

Central Bank Digital Currency: The Series, Vol. 2

Central Bank Digital Currency (CBDC): Retail Considerations

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Abstract

This paper in our Central Bank Digital Currency series looks at the implementation and design considerations for a retail CBDC in the Canadian context. A retail CBDC is aimed to take on traditional attributes of physical cash and would be used by consumers and businesses (relative to wholesale CBDC, which would be used by financial institutions). The Bank of Canada has taken into consideration the declining use of cash and the sovereignty of monetary policy transmission when discussing the objectives of a retail CBDC in Canada. This paper outlines the Bank of Canada's motivations behind retail CBDC issuance, the attributes needed for successful retail CBDC implementation in Canada, and investigates token versus account-based retail CBDC design considerations.

Objectives for a retail CBDC in Canada

The Bank of Canada has signalled its intentions to develop a retail CBDC in Canada in several short working papers,¹ public addresses² and through participation in collaborative discussions with other central banks,³ while at the same time making clear that, “there is currently no compelling case to issue a CBDC.”⁴

As mentioned in the [first paper of the CBDC series](#), the Bank of Canada has defined drivers that would cause them to issue a CBDC. These are:

- The emergence of an alternative currency (such as Diem, previously known as Libra)⁵ that could undermine the Canadian dollar as a unit of account and threaten monetary sovereignty and potentially render it a less stable store of value.
- The continuing decline in cash use which constrains fiat currency as a medium of exchange for everyday transactions. This could redirect end users toward costlier alternatives (i.e., commercial electronic and card-based payments), and risks excluding vulnerable individuals and remote communities.

The main objective of a retail CBDC in Canada is the maintenance of the Canadian dollar as the safest and most universally accessible form of money in the domestic setting. A Canadian CBDC would be a digital alternative to fulfill the role that banknotes currently play, and should provide the following attributes:⁶

- No-cost universal access to a ubiquitous medium of exchange;⁷
- A degree of privacy for end-users who store or transact with a retail CBDC;
- Be a competitive product in the payments market against other payment offerings for end users;

¹ e.g. <https://www.bankofcanada.ca/research/digital-currencies-and-fintech/>

² [Exploring new ways to pay. Speech by Timothy Lane - Deputy Governor, Bank of Canada. CFA Montreal FinTech RDV 2020. February 2020](#)

³ [Central bank group to assess potential cases for central bank digital currencies. BIS Press release. January 2020](#)

⁴ [Contingency Planning for a Central Bank Digital Currency. Bank of Canada. February 2020](#)

⁵ <https://www.diem.com/en-us/>

⁶ Ibid.

⁷ This is dependent on widespread adoption of CBDC.

- Resiliency to be constantly available for use, ward off cyber-attacks and function securely under varied and challenging conditions.

Design attributes for a retail CBDC

In addition to these attributes, a retail CBDC should be designed in a manner that would reduce the potential negative consequences of its introduction, including:

- disruption to the commercial banking role in the economy, particularly under conditions of macroeconomic stress;
- introduction of a new channel for illicit activities, money-laundering, terrorist financing and other socially undesirable behaviours.

The following are additional attributes for the successful design and implementation of a retail CBDC in Canada:

Universal access

Recent surveys by the Bank of Canada⁸ and Statistics Canada⁹ indicate that almost all adult Canadians (99%) have a deposit account with a financial institution and have been issued a bank card for debit purchases and ATM withdrawals. The surveys also found that almost 90% of adult Canadians owned at least one credit card issued by a financial institution.

