, extreme situations like this pandemic will affect how people, merchants and other CBDC users behaves in times of stress, for instance, moving into cash holdings as noted during the 2020 "Great Lockdown"²⁴. For retail CBDC ongoing pilots, the 2020 Great Lockdown is an unusual test. It shows that central banks should be ready to face this kind of situations as an opportunity to strategize and redirect efforts to both, ensure that the design is able to face such unusual situation, and guarantee that the operation and implementation process is flexible enough to allow key stakeholders to remain engaged.

With regard to expected outcomes of retail CBDC, it is also too uncertain and early to confirm which design choice will bring greater interoperability or reliability. These aspects go beyond the control of the central bank, as the ecosystem is made of different stakeholders and thus the results depend considerably on industry engagement and support, among other retail payments market performance issues. In terms of the effects a retail CBDC will have on monetary policy transmission and financial intermediation, it is also very early to foresee the real consequences, and as such, the central bank must pay special attention to design features like limits and interest-bearing to retail CBDC holders, above all other considerations.

Recalling the previous year CBDC WG report, it will be also important to carefully analyze alternative policy and operational options to retail CBDC. Fast payments are becoming a common practice worldwide, with important lessons on how the central bank can effectively underpin the access to digital forms of digital money, yet with major differences against a backstopped digital cash-like.

To conclude, pilots under review by the CBDC WG evoked a multi-sidedness planning in which the leadership of the central bank is thus fundamental. In this vein, design of the underlying technology system, its operation and implementation, there are several differences among the reviewed experiences. Interestingly, despite of the diversity in motives, envisaged solutions share in common that central banks mint some kind of digital liability, generally a token, which may be access by the general public, i.e. a CBDC, and keep control of key components of the new payments infrastructure that in general have a tiered architecture where the parts that are closer to final users are under competition among private sector participants accessing the system, innovating and providing overlay services.

²⁴ Financial Times 2020.

Since the CEMLA Fintech Forum, and its CBDC WG, were established there has been big progress regarding retail CBDC. Nevertheless, the CBDC WG would like to underscore that retail CBDC will be a long-term, continuous learning process. Thus, cooperation among the central banking community, as well as with the financial industry and academia will be a highly valuable avenue to continue exploring this new form of central bank money. In this respect, the CBDC WG aims to serve as a vehicle to keep supporting Latin American and Caribbean Central Banks to better understand this relevant novel subject.

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Annex 1. Peer Review full reports

Peer Review Report: Sand Dollar

The Central Bank of The Bahamas (CBOB) introduced a digital version of the Bahamian dollar, starting with a pilot phase in Exuma in December 2019. This initiative has acquired the name Project Sand Dollar. The Sand Dollar is therefore the Central Bank Digital Currency (CBDC), which main targets are: improving financial inclusion and access, and making the domestic payments system more efficient and competitive.

The following report present key findings of a Peer Review on the Sand Dollar conducted in January and February 2020 by representatives from the Central Bank of Uruguay, the Central Reserve Bank of Peru and CEMLA.

1. Background

According to the Bahamas Financial Literacy Results 2018, only 48% of individuals surveyed had access to credit card facilities²⁵. The CBOB also acknowledges exclusion from banking services partly because of the stringency of the customer due diligence requirements, although these were relaxed in June 2018²⁶. In the case of businesses, exclusion from using electronic transactions can be explained by the high cost barrier of entry.

Recently, policy and regulatory reforms have begun to tackle these barriers, with the CBOB advancing a payments system modernization initiative (PSMI). The PSMI seeks authorizing new categories of financial services providers and using the digital payments infrastructure to make available the supply of traditional banking services to all segments of the population. The Sand Dollar is a key component of the PSMI.

2. Motivation and design

The Sand Dollar is aimed at addressing some of the current financial access gaps provided by both, remoteness of some communities outside of a cost-effective range of physical banking services, and onerous customer due diligence (CDD) and know your customer (KYC) requirements in The Bahamas. With this CBDC initiative, the CBOB pursues to achieve universal access to digital payments and financial services, and underpinning government efforts to digitize and make a more efficient spending and tax administration.

²⁵ 1000 persons were surveyed via phone <https://www.centralbankbahamas.com/download/095827900.pdf>

²⁶ Streamlined Requirements <https://www.centralbankbahamas.com/download/068137700.pdf>

Against this backdrop, the CBOB successfully launched the Sand Dollar with participation from key stakeholders and the public, in the pilot placed in Exuma, Bahamas. This island, Exuma, is one of the territories featuring the (geographical, social, etc.) characteristics found across The Bahamas.

As stated by the CBOB, the legal framework is enough to scale-up the project; however, enhanced provisions need to be made around data sovereignty, KYC and customer protection. Such improvements need to be tabled for Parliament approval.

In terms of design, the proposed CBDC is token-based and is minted by the CBOB solely. The Sand Dollar can be seen as a real-time, retail, digital cash-transactions system, featuring 24x7 availability.

Interoperability is guaranteed through supervised financial institutions (SFI): commercial banks, payment service providers and money transmission businesses integrated via API connectivity to the Sand Dollar network. Furthermore, the system has a built-in proprietary resilience network that allows users to connect to the Sand Dollar network without data and internet connectivity. Regarding the distribution of Sand Dollars, only SFIs are allowed to handle it. For that purpose, SFIs have Sand Dollar Accounts at Central Bank.

Critical functions of the project are all under the CBOB direct control, e.g. minting and distribution, while certain maintenance, penetration testing and system audits will be outsourced. All transactional data is centralized and housed in Central Bank's datacenter on premise.

