The Bank of Japan's Approach to Central Bank Digital Currency

May, 2021

Bank of Japan

I. The Bank of Japan's Approach

1. CBDC

- **CBDC (Central Bank Digital Currency)** is a new form of digital central bank money that is different from the incumbent central bank deposits.
- CBDC is a payment instrument that is **a direct liability of the central bank**. It functions as a unit of account as it is denominated in legal tender of the jurisdiction.

		Form **Digital** ● Physical ○	Issuer **Central bank** ● Private ○	Amount outstanding (as of the end of September, 2020)
Wholesale access	**Central bank deposits**	●	●	**487 tril. JPY**
	Wholesale CBDC	●	●	—
Universal access	**Bank deposits**	●	○	**1,564 tril. JPY**
	Cash	○	●	**119 tril. JPY**
	General purpose CBDC	●	●	—

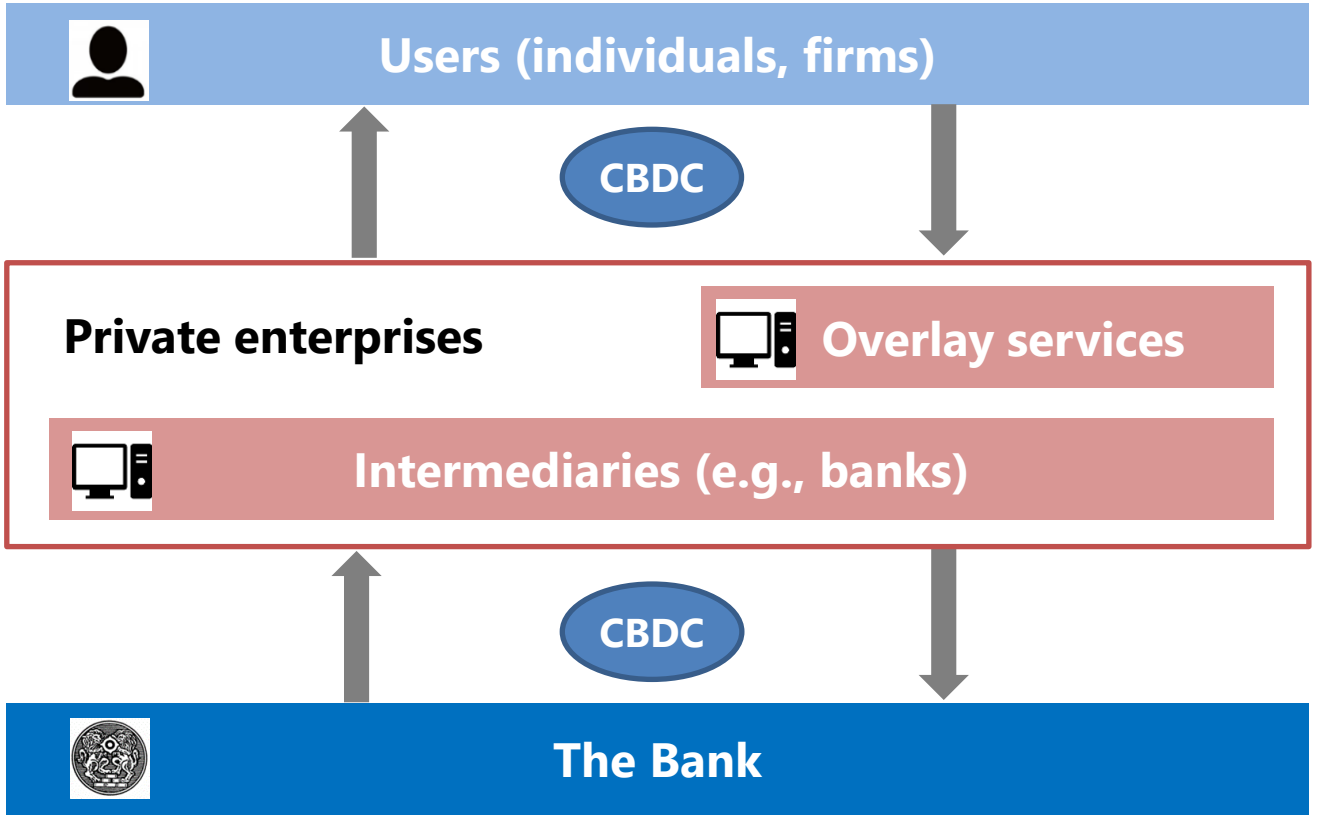
Note: "Bank deposits" is the sum of demand deposits, term deposits, and negotiable deposits by domestically licensed banks, foreign banks in Japan, agricultural financial institutions, SME financial institutions and other financial institutions.
Source: Bank of Japan