However, up to 15% of Canadians qualify as “underbanked”¹⁰ and are unable to access a broad range of banking services. Limited access to banking services may be driven by monthly account costs, minimum account balances, and high penalty fees for non-sufficient funds (NSF). Additionally, branch closures in low-income, rural and remote communities have further eroded access to banking services and redirected underbanked communities to high-cost payday lenders and cheque-cashing services. Physical impairments and socioeconomic vulnerabilities may exacerbate these factors. Low-income Canadians, newcomers to Canada and seniors may be particularly vulnerable to financial exclusion driven by these costs and accessibility issues.¹¹

Today, cash offers an accessible, low-cost payment alternative for underbanked Canadians. While

⁸ [2017 Methods-of-Payment Survey Report. Bank of Canada. December 2018](#)

⁹ [Survey of Financial Security \(SFS\). Statistics Canada. 2019](#)

¹⁰ [It's Expensive To Be Poor: How Canadian Banks Are Failing Low Income Communities. ACORN. 2016](#)

¹¹ [Designing a CBDC for universal access. Staff Analytical Note 2020-10. June 2020](#)

accessing cash may have costs associated with withdrawal, such as maintenance of a chequing account and ATM withdrawal fees, once in circulation, cash can be exchanged without additional cost to the consumer.¹² Even with the absence of local banking infrastructure, cash allows un/underbanked populations to participate in the economy.

A CBDC design should take into account the universal accessibility of traditional cash/coins and attempt to mimic these attributes in order to encourage widespread adoption of CBDC and support financial inclusion. Universal access attributes of a CBDC could include offline functionality, provision of universal access devices and compatibility across multiple devices.

Privacy

Consumers are concerned about the privacy of their transactions. Focus group testing by the Bank of Canada “has emphasized the importance of privacy for users of payment systems.”¹³ In a CBDC implementation, the Bank must weigh transaction visibility against the traditionally anonymous nature of cash.¹⁴ Bank of Canada research has also established that reduced privacy in individual transactions may allow firms to “use data collected through payments to price discriminate among future customers.”¹⁵ Because individuals do not immediately bear the effects of sharing data, privacy becomes a public good that should be considered when developing CBDC design and associated policy.¹⁶

A CBDC with the same level of privacy as traditional cash is highly unlikely. As with cash, privacy may be limited in the service of public safety priorities around money laundering, terrorist financing, tax evasion and parallel market activities, particularly for large CBDC transactions. Currently, financial institutions, as well as other entities that facilitate cash and large value transactions, such as casinos, real estate agencies and insurance companies, are required to establish client identity through Know-Your-Client (KYC) procedures.¹⁷ Furthermore, they must report suspicious, international and large cash transactions to the Financial Transactions and Reports Analysis Centre of Canada (FINTRAC). Should CBDC not offer the same level of anonymity

¹² [The Costs of Point-of-Sale Payments in Canada.” Bank of Canada Staff Discussion Paper No. 2017-4. 2017](#)

¹³ [Contingency Planning for a Central Bank Digital Currency. Bank of Canada. February 2020](#)

¹⁴ [Privacy in CBDC technology. Staff Analytical Note 2020-9. Bank of Canada. June 2020](#)

¹⁵ [Privacy as a Public Good: A Case for Electronic Cash. Bank of Canada Staff Working Paper No. 2019-24. July 2019](#)

¹⁶ [Ibid.](#)

¹⁷ [Financial Transactions and Reports Analysis Centre of Canada](#)

and privacy as cash, some users may be driven to alternative private digital currencies or continue using cash. There are several technological solutions that can support CBDC user privacy, including zero-knowledge proofs where claims can be verified without revealing any underlying data.¹⁸ Balancing the public and private goods associated with transaction privacy with public safety will be a key decision for any CBDC design.¹⁹

Competition

Financial service providers seek revenue from the payment services they provide. The costs of using these services differ and may be borne by the payor or payee. For example, credit card transaction costs at the point-of-sale are typically charged to the merchant and include interchange, acquirer processing and network fees, which amounts to 2% of the transaction amount, on average.²⁰

Market asymmetries (i.e., only one end user paying fees), lack of available alternatives, and industry concentration can lead to high costs associated with accessing a payment method. Cash currently acts as a competitive offering in the payments space because, as a payment option, it constrains market power that could develop with commercial offerings alone.