3. Technology and implementation

The system underpinning the Sand Dollar is a DLT-enabled core system which works as a private and permissioned platform. Regarding the validation process, the system relies on a cognizant consensus model based on the Proof of Work protocol. In order to prevent double-spending and falsification the system utilizes enhanced short-lived (time sensitive) one-time web tokens instead of traditional reusable session tokens. The wallets are encrypted and secured and can only be accessed with unique pin number or through biometrics. Wallets can also be blocked through accessing the wallet on a secondary device, in case it is necessary (if it is stolen).

The CBOB undertook a rigorous process to select a technology solutions provider for the design and implementation of digital currency platform. The search process stressed a need for a robust solution able to address both the geographical and infrastructural challenges of providing digital financial services.

The CBOB issued an expression of interest and more than 30 entities submitted their bid. An evaluation committee was appointed to evaluate the vendors based on a white paper and live demonstration. Ultimately, NZIA Limited was selected as the solutions provider.

In terms of implementation, it consists of a pilot for which two islands were selected: Exuma in the first place, and Abaco in the second place. Exuma was chosen due to its landscape and similarity with the Bahamas' geographic landscape. Abaco was selected due to its economic recovery after

Hurricane Dorian. A third closed pilot was implemented at the Central Bank open to staff who utilize the cafeteria. Before the lockdown, all purchases at the cafeteria were made in sand dollars.

A public relation national campaign is being developed to educate the public on Project Sand Dollar. At the moment, the CBOB is planning to perform enrollment fairs and town halls as a communication strategy once the national curfew is lifted. However, the main dissemination efforts are based building user base through public outreach and authorized financial institutions.

By February 2020, the CBOB voluntarily onboarded over 1,000 users in Exuma, with another handful of potential CBDC holders to be onboarded once the availability of CBDC devices is ready. Over 30 vendors and numerous points of access have been set up to accept Sand Dollars. They all volunteered to participate in the pilot. Important noting that KYC procedures are required for all the users, and there is a three-tiered KYC framework. SFI are expected to perform customer due diligence as a part of the mandatory onboarding procedure.

The cost of the pilot is being borne by CBOB. Moreover, it offers a virtually costless service, which is free of charge for final users. However, looking ahead, the operation may generate a nominal fee for the upkeep of the service which may be shared amongst all of the beneficiaries of the system.

4. Key lessons

A very preliminary assessment indicates that the CBOB set high requirements to deliver a solution that was robust against international regulatory standards, including technological solutions which are scalable and trustable. Available details of the architecture show that the system will be able to respect and protect users' data and anonymity, accordingly, as no personal information is ever stored on the DLT permissioned network.

At the moment there is no impact evaluation on monetary policy issues. Regarding cross-border transactions, at the moment, Sand Dollar will only circulate and be used domestically by citizens. In terms of financial intermediation, there are no possible trade-offs between deposits (held at SFI) and CBDC, as the project is only cash-in/Sand Dollar-out and vice versa for now. Moreover, the CBOB is working with SFI to link the Sand Dollar wallets directly to bank accounts, and with that bringing unbanked into the formal financial sector. In this vein, SFI are responsible for on-boarding and servicing their own customer base related to the Sand Dollar.

Moreover, end-user applications are expected to operate in a competitive environment. Currently there are 7 payment service providers in the market. In this respect, innovations are expected to be developed, based on the CBDC ecosystem, i.e., micro-lending, investment instruments, credit rating facilities, e-commerce, etc.

There are important lessons regarding the design of the CBDC, but the following are noteworthy:

- As the Sand Dollar offers real time retail transactions, SFIs have no control over the transmission and settlement. Moreover, the envisioned ecosystem provides room for the

private sector to play different roles, while the central bank maintains control of the most strategic ones (i.e. minting and data protection).

- There are no relevant differences between CBDC access channels, either mobile- or card-based account options. Card-based accounts were introduced purely to satisfy the needs of the less tech savvy demographic. There is no direct cost for the final user in either option.
- In terms of data protection, whether there is a need to investigate nefarious activity or not, SFIs are always able to request information on a particular transaction.
- In relation to the balance sheet of the CBOB, the issuance of a CBDC will become a liability of the Central bank (same as fiat), but as the current pilot only represents a controlled issuance of Sand Dollars, this may not necessarily inflate the monetary base, nor have other policy implications.

As regards to the operation of the CBDC system, so far, the following lessons can be highlighted:

- Regarding the daily transactions monitoring, the CBOB has a dashboard that allows overseeing the circulation of Sand Dollars. A balance and evaluation of the pilot is expected to be done, and following steps will be determined.
- The CBOB is also exploring alternatives to better exploit a CDD/KYC framework to be implemented by all SFIs, MTBs or PSPs as a common incentive to access customers' data and with that being able to target new products for CBDC users.
- Potential disintermediation risks are controlled through limits to the amount of Sand Dollars that customers' can hold.

As regards a CBDC project:

- The CBDC project is a cost that is primarily undertaken by CBOB. With appropriated incentives, the agents in the market will allocate their efforts accurately.
- Starting the project in one of the Bahama islands was a crucial decision in order to eventually include the rest of the population. Indeed, habits on transactions are very important to both recognize and take into account. In that vein a national survey on spending habits is a necessary practice as part of the preliminary development of the project.
- Coordination with private sector is crucial; not only with financial institutions but also with payment providers, technological platforms, fintech, other authorities, etc.
- A CBDC has the potential to generate competition in the financial market and then better products and services. The design is a key point so that it does not impact financial system stability.
- Impacts on the balance sheet of the central bank, power of the monetary policy instrument, disintermediation, financial integrity or stability, payment markets infrastructures, competition in the market, price of the money, etc. is not that easy to estimate in early stages of the project.