2. Basic standpoint of the Bank

- Digitalization has advanced in various areas at home and abroad on the back of rapid development of information communication technology. There is **a possibility of a surge in public demand for CBDC going forward**, considering the rapid development of technological innovation.
- While **the Bank currently has no plan to issue CBDC**, from the viewpoint of ensuring the stability and efficiency of the overall payment and settlement systems, **the Bank considers it important to prepare thoroughly** to respond to changes in circumstances in an appropriate manner.
- Therefore, **the Bank will carry out experiments and deepen its exploration of institutional arrangements**, coordinating with stakeholders at home and abroad.
- **The future payment and settlement systems suitable for a digital society** need to be discussed with various stakeholders. CBDC could have more of a function than merely as a payment instrument alongside cash. It could serve as the basis for innovation of private payment service providers (PSPs; e.g., banks and non-bank PSPs) to offer various new payment services.
- As long as there is public demand for **cash**, the Bank will stay committed to supplying it.

3. Issuance model of CBDC

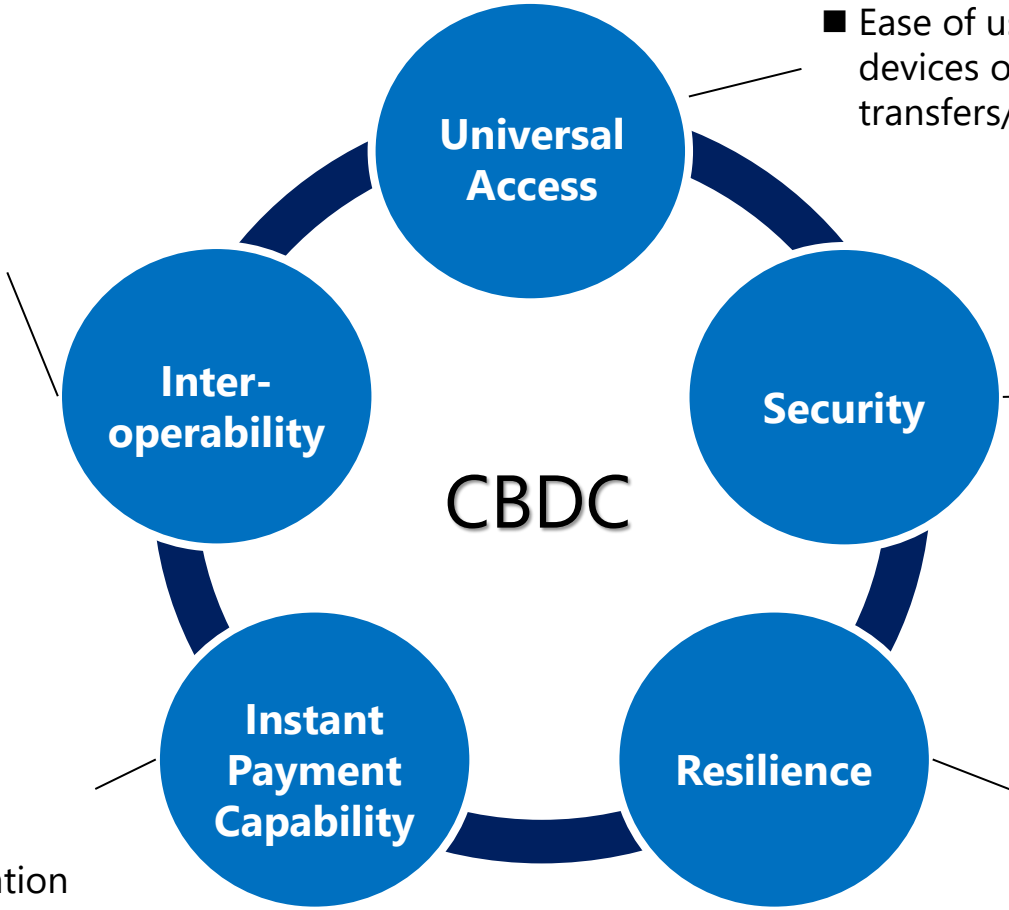
- Even if the Bank were to issue general purpose CBDC, it would still be **appropriate to maintain a two-tiered payment and settlement system** of a central bank and the private sector (i.e., **indirect issuance**).
- Intermediaries and other private enterprises provide services **in accordance with user needs** through their knowledge and technological innovation. The Bank designs and provides **a CBDC that would serve as the basis or ingredient** of such services.