Resilience

Payment system operators and participants devote considerable effort to ensuring their systems are available for use when needed and remain highly resistant to cyber security threats.²¹ This presents a challenge for exchange, clearing and settlement of payment items across established electronic networks with limited access channels. However, the challenge may be even greater for a retail CBDC that must operate in offline, powerless, remote, and long-term storage situations. One of the key design attributes for a retail CBDC is the nature of the infrastructure used to hold and update user ledgers - centralized, distributed or a hybrid - and how it will maintain resilience across payment use cases.

¹⁸ [Privacy in CBDC technology. Staff Analytical Note 2020-9. Bank of Canada. June 2020](#)

¹⁹ [A Survey of Research on Retail Central Bank Digital Currency. IMF Working Paper WP/20/104. June 2020](#)

²⁰ [Payment Card Network Fee Updates. Moneris, 2020.](#)

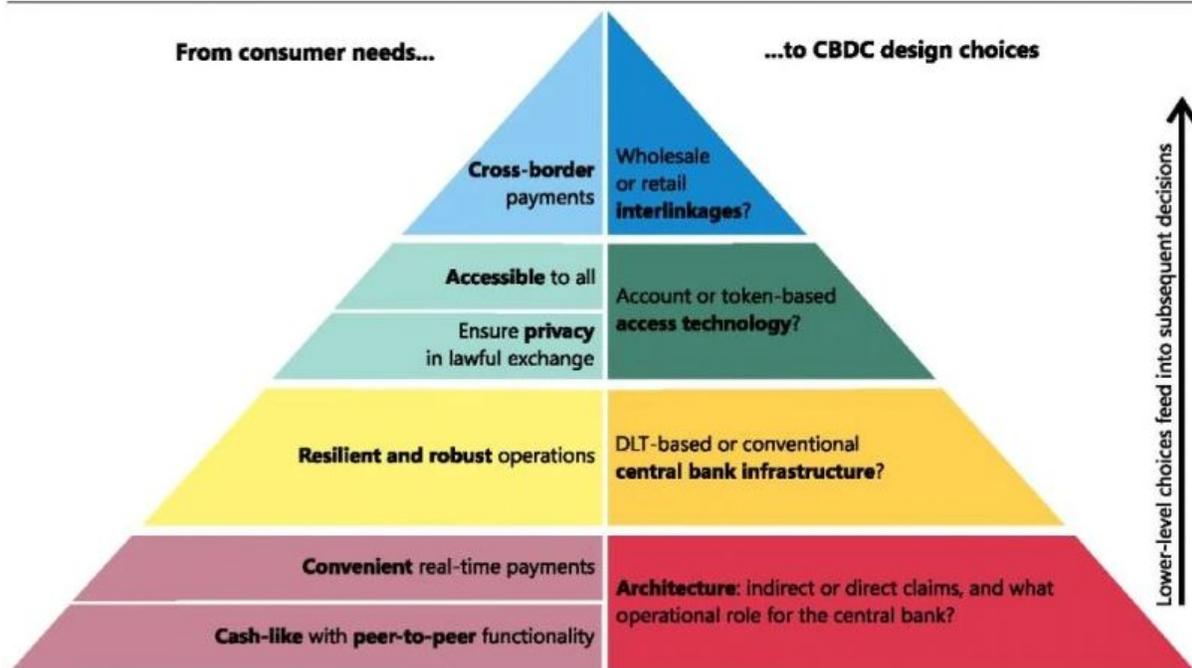
²¹ e.g. [Corporate Plan: Payments Canada 2019 To 2023.](#)

Retail CBDC design considerations

The objectives of a Canadian retail CBDC, considered above, dictate the design choices that must be considered in its development. A recent paper by BIS identifies a hierarchical set of needs that drive technology decisions for a CBDC and where those decisions must occur.²²

The CBDC pyramid

Graph 1



The CBDC pyramid maps consumer needs (left-hand side) onto the associated design choices for the central bank (right-hand side). The four layers of the right-hand side form a hierarchy in which the lower layers represent design choices that feed into subsequent, higher-level decisions.