5. Special update on the COVID-19 effects

Following the successful launch of the pilots in Exuma and Abaco, the CBOB and its technology provider are monitoring the economic activity and feedback from the various stakeholders and, in turn, applying a heuristic approach to refine the payment system's model. Upon examining the early returns, the CBOB decided to expand its outreach by mobilizing additional on-ground resources and working more closely with the participating financial institutions to on-board more businesses onto the payments network to proliferate the circulation of Sand Dollar for a more self-sufficient ecosystem. Unfortunately, the effort was curbed by the onset of the global COVID-19 pandemic, which by extension, also delayed the development of physical network infrastructure necessary to fully extend coverage across all piloted grounds. The CBOB is taking this state of affairs as an opportunity to strategize with wider stakeholder groups on various community-building initiatives and to further refine its current solutions in order to meet the future needs of changing economic and social norms stemming from the pandemic.

Some of the major technological milestones completed thus far are; extending card-less onboarding module to the authorized financial institutions, which eliminates the bottleneck and risk of future card production shortfalls and/or deficiencies while also enabling institutions to facilitate batch payments to many wallets instantaneously by uploading a single CSV formatted file. Given the glaring cybersecurity risks surrounding such an environment, the Bank continues to enhance the Sand Dollar monitoring footprint and management systems to ensure that stringent security conventions are being upheld. The Bank is also taking an active measure to advance regulatory reforms for the use of Sand Dollars through legislation as well as strengthening AML/CFT protocols through the deployment of a centralized customer due diligence (eKYC) module, which will be accessible by all participating institutions. The purpose of the module is to promote acceptance, portability, and interoperability of KYC data across authorized participants by developing a centralized repository and will be available for testing in the very near future. The two final major developmental work close to completion are the direct integration of Sand Dollar to the Automated Clearing House (ACH) and Real-Time Gross Settlement (RTGS) systems as well as offline functionality of sovereign wallets. As part of the ACH/RTGS integration, conversion between fiat and Sand Dollar will be accessible to those non-banking agencies (credit unions, PSPs, MTBs) that are not a part of the ACH/RTGS settlement network. Offline functionality will allow Sand Dollar wallets to deliver on the premise of 24/7 transactional availability irrespective of telecommunication network connectivity.

The CBOB anticipates that developmental work will continue to be underway during this critical time and that on-the-ground implementation will resume once the national restrictions are eased. While the crisis underscores the importance of upgrading our financial infrastructure, the urgent need to implement contactless payment methods also serves as a timely opportunity to further drive the adoption of Sand Dollar and create more use cases within other industries.

Looking forward, the CBOB will work closely with its technology provider to define the full-scale deployment of Sand Dollar platform nation-wide on an island-by-island basis. The framework of this

future phase will be subject to revision pending review of the outcome of the IT security assessment and the Pilot.

Peer Review Report: e-Krona

This document summarizes the main findings and information raised by the peer reviewers of the Central Bank Digital Currency project led by the Riksbank in Sweden, the so-called e-Krona. These findings were assessed from a questionnaire directly answered by Riksbank officers who are in charge of the e-Krona project. The inquiry process considered a reasonable offset between broadness and deepness in the questions raised.

It is important to note that this review does not intend to get a comprehensive overview of the CBDC e-Krona. On the contrary, this review place a set of notions that are useful for central banks to enlighten on the one hand, a broad understanding of the e-Krona project and, on the other, to help them learning on specifics technology and implementation matters of this CBDC project, from a central bank perspective²⁷.

1. Background

The use of banknotes and coins is declining in Swedish society. At the same time, technological advances concerning electronic money and payment methods are proceeding rapidly. These considerations have been generating a lasting dynamic of marginalization of cash in Sweden, which one has been motivating the e-Krona project. E-krona started publicly in 2017 and it is currently in a Proof of Concept (PoC) phase with some tests being considered using DLT technology.

The expert team in the Riksbank has underlined that the current state of the work on the e-Krona is analytical and experimental and that there is neither decision to issue a CBDC yet, nor any choice has been taken on any CBDC to be potentially issued. Any kind issuance of a CBDC will require approval by the Swedish Parliament. This step needs first the resolution of a government inquiry on the special issue, which has not yet started.

2. Motivation and design

The reasons that central banks have begun to consider exploring CBDC is certainly broad based. Thus, it is relevant first to clarify which reasons Sweden has for this project and, also, if there is a genuine need in their economical-financial landscape that motivates their research, exploration, and eventual future implementation of their e-Krona.

In this regard, some central banks have considered research, PoC and pilots of CBDC to be scoped in an Research and Development program without any real need in their jurisdictions, nor explicit

²⁷ If the reader intends to get more detailed information, please revise the footnotes of this report and the public references of the e-Krona project on <https://www.riksbank.se/en-gb/>

policy issues to be solved for their central bank.²⁸ Also, in recent years, the BIS and advanced economies have recommended only to deploy a CBDC if there exist first strong reasons for their central banks and only after a thoroughly previous assessment. However, the launch of the Libra project and the Corona virus pandemic have opened new opportunities for CBDC and some central banks, even large ones, are reconsidering their stance, see below.