4. Core features required for CBDC

- If the Bank were to issue general purpose CBDC, CBDC would **need to have the following instrument and system features**.

  -- When introducing CBDC, it might be appropriate to implement the features of universal access and resilience in a phased manner according to the use of cash.



- Ease of use and portability of devices or cards used for transfers/payments
- Counterfeit deterrence technology
- Security to prevent various illicit activities
- 24/7/365 availability
- Offline use support
- Settlement finality
- Instant payment capability
- Sufficient processing capability
- Scalability in preparation for the future
- Interoperability with other payment and settlement systems
- Flexible architecture to adapt to changes in the future

II. Experiments (Proof of Concept Phase 1)

1. Outline of the 'PoC Phase 1'

(1) Purpose

- As the initial phase of experiments, the Bank will first test the **technical feasibility** of the core functions and features required for CBDC through a Proof of Concept (PoC).
- In the 'PoC Phase 1', the Bank will develop a test environment for the CBDC system and conduct experiments **focusing on CBDC's basic functions as a payment instrument, including issuance, delivery, transfer, reception, and redemption**.

(2) Test environment

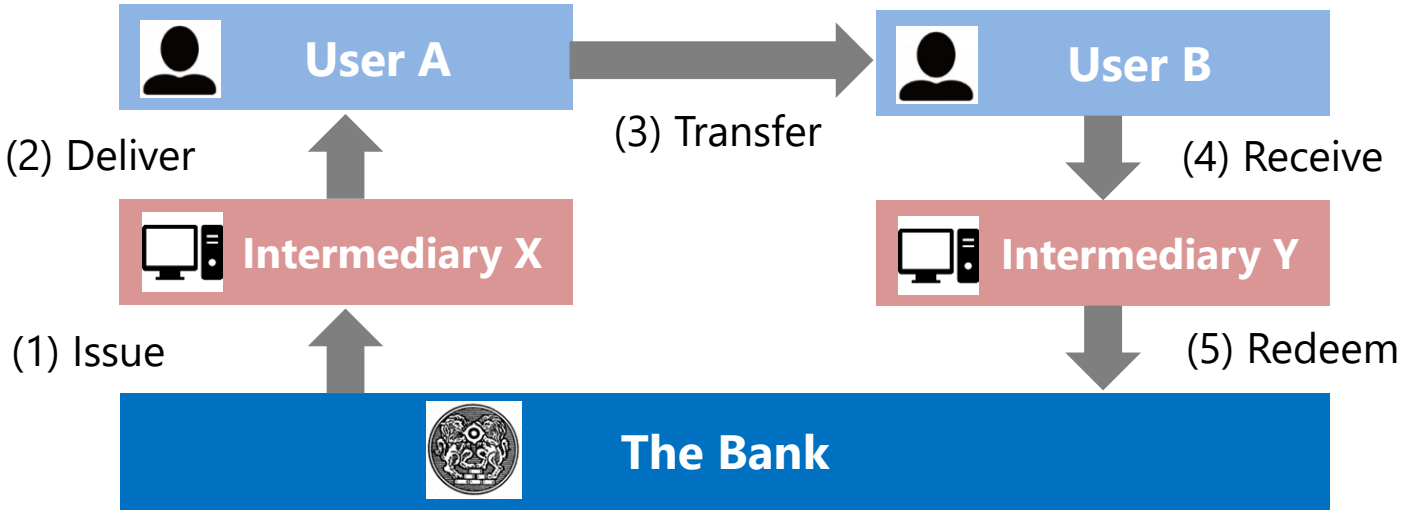
- In line with the purpose of this experiment, **the test environment will be developed focusing on the 'ledger'**, which is the foundation of the CBDC system and records transactions representing basic functions mentioned above.
  - -- Linkage with the BOJ Net system, systems of intermediaries, and wallet apps for end-users are assumed using their mock-ups.
- This experiment will be conducted by the Payment and Settlement Systems Dept. of the Bank, supported by a contractor selected through a tender process.