²² [The technology of retail central bank digital currency, BIS, March 2020](#)

CBDC access approaches

Generally, two approaches are being widely considered for retail CBDC. At present, the Bank of Canada has not signalled which approach it would take.²³

- *Account based:* under this approach, an account would be opened at the central bank, or with a third party provider on behalf of the central bank, for every participating consumer and business end user. CBDC account identity would be associated with the account, as with other bank accounts, and payments would be made against available balances.

If end users were to hold accounts directly with the central bank, this approach would be akin to a closed-loop payment system where entries are recorded in a single ledger by the central bank. If CBDC accounts were held at financial institutions and other distributors, they would likely require fiduciary separation of central bank funds and commercial bank deposits within accounts. Accounts held at intermediaries could allow for convertibility between CBDC and commercial bank deposits and create an open-loop payments system.

- *Token based:* under a token-based approach, consumer and business end-users would exchange cryptographic tokens in a digital space in a manner similar to the way physical tokens (i.e. banknotes and coins) are exchanged in conventional transactions. Unlike account-based approaches, identity, while sometimes required, is not necessary for payment; the integrity and security of the token itself is critical. This is analogous to physical cash, where the authenticity of the banknote is the important factor in transferring value rather than verifying the identity of the person using it and drawing from the correct account. Token-based approaches can choose to incorporate identity as well which would remove anonymity.

Architecture

Foundationally, a CBDC must serve several of the basic functions of cash in that it can be transferred directly by end users (i.e., for peer-to-peer transactions), it's easy and intuitive to use, and obligations are settled in real-time. Cash is essentially risk-free as a negotiable instrument, and

²³ [A Policy Framework for E-Money, Should the Central Bank Issue E-Money](#). Bank of Canada, 2018.

requires no direct central bank involvement in the transaction. Commercial payment services offer convenience and value-added services, but typically entail cost, settlement delay and risk.²⁴ The architecture decision represents one of the most fundamental design aspects of the CBDC: how can CBDC address consumer demand for attributes of cash while incorporating the convenience of electronic payment methods?²⁵

The role the central bank plays in administering a retail CBDC is referred to as “architecture” by BIS.

- In a “direct” model, the central bank runs a centralized ledger and provides direct service to end users. This would be akin to a closed-loop model, such as a reloadable card or an online digital wallet.
- With an “indirect” model, commercial intermediaries provide the ledger for retail transactions. The central bank maintains a “wholesale” ledger of CBDC transactions with the commercial intermediaries. This model is conceptually similar to the “tiered” operating models outlined by the IMF.²⁶
- An indirect model can also refer to the synthetic CBDC (sCBDC) model. This iteration does not involve a direct retail claim on the central bank. In this case, commercial FIs and other intermediaries have a claim on the central bank through wholesale CBDCs, while consumers and businesses have a claim on the commercial intermediary through a commercially-issued retail CBDC. In this case, the commercial bank wholesale CBDC acts as a one-to-one asset to back their retail CBDC liability. This model is less widely considered for retail CBDC design relative to strictly “indirect” models.²⁷
- Under a “hybrid” model, commercial intermediaries provide retail services to end users, but the central bank retains a ledger of retail transactions. According to the BIS, this is currently the most considered architecture model for retail CBDC by central banks that have specified a design option.²⁸