Furthermore, peer reviewers identified that in some jurisdictions, central banks could consider imperative to have a counteraction to any Global Stablecoins scheme. For instance, this scenario could be the case where relevant cross-border payments are involved in the country. But at the moment it is not clear if every jurisdiction has already assessed this new kind of scenario, nor is it evident if for Sweden this could be a real concern for a current not real issue.²⁹ Indeed Riksbank acknowledge that these new digital products can potentially pose a threat to the sovereignty of the central bank authority to issue money if their central bank does not have a strategy to adapt their supply of services once these initiatives come true. According to Riksbank, such a situation could threaten the central bank's mandate to reach its monetary policy goals and, in a situation of financial unrest, even the central bank's function as lender of last resort (LoLR).

The Riksbank response to the peer-reviewers has indeed confirmed that the starting point of the e-Krona project begun from a real decline of cash usage in Sweden, namely, the displacement of public payment means. During the last decade, cash in circulation has halved from an already very low level. It currently amounts to approximately 1 percent of GDP. This is the result of the overall digitalization of the Swedish society, the introduction of payment innovations such as Swish, a mobile app that allows real time payments both peer-to-peer and P2B, and the change in consumption habits of the Swedish population with increasing online transactions. In this situation, the Riksbank is using the e-Krona to rethink its responsibility of both promoting safe and efficient payments and providing fiat currency as a public good. Additionally, the Riksbank consider that there is a need to provide a public alternative that has no commercial profit and protects individuals' integrity and privacy.

In essence, the motivation was that access to central bank money to the general public was still needed but that the technology used for it would need to be adapted to the digital era.³⁰

Depending on the domestic landscape and local definitions of central bank policy mandates, a design of a new type of CBDC could lead to several questions in terms of concerns/risks or even in terms of solutions/advantages in any policy matters of the central bank. Monetary policy and financial

²⁸ For instance, the first explorations of CBDC considering the DLT technology in their operational wholesale processes in Canada and Singapore, Project Jasper and Ubin, respectively, can be interpreted in this direction.

²⁹ In addition, it was asked to Riksbank what could happen to the Swedish economic-financial-monetary landscape if a foreign CBDC issuance or a new private digital currency could be the facto a natural mean of payment in their jurisdiction. This question was supported by some novel concerns that have been getting traction in the last two years, and which ones currently are with a new concept of the so-called "Global Stablecoins". This international concern certainly was developed strongly in 2019 with the first announcement of the stablecoin Libra.

³⁰ For more details on motivation, see e-Krona reports:

<https://www.riksbank.se/sv/betalningar--kontanter/e-Krona/e-Kronarapporter/e-Kronaprojekt-rapport-1/>

<https://www.riksbank.se/globalassets/media/rapporter/e-Krona/2018/riksbankens-e-Kronaprojekt-rapport-2.pdf>

stability issues, KYC-CFT regulations, financial inclusion considerations. All these macro topics could be relevant to analyze in a CBDC exploration process flow; however, the level of relevance in each country certainly could be quite different from one jurisdiction to another.³¹

In this direction, it is notable that to Riksbank, none of the above have been drivers for the e-Krona project. The starting reasons for the e-Krona are explicitly linked to the payments market. The rapid decrease in the use of physical cash has led Riksbank to explore new alternatives for its process of supply of money, and thus considering eventual new digital alternatives for cash, especially with uses in households and retail markets.

Nevertheless, even if neither financial stability nor monetary concerns were drivers to the initial project, in any case, for Riksbank it has been relevant to assess the implications of a potential e-Krona on both financial stability and monetary policy matters. According to the Riksbank, CBDC eventually could be deployed in Sweden without any material concern in monetary or financial stability issues³². In particular, analytical work indicates that likely, it would be plausible to avoid or manage systemic bank runs and disintermediation of the financial system.

Furthermore, the peer reviewers understand that this finding could encourage, in some particular jurisdictions, a role for the CBDC as a new tool for central banks and their payment mandates, that is, an alternative to the physical issuance of cash. Depending on the specificities of their implementation, it could have non-material secondary unwanted effects in the financial and monetary system.

3. Considerations for a potential implementation

Although during the last years there have been published several public reports concerning the e-Krona project, it appears that currently, there is not yet an available high-level workflow on the intended circulation of the CBDC, nor macro specifications on how the digital central bank money would be minted and then rolled out into the economy. As the Riksbank's expert e-Krona group stated, since the work is still in an exploratory phase, there is not a real urgency to publish any explicit consideration of the rules and economics that would undergird its supply and circulation. Moreover, for the current state of the e-Krona project, it is not possible yet to have a substantial evaluation of the similarities or differences between the physical issuance and its possible version in a digital form.

In the same direction, the current exploration of the e-Krona does not yet consider any definitive model of how the central bank would connect with other private players to deploy digital cash, in other words how the CBDC ecosystem would look like.

Nevertheless, it appears to be a direct distribution channel through banks and authorized payment service providers, with limited features and thresholds in comparison with traditional bank accounts. One possible confirmation is that the e-Krona project considers no significant financial stability issues,

³¹ BIS, 2019.

³² <https://www.riksbank.se/globalassets/media/rapporter/pov/engelska/2018/economic-review-3-2018.pdf>

so it is not envisioned a disintermediation process in the banking system. The demand for e-Krona would be determined by the market. The Riksbank will then meet the demand, just as with cash; the Riksbank would be responsible for issuing and in that sense in control of the supply. PSP would manage the roll out and management of e-Krona wallets/accounts, this is the operational issues of running the payment instrument. There are still very open questions of what sorts of operational issues in the distribution flow, after the minting process, would be controlled in some way by Riksbank. Even when, in any case, Riksbank is going to be the sole financial owner of the liability considered in the digital asset e-Krona, it appears there is still open which responsibilities of any critical process after minting would be charged to the central authority. In the same direction, there are unanswered questions on what sort of duties would be managed daily by third parties, such as payment service providers.