(3) Timeline

- This experiment started in **April, 2021**. It is expected to continue **for one year** until March, next year.

2. Basic functions as a payment instrument

- CBDC, **issued** in exchange for current account deposits at a central bank, is **delivered** to a user through an intermediary. CBDC, delivered from an intermediary, is **transferred** between users. CBDC, **received** by an intermediary, is **redeemed** in exchange for current account deposit.



	Flow of CBDC
(1) Issue	Debit current account deposit of Intermediary X, and issue CBDC
(2) Deliver	Debit account (e.g. bank deposit) of User A, and deliver CBDC
(3) Transfer	Transfer CBDC between Users, along with their transactions
(4) Receive	Receive CBDC from User B, and credit his/her account (e.g. bank deposit)
(5) Redeem	Redeem CBDC from Intermediary Y, and credit its current account deposit

3. Three deign models

- In this experiment, for the conceptual design of CBDC ledger, three models are to be developed, compared and tested, assuming **online payments** only. These models are classified by 1) **the ledger management structure** (the Bank/intermediaries), and 2) **the underlying data structure** (account-based/token-based).

Model	(1) Ledger management structure	(2) Underlying data structure
Model 1	The Bank	Account-based
Model 2	The Bank and intermediaries	Account-based
Model 3	The Bank	Token-based

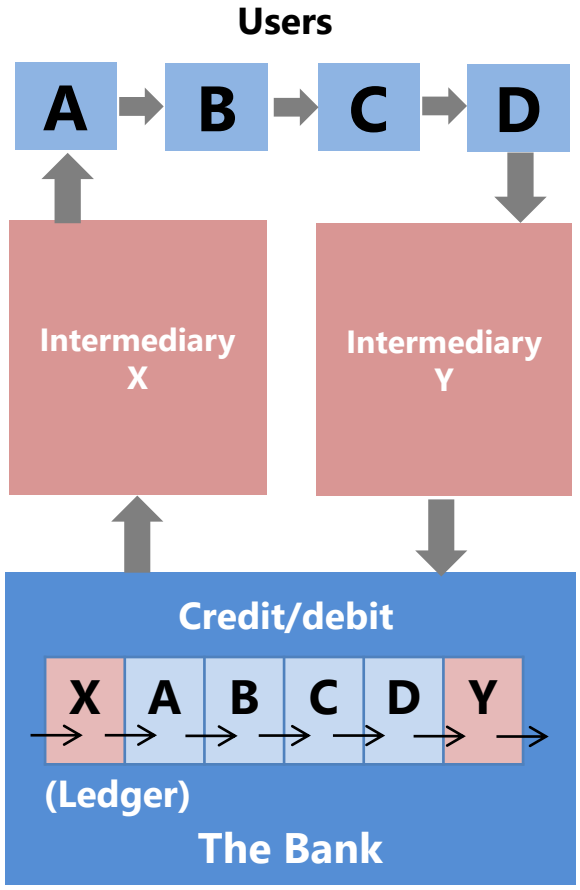
Note: In this experiment, 'token-based' data structure means the state of the system as a list of identifiable data of a specific value (or 'tokens'), each of which has a corresponding 'owner' who can control the token.