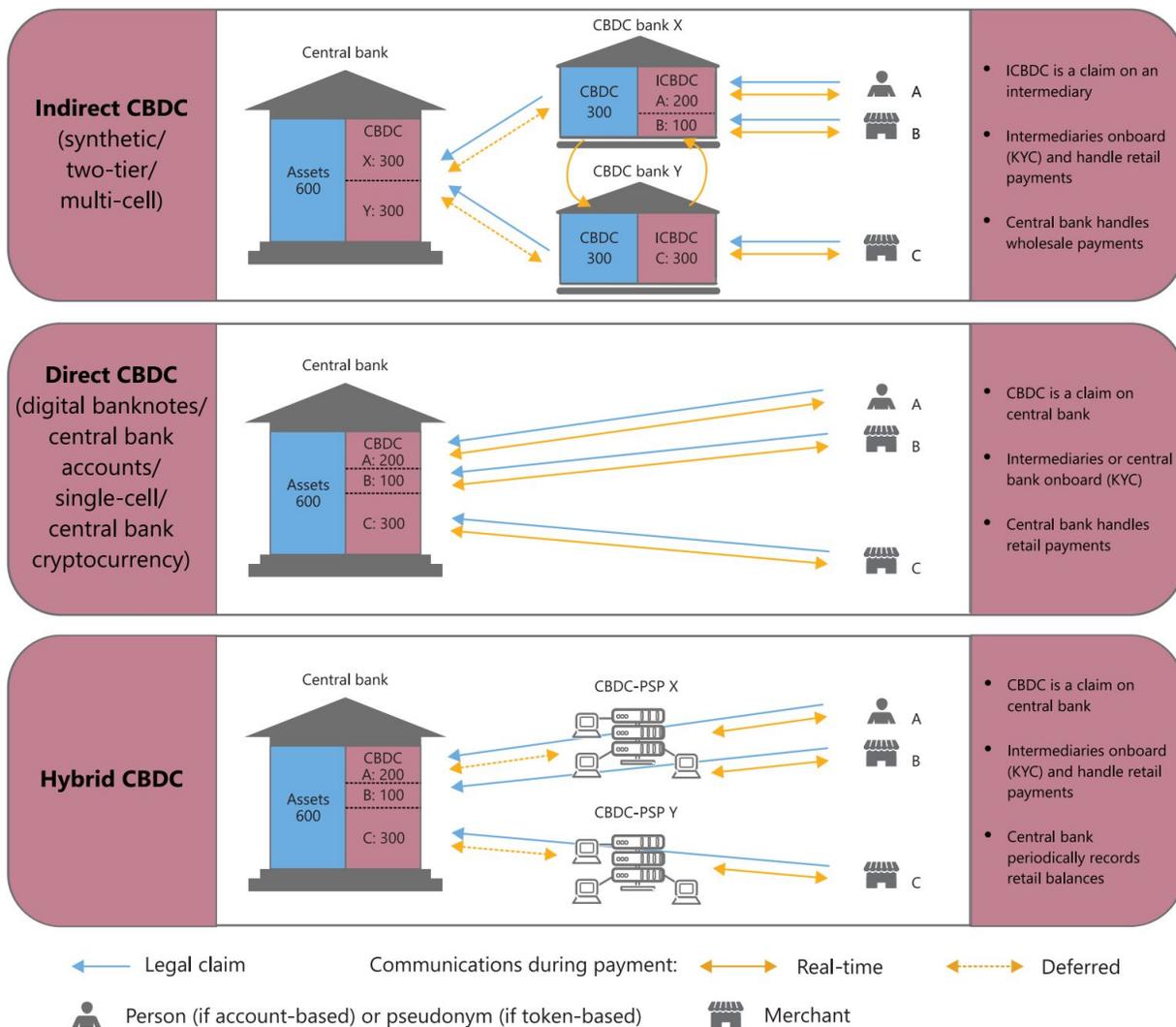
²⁴ [A Survey of Research on Retail Central Bank Digital Currency. IMF Working Paper WP/20/104. June 2020](#)

²⁵ [The technology of retail central bank digital currency, BIS, March 2020](#) p. 87

²⁶ [A Survey of Research on Retail Central Bank Digital Currency. IMF Working Paper WP/20/104. June 2020](#)

²⁷ The most recent paper from the CBDC international coalition group (at the time of publication) removed mentions of synthetic CBDC. See: [Central Bank Digital Currencies: Foundational Principles and Core Features.](#)

²⁸ [Rise of the Central Bank Digital Currencies: Drivers, Approaches and Technologies.](#) The majority of central banks surveyed are undecided, followed by hybrid and direct models.