Given the early phases of the PoC³³, which could be underpinned with DLT technology, -in this experimental scenario- the e-Kronas are minted by Riksbank in some very particular e-Krona nodes and then distributed to other e-Krona nodes through a private DLT network. Under this exploration landscape, the e-Krona will be provided against reserves in the same way as it is with cash today. For instance, a person who wants e-Kronas orders her bank to make a transfer of reserves to the central bank, after which her account is credited in the e-Krona system or the newly issued tokens are registered in her name. In this scenario, the reserves of banks in the central bank with their collateral assets determines the liquidity provision.

Under this theoretical scenario, the central bank might have to revise its collateral policy to accept a broader range of collateral, and it should also monitor volatility in the amount of e-Krona since that may induce stress in the balance sheets of one or more banks. In this regard, the peer reviewers estimate this type of risk management policies and controls may need to be considered in a high-level perspective within the supply process of e-Krona. At the same time, the peer reviewers find relevant to considering this risk management processes in a detailed micro-level within the technological framework that supports some parts of the supply macro process itself. In particular, it is expected there should be some mechanisms built into the technological framework to counteract or short circuit any unintended liquidity risk.³⁴

³³ DLT PoC is being realized with Corda, a framework and architecture for DLT processes. For more information, see <https://www.r3.com/corda-platform>.

³⁴ As a reference, see the Sand Dollar Project Peer Review.

3.1 Possible scope

The peer reviewers also asked Riksbank some information that appeared as a second order in the CBDC explorations of Sweden but may be quite interesting for some other jurisdictions such as notions on financial inclusion and cross border payments.

Regarding cross-border transactions, Riksbank commented on Global Stablecoins concerns, but without further considerations related to the e-Krona or any link to remittances or how foreigners would access the CBDC system. In this regard, the peer reviewers estimate that even if remittance flows are not relevant to the current analysis for the e-Krona project, there could be some gains if the exploration considers some deeper notions of cross-border transactions. The peer reviewers' argument considers the recent disruptive development of Global Stablecoins and the historical integration process held in European financial markets. This entails shared rules or cultural practices that could strengthen the citizen perception of a "borderless landscape" in terms of payments.³⁵

CBDC could embrace a new cooperation agenda in the central bank community. In fact, the Riksbank acknowledges that indeed the current exploration of e-Krona includes some issues of interoperability and cross-currency payments provided by central banks. Also, given the recent developments mentioned as "Global Stablecoins" and the COVID-19 pandemic, Riksbank considers relevant to strengthen cooperation between central banks. Indeed, in the early 2020 Riksbank jointly with a group of central banks have started to assess potential cases for central bank digital currencies³⁶. This peer review diligence itself is certainly in that direction.

Concerning financial inclusion issues broader than the Riksbank mandate, given the Swedish landscape where aging population is becoming a policy concern, according to Riksbank, there are some challenges in the development of simple solutions that can be used by elderly citizens or by people who have some difficulties in the daily use of digital technology. It is interesting to note these obstacles are broader than the availability of suitable payment instruments; this is because the interactions with people and transactions are increasing as transactions deepen in digital realm, including interactions between public authorities and Swedish citizens. The Riksbank has mentioned that there is a need for a comprehensive approach from the public sector in cooperation with the private sector to alleviate these concerns.

In addition to the above, it is worth mentioning that the process for a minor to access a digital account has not been tackled yet in the e-Krona project. In the Sweden banking sector, an account for a minor is opened by the parents or guardians. The parents or guardians can decide to a large extent if a card (online only), mobile payment service, and a simplified online or mobile bank service should be attached. There are usually strong limitations on these services, e.g. the card works only in an online environment, there are no credit lines attached, only limited amounts can be transferred by the mobile service, and the online banking service only allows for transfers between own accounts.

³⁵ The recent entry in TIPS for Swedish krona could be viewed indirectly as a concrete case of this broad intuition of payments demand in Europe.

³⁶<https://www.riksbank.se/en-gb/press-and-published/notices-and-press-releases/press-releases/2020/central-bank-group-to-assess-potential-cases-for-central-bank-digital-currencies>

According to the Riksbank expert e-Krona group, it could be envisaged that the CBDC project could set up an inclusive model but with considerable limitations.

3.2 Legal considerations

The review also addressed legal actions to establish an entirely acceptable CBDC in Sweden. The Riksbank indeed made a petition to the Swedish parliament Riksdag, “The state’s role on the payment market”³⁷. In the petition the Riksbank proposes that a committee with all-round expertise should be tasked with performing a review of the concept of legal tender, the state’s role with regard to means of payment in a digitalized economy and the role and responsibility of both the state and the private sector on the payment market. The committee should propose the legislative amendments needed so that Sweden continues to have a stable and efficient payment market.

In June 2019 the Swedish Riksdag decided to support the Riksbank’s request regarding an inquiry into the payment market in a cashless digital economy and the roles of the central government and the private sector in such a market.³⁸

The peer reviewers find this interesting to follow as it will shade light for jurisdictions where major legal changes are required to possibly deploy digital fiat money. Conversely, there are projects like Uruguay where very little legal amendments have been required during the process.

3.3 CBDC against the PFMI

This section seeks to provide a non-exhaustively outlook of how the e-Krona project as a financial infrastructure could be assessed against sound principles.

The Riksbank was asked on which principles of the CPMI-IOSCO Principles for Financial Market Infrastructures would be critical to develop and deploy the e-Krona. Their comments stated that as a starting point, all principles relating to payment systems (P1 to 5, P7 and 8, P13, P15, P17 to 19, and P21 to 23) should be applied when assessing the e-Krona. At this early stage in the e-Krona project, their focus was on the principles on a sound legal basis (P1), governance (P2), risk management framework (P3), settlement finality (P8), operational risk (P17), access and participation (P18) and communication procedures and standards (P22).