- For each model, 1) requirement definition, 2) system design and development, 3) tests and actual machine verifications, and 4) desktop verifications will be conducted in an organized manner.

4. Ledger management structures and underlying data structures

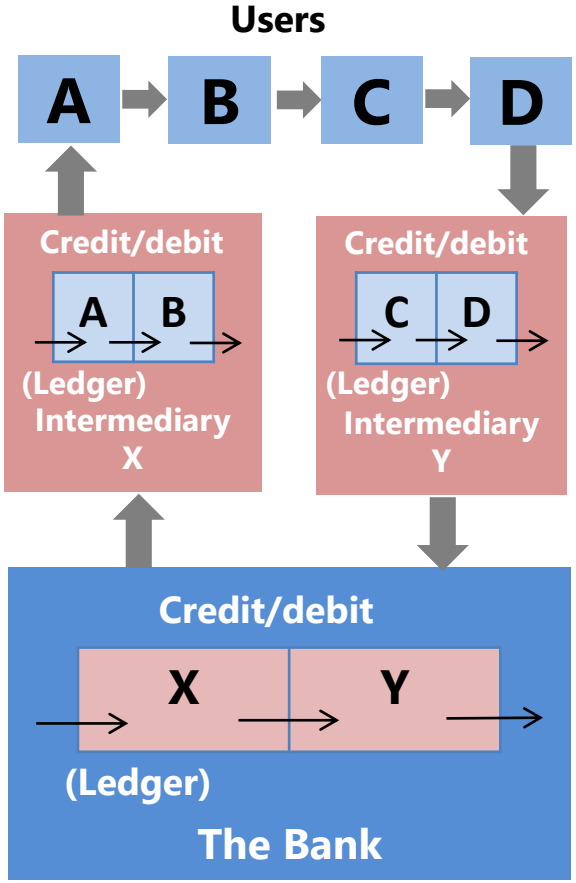
Design model 1

- **The Bank** manages the ledger.
- CBDC is transferred **by crediting to and debiting from the accounts**.



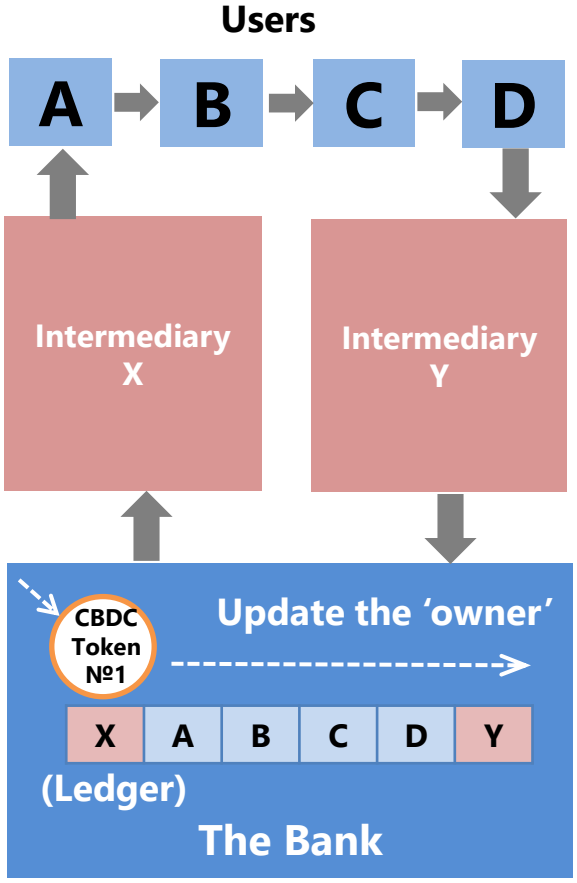
Design model 2

- **Intermediaries** manage the ledgers recording the balances of users, while **the Bank** manages the ledger recording the balances of intermediaries.
- CBDC is transferred **by crediting to and debiting from the accounts**.