The figure above, from BIS, illustrates these three design models.²⁹

²⁹ [Quarterly Review: International Banking and Financial Market Developments, BIS, March 2020](#)

Infrastructure

Users will require a resilient CBDC “infrastructure” that has the dependability of cash. As the ledger moves from the user’s pocket to electronic form, there is a technology trade-off. That is, the potential inefficiency of a consensus-based distributed system versus the single point of failure associated with a centralized system.³⁰

Work from BIS suggests that DLT would be a possible infrastructure choice for a retail CBDC as it can offer elevated resilience.³¹ If DLT is pursued, the Bank of Canada has signalled that a retail CBDC would not employ a permissionless DLT, suggesting that these ledgers pose higher security risks and offer limited capacity for wide scalability. At the same time, they observe the inherent trade-off that “private and permissioned DLTs offer redundancy and payment authenticity (non-repudiation) by design, but increase operational complexity and points of vulnerability.”³²

Both distributed and centralized ledgers would be high-risk targets for fraud, denial-of-service attacks and data breaches.³³ To avoid the double-spend problem, distributed ledger transactions must achieve consensus with a critical number of participating nodes. This process can be relatively time consuming compared to updating centralized ledgers, leading to slow transaction times and a less optimal user experience.

Access

Users will require the current benefits of cash use to be retained - anonymity and accessibility. Cash, being a token-based system, allows almost perfect privacy (for both legal and nefarious purposes) and is easily accessible by those for whom establishing identity-based relationships would be difficult.

A decision regarding access is required to design a CBDC system. A CBDC system can be account-based or token-based where “there is an underlying trade-off between privacy and ease of access on the one hand, and ease of law enforcement on the other. The associated design choice is whether access to the CBDC is tied to an identity system (i.e., an account-based technology) or

³⁰ [A Survey of Research on Retail Central Bank Digital Currency. IMF Working Paper WP/20/104. June 2020](#)

³¹ [The Macroeconomics of Central-Bank Issued Digital Currencies. BIS. February 2019](#) p. 7

³² [Security of a CBDC. Staff Analytical Note 2020-11. Bank of Canada. June 2020](#)

³³ Ibid.

instead via cryptographic schemes that do not require identification (i.e., an access technology based on so-called digital tokens).³⁴

In the digital world, there is a rare “double spend” risk where digital tokens can be spent twice through user manipulation which leads to a loss or misdirection of funds and poses security risks for end users.³⁵ However, in a distributed ledger, there are consensus mechanisms in place to combat the double spend risk and users are able to maintain privacy and security of transactions³⁶ Account-based systems offer additional benefits in this scenario: because they are identity-based, risk management by intermediaries or merchants at the other end becomes possible, and this removes the burden of security out of the hands of end users.

International interlinkages

For their transactional requirements in an increasingly interconnected global landscape, users may also require ways to spend CBDC beyond domestic borders, requiring cross-border “linkages”. This entails a design decision between direct retail transfers (i.e., end-users in other jurisdictions have direct or indirect access to the CBDC ledger) or aggregate settlement through interbank (wholesale) channels such as a wholesale token-based system or existing channels (e.g., correspondent banking). A token-based approach would be difficult to constrain to domestic use whereas an account-based approach would allow for flexibility and control of foreign ownership.

Emerging trends in CBDC design³⁷

The nascent CBDC proofs-of-concept and pilot programs being explored globally employ a mix of various architectures, infrastructures and access models, although most seem focused on the domestic use case as an early priority. Interlinkages often involve low-value visitor token-based cards or conventional use of wholesale infrastructure such as correspondent banking.

³⁴ [The technology of retail central bank digital currency, BIS, March 2020](#) p. 88

³⁵ This double spend risk can occur as a result of the 51% exploit where a single entity has 51% control of the processing power on a network. With this power the entity could manipulate information (e.g. messages, payment, etc) flow over the network.

³⁶ [Blockchains and Distributed Ledger Technologies](#), Blockchain Hub.

³⁷ [BIS Working Papers No 880. Rise of the central bank digital currencies: drivers, approaches and technologies. Aug 2020](#)

In two countries, Canada and Sweden, the access model may be “tiered” based on the value of the transaction, with smaller transactions using anonymous tokens while requiring user identity to protect public safety for large transactions.³⁸

In terms of architecture, most CBDC pilots have defined the digital currency as a direct claim on the central bank. However, many of these pilots also envision using intermediaries for distribution and payment services. It would appear that the direct and hybrid models are favoured at this stage, where the claim is shifted to a commercial entity.