The peer-review group acknowledges this pre-assessment an insightful exercise for central banks with interest in CBDC, as central banks could focus on some particular issues when they start to advance their analysis in terms of a potential new financial infrastructure in their own jurisdictions. Also, interestingly, according to the Riksbank CBDC approach, PFMI related to financial risk and general business are less relevant.

³⁷<https://www.riksbank.se/globalassets/media/betalningar/framstallan-till-riksdagen/petition-to-the-swedish-riksdag-the-states-role-on-the-payment-market.pdf>

³⁸ https://www.riksdagen.se/sv/dokument-lagar/arende/betankande/statens-roll-pa-betalningsmarknaden_H601FiU44

It is important to note that in the Riksbank perspective when the CBDC process is considered as a financial infrastructure, there is no third-party directly related to the CBDC infrastructure management. Hence, according to Riksbank all relevant PFMI would have to be applied to the Riksbank or the technical service providers used by the Riksbank, which in this case are still the ultimate responsibility of the Riksbank. In other words, this can be interpreted, on one hand, as an evident responsibility enforcement for the whole process to Riksbank, and on the other, it narrows to a very secondary frame all the issues related to the distribution of e-Kronas that are not relevant from a central bank perspective, for instance, some KYC or “digital onboarding” policies which may not be relevant to the central bank. Indeed, the Riksbank expert group commented that if it were to implement a DLT-based solution where PSP could operate nodes, the Riksbank, as owner/administrator of the whole system, is ultimately responsible for ensuring that the node operators living up to the set standard.

3.4 Other operational and technical considerations

This section considers information mainly related to the PoC in DLT that Riksbank is developing and some inferences made by the peer reviewers, based on the available information.

First of all, it is relevant to note that in this model, the CBDC process flow in terms of issuing, settling transactions and redeeming is operated entirely by the central bank. In such an environment, the central bank will, at a minimum, operate the so-called notary node (or nodes). It may also operate other nodes. Quite similar to other existing projects, PSPs will supply payment services to end-users and thus act as an interface between the CBDC-system/central bank and the end-users. A PSP may operate one or several nodes. It may also be possible for technology suppliers to operate nodes.

In terms of the whole CBDC processes, Riksbank considers that any adequate operational risk policy should induce the correct incentives to mitigate risks on all involved parties. Each participant should have to be responsible for the risks that it may be exposed to. As an example, a PSP that provides CBDC-based payment services to consumers should also be fully responsible for any consumer protection measures regarding fraudulent transactions being made through its system.

Some of the division of responsibility has to be made through a contractual agreement with the Riksbank. Secondly, the Riksbank has to do a periodical assessment on those PSP or technical suppliers that are a part of the CBDC-infrastructure. Penetration tests should be a part of this assessment. There are also ISO-standards that could be used as a reference. Thirdly, clear and transparent communication channels for crisis communication and information sharing should be established in advance. Clear division of authority and responsibility within organizations should be a part of this. Fourthly, clear and transparent communication channels for crisis communication and information sharing between participating institutions should be established in advance. Very similar recommendations but in ad-hoc basis for the central bank, any potential CBDC process directly operated by the central bank, also should consider correct incentives to mitigate risks for all involved decision-makers and central bank staff, and similar recommendations of operational policies should be placed as well.

Finally, Riksbank recommends implementing a forum for operational risks that meets regularly to share information and experiences.

4. Key Lessons

As identified along the document, the peer reviewers deem the e-Krona is a remarkable example to learn on specific CBDC policy making aspects. In terms of motivation, one can underscore the fact that potential hazard of a payments market failure in a situation where no public payments means are available in the public, can led the central bank to consider a (digital) payment instrument similar to fiat money. This could be conducive for economies where the payments industry lagged behind customer needs and innovation is available for central banks to fill the gaps.

In connection with the above, design considerations for the e-Krona are also clear in terms of the expected gaps to fulfill. This is a remarkable finding for central banks, given the concerns raised internationally on the unintended effects of a CBDC on financial intermediation. The e-Krona is conceived as a digital payment instrument for which the payments ecosystem will have to “plug-in” and with that provide the public with access to central bank money, but without any material concern in monetary or financial stability issues.

Despite the current status of the e-Krona project, the peer reviewers consider that the expected design will be one in which decentralized technologies will be used for the core system (minting, data safeguard) of the CBDC and a periphery in charge of rolling out the wallets and digital fiat money, will be made of authorized PSP, including banks. This is becoming a common approach in CBDC projects and, the results of a PoC, or even more a pilot, will be illustrative to see how the payments industry accommodates to a central banking led payment solution in an advanced economy. Yet, it is early to determine how the operation would look like and what technological economics will underpin the e-Krona, whether tokenized or 24/7 feature to be available.

As a quasi-retail payments system, a CBDC should be sound and safe. An approach to assess how the e-Krona will meet international standards such as the CPMI-IOSCO PFMI is useful to realize that operational, governance, access and business management are key to design and deploy digital cash. It will be necessary to revisit this kind of assessment when a decision on the next steps for the e-Krona project are taken. Indeed, this is purposeful approach any central bank may take when considering a CBDC initiative, because it takes comprehensively the several aspects of such a new paradigm, and not only the high-level policy making aspects.