Design model 3

- **The Bank** manages the ledger.
- CBDC is transferred **by updating the 'owner' of each token**.



means CBDC flow.

5. Testing future scalability

- While the test environment for the PoC Phase 1 will be a small system aiming to test basic functions of CBDC, we will compare and evaluate **the feasibility and practicability of additional functions** for each model to be prepared for the future eventuality where development of the live CBDC system is decided.

-- Such additional functions will be, if necessary, deployed in the PoC Phase 2.

▽Offline payments
▽Remunerations, holding/transaction limits
▽Interoperability with other systems
▽Cyber security
▽Ensuring anonymity
▽Embedding transaction data
▽Programmability　etc

- **Performance (throughput, latency)** of the system will also be verified using the test environment, and scalability of each model will be compared in light of the high operational load of the live CBDC system.

III. Future Steps

1. Experiments

- The Bank will **carry out experiments in a phased and planned manner** to explore general purpose CBDC in a more concrete and practical way.
- Once the purpose of the 'PoC Phase 1' is achieved, the Bank will step forward to '**PoC Phase 2**'. In this phase, the Bank will implement additional functions of CBDC (e.g., additional functions listed in Slide 11) in the test environment developed in Phase 1 and test their feasibility.
- Based on the PoC, if the Bank judges it necessary to step things up further, it will also consider a '**Pilot Program**'.

PoC Phase 1	**PoC Phase 2**	**Pilot Program**
Develop a test environment for the CBDC system and conduct experiments on the basic functions that are core to CBDC as a payment instrument -- namely, issuance, distribution, and redemption. →Started in **April, 2021**.	Implement additional functions of CBDC in the test environment developed in Phase 1 and test their feasibility.	Based on the PoC, if the Bank judges it necessary to step things up further, it will also consider a pilot program that involves PSPs and end users.

2. Exploring institutional arrangements

- The Bank will **explore institutional arrangements**, in cooperation with private enterprises, IT specialists, legal experts, and relevant public authorities. Priority areas of exploration are:

(1) Cooperation and role-sharing between a central bank and private enterprises

- ✓ Central bank's roles
- ✓ Intermediaries' roles, their numbers/requirements
- ✓ Scope of overlay services, their providers
- ✓ Business models to fund CBDC system

(2) Relationship with financial stability

- ✓ Economic design of CBDC, including caps and remuneration

(3) Ensuring privacy and handling user information

- ✓ Anonymity expected for CBDC
- ✓ User information for authentication
- ✓ AML/CFT compliance
- ✓ Utilization of transaction data

(4) Technical standardization

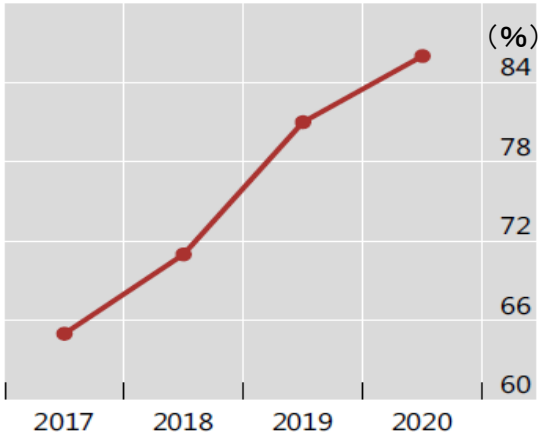
- ✓ Interoperability with other domestic systems
- ✓ International standardization (e.g., data format) and possible application for cross-border payments

(Appendixes)