Infrastructure choices vary across jurisdictions. Token-based access models may lend themselves more naturally to distributed ledger implementations whereas account-based access aligns with more conventional databases housed at the central bank in the case of a direct architecture or potentially at commercial intermediaries in the case of a hybrid/intermediated architecture. The trend suggests that, at this early stage, the central bank will retain at least a record of retail transactions as opposed to being entirely mediated.

Implementation challenges

The implementation challenges associated with a CBDC differ based on the design choices being made. However there are some general challenges to a retail CBDC that are dependent on several design options.

Banking disintermediation

Firstly, a retail CBDC would introduce a new method of storing and exchanging value that directly competes with commercial services and could potentially disrupt the financial services market and impact credit availability/money supply through shrinking bank balance sheets.³⁹ This competitive effect already exists with cash, but a CBDC could eliminate the typical friction and costs associated with withdrawal and storage of physical cash.

Although the Bank of Canada currently indicates that potential CBDC in Canada would be non-interest-bearing, in a low interest environment, deposit-taking FIs could be vulnerable to

³⁸A deeper analysis of international CBDC developments will be examined further in an upcoming paper in this series.

³⁹[Contingency Planning for a Central Bank Digital Currency. Bank of Canada. February 2020](#)

conversion of deposits. This vulnerability arises during periods of financial stress, where consumers may prefer the security of a central-bank liability.⁴⁰

Additionally, strong demand for CBDC, without an accompanying decline in physical notes could create expansionary pressures on central bank assets⁴¹ held against money liabilities.

Service provision

At the “architecture” or operating model level of service provision, direct management by the central bank would likely entail changes to various legislation (i.e. the Bank Act) to allow the Bank of Canada to deliver account services to consumers. The logistical and operational changes involved in pivoting to a retail service model on a large scale while adhering to KYC and other regulatory requirements would also be significant.⁴² Additionally, fraud, account take-over, hacking etc. would be a risk for central bank retail accounts, as would recourse for error or malfeasance.

Accordingly, most retail CBDC projects around the world are maintaining the currency as a direct claim on the central bank but distributing and transacting it through commercial entities using a hybrid or indirect model. This aligns more closely with the current reality and would entail less structural change and disruption to commercial banking services. Additionally, regulatory requirements around client identity could be off-loaded to commercial banks if they are required to provide CBDC wallets, as is the case with the U.S. approach.⁴³

However, commercial electronic offerings may not satisfy all of the requirements of CBDC in terms of access, resilience and inclusion. It could also be challenging to establish a revenue model for commercial entities, particularly when CBDC operates in competition with their other offerings. If commercial banks or fintech services are used for token distribution, consideration will have to be given to maintaining zero or utility costs for the end user and how this impacts the bottom line for profit driven organizations. Some of these costs could be offset through superior seigniorage margins.⁴⁴

⁴⁰ [Contingency Planning for a Central Bank Digital Currency. Bank of Canada. February 2020.](#)

⁴¹ [Bank for International Settlements. Committee on Payments and Market Infrastructures: Markets Committee. Central bank digital currencies. March 2018](#)

⁴² [A Survey of Research on Retail Central Bank Digital Currency. IMF Working Paper WP/20/104. June 2020](#)

⁴³ [The American Central Bank Digital Currency Plan](#)

⁴⁴ e.g. [Central Bank issued digital currencies: a global trend. Payments Canada. March 2020](#)

Consumer demand

Preliminary, Bank of Canada research suggests that consumer perception may be a hurdle to the adoption of CBDC.⁴⁵ The payments landscape is evolving quickly and new commercial alternatives associated with the real-time-rail, digital wallets/platforms and credit cards may be entering the market coincidentally with the roll-out of a retail CBDC.

⁴⁵ [Demand for Payment Services and Consumer Welfare: The Introduction of a Central Bank Digital Currency. Staff Working Paper 2020-7. Bank of Canada](#)