To conclude, the peer reviewers highlights that central banks initiatives like the e-Krona are insightful and rich sources of policy alternatives for upcoming issues like the Global Stablecoins, the Bigtechs and Super Apps, but from a central banking perspective of attaining innovation to principles of safety and efficiency.

Peer Review Report: e-Peso

A central bank digital currency issued by the Banco Central del Uruguay (BCU), called e-Peso, circulates in Uruguay between November 2017 and April 2018. The digital issuance of this legal tender currency was done in the controlled framework of a pilot plan. The objectives of this experience were to test technological aspects of the e-Peso system and to learn about central banks digital currencies (CBDC).³⁹

The following report present key findings of a Peer Review on the Uruguayan e-Peso.

1. Background

The use of cash has been relatively stable and cashless payments have gained importance, especially with the advancement of the financial inclusion agenda set in Uruguay in early 2010's. Cash management in Uruguay is relatively high. Recent estimates show that the cost of using cash is below 1% of GDP, like in many economies, but it is mainly borne by retailers, households and also banks. Overall, there is room for reducing transaction costs in payments.

Against this context, the BCU takes seriously a proposal to test a technology for a digital currency that potentially could help the reduction in the use of physical cash, efficiency gains and security improvements in payments, and financial inclusion. The e-Peso pilot was designed to supplement cash by offering similar features but profiting from the benefits of being digital.

2. Motivation and design

The e-Peso was motivated to evaluate several aspects of new technologies and central bank business model. It was also useful to answer relevant questions about the impact of a CBDC on specific sectors. The pilot intended to determine a possible design for a CBDC adapted to Uruguay in case policymakers decide to put it in production.

Other key aspects that motivated the e-Peso pilot, include the following: (i) to test in a real world, yet controlled, experiment a technology to issue and put in circulation a CBDC for the retail sector, (ii) to learn about CBDC in general, and the specific implementation in particular, (iii) to learn whether CBDC could help meeting public policy goals like improving safety and efficiency in payment systems, financial inclusion, security, and the provision of a level playing field for financial innovation.

Between 2014 and 2017 the BCU led several feasibility studies, legal assessment, risk management in order to mitigate and hedge risks. The pilot was conducted during 6 months from November 2017 to April 2018. Since then, a series of evaluations are being conducted in order to inform decision-makers on further steps.

³⁹ Bergara, M. and Ponce, J. "Central bank digital currency: The uruguayan e-peso case". Edited at Conference Proceedings 2018/2 "Do We Need Central Bank Digital Currency? Economics, Technology and Institutions ». Société Universitaire Européenne de Recherches Financières. June 2018.

For the establishment of the project, it was assessed at the outset whether the BCU had the legal to issue digital money. In effect, the law indicates that BCU holds the monopoly to issue Uruguayan Peso without specifying the mean or format. Hence, it can be interpreted that BCU can issue e-Pesos. Nonetheless, there is a proposal to include explicitly in the law that the issuance could be either in physical or in digital formats.

In terms of design, the e-Peso is a general-purpose digital currency. The e-Peso was intended to be another representation, i.e. digital, of the legal tender currency of Uruguay. Since it aimed to replicate the same features of physical cash, it did not bear interest. Moreover, the BCU required that the test digitally represent the Uruguayan Peso, i.e. the e-Peso, keeping as far as possible the same features than physical banknotes. In fact, peer reviewers found that this a special design feature that is unique against other CBDC projects, and it may bring benefits and costs in terms of security and scalability, respectively.

Finally, and perhaps more importantly, the peer reviewers confirmed that the current legal framework does not allow opening accounts to the general public at the central bank. Thus, the importance of tokenizing the e-Pesos and distribute them via specialized account managers who directly operates with payment service providers in charge of the onboarding. This ecosystem allowed the BCU to both fix the security required for the issuance of digital cash and allowing end-users to access the payment instrument, namely e-wallets.

E-peso provides instantaneous payment. Given the scope of the pilot, it was not feasible to assess pricing, and the operational and financial costs of running a CBDC. Another important aspect that were not tested directly by the central bank during the pilot, has to do with supporting 24/7 operation and the respective scalability of a national fully available digital currency. This was a role played adequately by the vendor but that may require further research on whether the BCU would be able or willing to make the e-Peso 24/7.

3. Technology and implementation

The core e-Peso system has two components. First, a “digital mint” generates the e-Peso notes and uses cryptography to provide security. Digital notes are then tokens. Nevertheless, the system needs a second component to operate and e-Pesos could not be transferred directly among final users without being validated in this second component: “a digital vault.” This vault hold e-Pesos in individual and anonymous digital vault that are linked one-to-one with final users digital wallets. Hence, e-Peso is not purely token-based neither account-based in their classical definitions: tokens need to be centrally validated and there is not accounts but vaults. The partition of information allows to provide anonymity to transactions since final users are just identified through their telecom provider and digital wallet, but they are anonymous in the core system. Nonetheless, transactions can be traced back and the identity of users revealed under the authorization of a competent authority, e.g. a court of law.

Regarding the above, the central digital vault manages and stores all the transaction data. This is one of the reasons why it is being evaluated who manages this component of the system, should e-Peso go into production. Other component, i.e. final user digital wallet, is managed by other participants and need to interoperate under technical and security standards. Several aspects related to these points are under evaluation in order to inform the final design of the system.

The e-Peso system requires several participants. The BCU is clearly the responsible of issuing e-Pesos. During the pilot, the central digital vault and support was outsourced to IBM. It was considered whether, should the e-Peso go into production, this component should be directly managed by the central bank. Final users access the system through their mobile phones, which need to have a working cell phone line with Antel, the state-owned telecom company. Their need to use a digital wallet, an app, provided by InSwitch, a Uruguayan start-up. As mentioned, this design is under evaluation, some parts could change its management and others could be open to competition and the provision of services by several competitors.