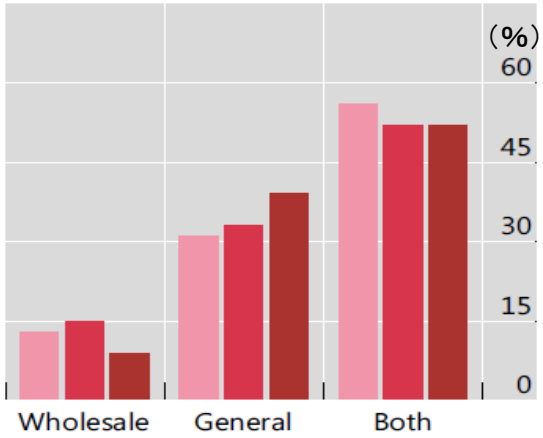
1. Works on CBDC in other jurisdictions

- The result of a survey carried out by the BIS (Bank for International Settlements) during October-December of 2020 shows that **86%** of 65 responding central banks are engaging in some form of CBDC work.
- Work related to '**general purpose CBDCs**' is gaining in relative popularity.
- The share of central banks conducting **'experiments or proofs-of-concept'**, in addition to research activities, has significantly increased from 2019.

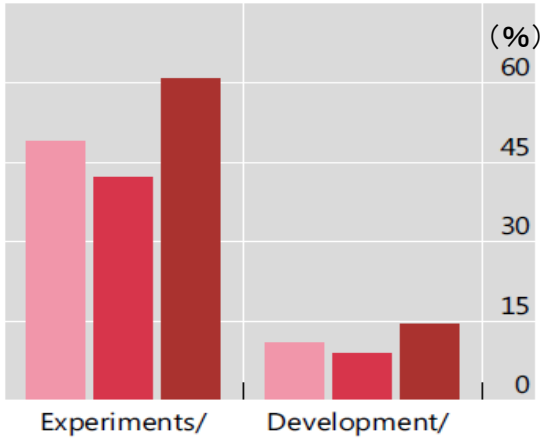
Engagement in CBDC work [1]



Focus of work [2]



Type of work in addition to research [2]



1: Share of respondents (65 central banks).
2: Share of respondents conducting work on CBDC.
Source: Boar, Codruta and Andreas Wehrli, "Ready, steady, go? – Results of the third BIS survey on central bank digital currency," BIS, January 2021.

2. Activities of CBDC Group

- The central banks of Canada, **Japan**, Sweden, Switzerland, the UK and the US, along with the ECB and the BIS, have been carrying out joint researches on CBDC since last year.
- The report published last October set out the '**foundational principles**' and the '**core features**' for a central bank's consideration of CBDC issuance.
- A continued and deepened shift in emphasis towards **practical policy research and applied technical experimentation** is under way.

Foundational principles

1. **No harm to monetary and financial stability**
2. **Coexistence and complementarity of public and private money**
3. **Promotion of innovation and efficiency**

Core features

Instrument	Convertible, Convenient, Accepted & available, Low cost
System	Secure, Instant, Resilient, Available, Throughput, Scalable, Interoperable, Flexible & adaptable
Institutional	Legal framework, Standards

(CBDC Group: Questions to guide further research)

Core features of CBDC

- What are the best approaches to system design that enables all key features?
- How can features that enable convenient use (eg open access, offline usage) and low costs be balanced with security considerations?
- How should systems be secured against the most sophisticated attackers? What is the path to ensuring future-proofing of a CBDC?
- Can tamper-resistant devices for offline transactions survive unbreached for long periods of non-connectivity?
- How can future demand be forecast? Is there an upper bound to scalability where the incremental cost per transaction is not acceptable?

Institutional arrangements of CBDC

- How effective are potential controls against risks to financial stability (eg caps, use of interest rates)?
- Which cryptographic techniques can be usefully applied to privacy? What institutional arrangements will be required along with technology?
- What are efficient approaches to KYC/AML/CTF?
- What data should be collected by participants in the CBDC system, including the central bank?
- What CBDC design can best enable cross-border efficiencies?
- Is there value in developing standards for CBDC (eg interoperability between jurisdictions, avoiding vendor lock-in and enabling vendors to build products for common market)?

Note: Excerpt from the CBDC Group report