For the implementation process, the e-Peso pilot was limited in size in order to keep risks under control. During the pilot there were not technical incidents. According to preliminary technical evaluation, scalability could be done without technical issues. Regarding interoperability, the design of interconnection with existing payment systems, and potentially with banks accounts, is under evaluation. Furthermore, previous to the pilot, several tests were conducted to ensure business continuity. Contingency plans were also developed. Of course, cyber-security, business continuity, data protection, 24/7 support, will be of particular importance should a CBDC like e-Peso goes into production. This must be underlined as risk management was an important part of the evaluation of the pilot prior to decide launching it.

In terms of business continuity, the pilot comprised existing contingency plans to keep running the system. In that respect, the e-Peso system uses internet as the principal channel and the USSD telecom protocol as secondary and contingency channel. Important noting that the e-Peso pilot did not feature off-line transactions, but without internet, transactions were processed on-line via the USSD protocol. While security of the e-Peso was largely tested during the pilot, the BCU concluded that the system performed correctly under strong standards, yet cyber-threats could not be completely ignored and adequate risk management might be necessary in the future.

As regards the last mile, during the pilot, the e-Peso was advertised through the media, e.g. television. It was also in place a system of incentives: (i) first users (1000 wallet holders) gained automatically 1000 e-Pesos, (ii) 20 monthly awards of 1000 e-Pesos were granted to most active users and retailers. The cost of the advertising and incentives was borne by the private counterparty, i.e. The Roberto Giori Company.

Concerning use and adoption, 90% of registered users were older than 25: approximately half to them were between 25 and 40. Approximately 2/3 of registered users were men. Onboarding was voluntary and given the pilot was limited in size, the users adopting e-Peso in the project do not necessarily represent the entire population.

4. Key lessons

The future steps of the e-Peso are under consideration by the central bank. Hence, it is not possible to forecast how the e-Peso could be adopted. It is also not plausible to know if the e-Peso will go into production and if yes, it is also uncertain the specific design and parametrization of the in-production system. For instance, the peer reviewers highlight that if the vendor solution that was used for the pilot is likely to be used on a CBDC system for national scope, it could bring scalability challenges. This could be a red flag for central banks when dealing with vendors and solutions providers to ensure the design of a CBDC can be met by third parties playing a role in such a “payments system”.

Above all, it has been an enricher experience. It has involved great effort by an interdisciplinary team inside the BCU, in collaboration with external technological companies. Several technological aspects have been tested and several other questions were raised and are under evaluation thanks to the pilot. One can underscore that critical concerns that should be managed ex-ante by the central bank, comprise: safety policy and rules, market structure and industry dialogue.

A CBDC like e-Peso would have a potential for financial inclusion and for financial innovation by third parties. It could provide a prolific field for competition through innovative financial products trying to fulfill customers’ increasing digital needs. It could also increase competition on existing cashless payment instruments. All these aspects are being taken into consideration for a potential final design and parametrization for a CBDC system. Moreover, the BCU is conducting an evaluation to analyze other technologies and systems in order to fulfill its mandates and contribute to a healthy development of the payment system.

A very preliminary assessment indicates that there will not be major disruptive effects in the financial intermediation activity, nor in the transmission mechanisms of monetary policy. Importantly, such effects will depend on the design and parametrization of the CBDC system, e.g. on their cases of use, limits to transactions and cash holding in digital wallets, etc. Nevertheless, aspects like the velocity of circulation, the stability of the money multiplier and the propension of final users to use cash could be altered. Other aspect that need to be considered is regarding transactional information.

There are important lessons regarding the design of the CBDC, but the following are noteworthy:

- After concluding that the legislation and the mandate of BCU were enough to conduct the pilot, several risks were necessary to map and control, including: cybersecurity, data protection, financial risk, business continuity and reputation. Several technical tests were conducted, financial risk was hedged through guarantees of the counterparties and reputation risk was minimized by restricting the pilot in several respects: size, number of users and by isolating the pilot from the banking sector.
- For the scalability of a CBDC system, the BCU is still evaluating the pilot results, but preliminarily one can underscore that there are important concerns about the hardware (and its costs) necessary to scale up the e-Peso, the management of the central digital vault, the

24/7 technical support (at IBM during the pilot), and other operational issues related to monetary policy.

- The peer reviewers find extremely important to emphasize how relevant is the design stage of a CBDC pilot. Given a design in which digital identification of individual banknotes and coins prevails, the scalability and scope of the CBDC system could be limited by the own central bank infrastructure or the interaction with relevant payment service providers. Yet, the traceability gains in such a system could be considerably powerful under such design.

As regards the operation of the CBDC system, during the pilot, it can be highlighted the following lessons:

- During the pilot, registered business just needed a mobile phone to operate e-Peso. Given the small scale and limited time of the pilot no other investment were done to link existing billing systems to the e-Peso system, and existing communication technology were enough to operate the e-Peso. The core system was provided by the central bank, but it would be necessary further analysis to determine the ways in which other payments platforms and systems (POS, for instance) will connect to the core system. It could be feasible although it was not tested during the pilot.
- Overall, the pilot works without technical incidences, in particular regarding final users. Users' requests were handled by IBM, who provides the call center support during the pilot, and refer to forgetting the password or recovering the digital wallet after changing cell phones.
- On average during the pilot, users have a profile compatible with the already financially included. Despite the relatively small-scale pilot, there is some evidence that e-Peso might have reached non-included users.

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