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CBDC: Motivations, Technology and Implications

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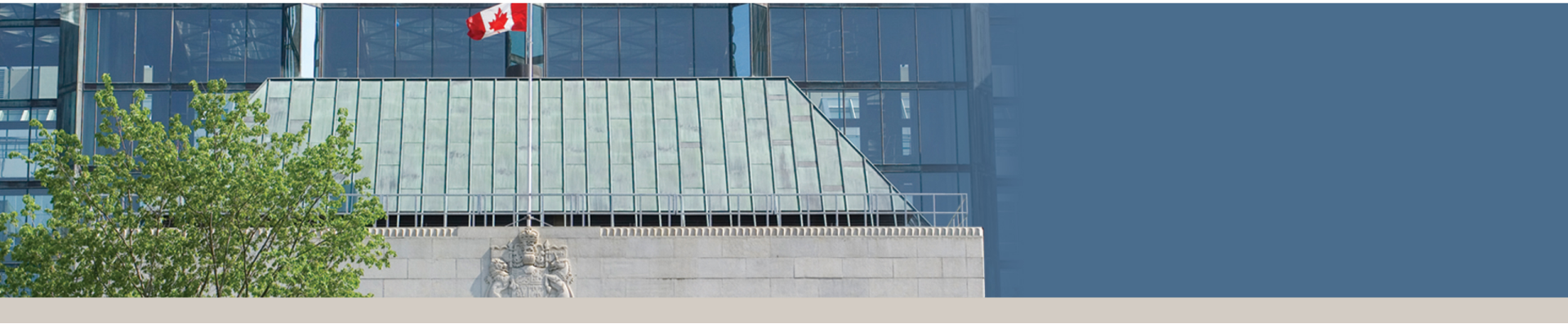

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CEMLA Course on Financial Market Infrastructures
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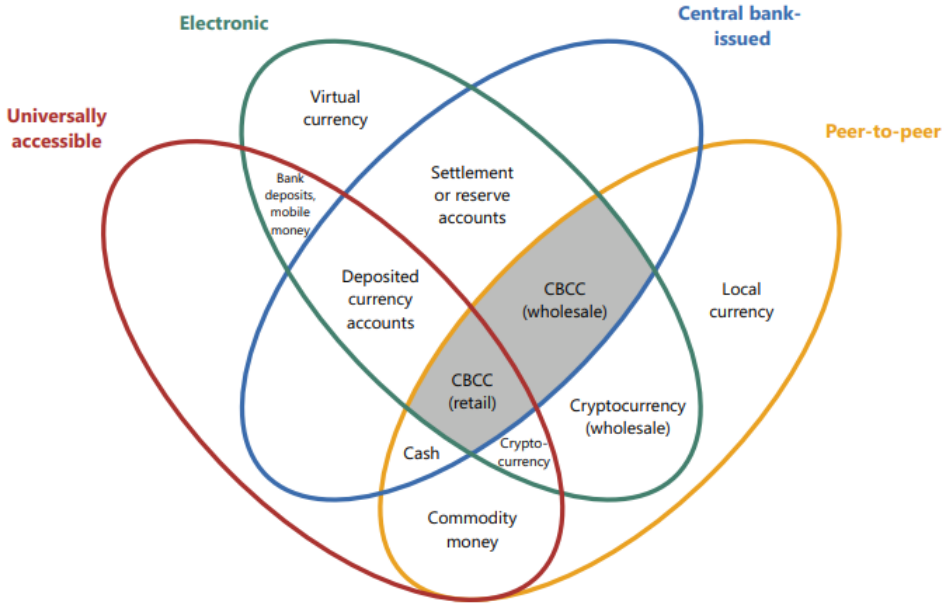
What is a central bank digital currency (CBDC)?

- A widely-accessible direct liability of the central bank in digital form

  1. Widely-accessible (v. reserves)
  2. Direct liability (v. bank deposits or PayPal balances)
  3. Digital form (v. cash)



Bech & Garratt (2017)

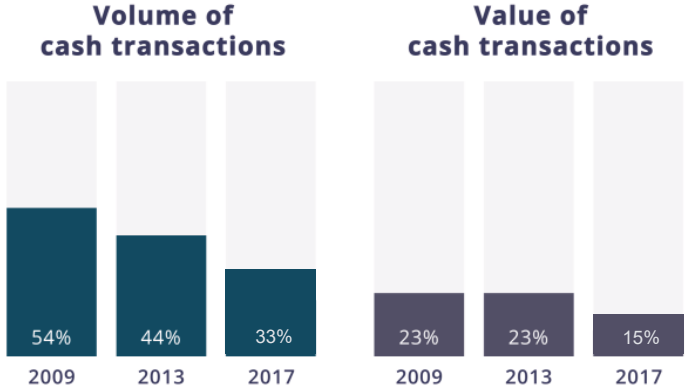
Plan for today

1. Discuss the **motivations** of central banks
2. **Economics of payment arrangements**: access, privacy and security
3. Potential **designs of CBDCs** and their trade-offs
4. Potential **Implications** of CBDCs
5. Open questions

Motivations for a CBDC

Why the interest from central banks? The case of the BoC

1. Use of cash at the point of sale has been declining
   - Risk of not being useful for a wide range of transactions
   - COVID-19 likely accelerated this trend



Source: Henry et al. 2019

2. Threat of alternative digital currencies (Bitcoin, Libra, eCNY)
   - Loss of monetary sovereignty and/or loss of seigniorage
   - Privacy concerns

Why the interest from central banks? More broadly

Motivations related to central bank mandates:

- **Monetary policy**
  - Maintain or improve the effectiveness of monetary policy (break below ELB, targeted transfers)
- **Financial system**
  - Provide, regulate or oversee safe and efficient payments systems (including bank notes)
  - Ensure financial stability

Why the interest from central banks?

Less typical public policy objectives (for central banks)

- Financial inclusion (cheaper financial instruments)
- Spur innovation of financial services (e.g. nanopayments, IoT)
- Promote the digital economy, competition
- Provide privacy
- Acquire reserve currency status
- Reduce tax evasion and crime (by eliminating cash)

Summary of motivations

Monetary policy

- Maintain monetary sovereignty
- Improve monetary policy

Financial system

- Safe and efficient payments systems
- Financial stability

Other

- Financial inclusion
- Digital economy, platform competition, payments innovation

What can the central banks do?

- Provide universal access to a risk-free, private and resilient means of payment
  - We do this today with cash
- Promote payment arrangements that are stable, competitive and interoperable

- A CBDC could potentially fulfill these objectives

If yes, how should central banks approach CBDC?

- Principles
  - Do no harm: do not endanger monetary and financial stability
  - Ensure coexistence and complementarity of public/private money
  - Promote innovation and efficiency
- Features
  - Instrument: convertible, accepted, convenient, low cost
  - System: secure, resilient, scalable, interoperable
  - Institutional: compliance with applicable rules

See: Coalition Report on CBDC

Alternative policies

- For each motivation, impediments and alternative policies can be discussed. Examples:
  - Monetary policy: breaking below the ELB requires removal of cash (very contentious)
  - Financial inclusion: other competition policy initiatives could also help, open the wholesale payments system to new FinTechs, develop new Fast Payments Systems, etc.

Further reading

- Davoodalhosseini & Rivadeneyra (2020) A Policy Framework for E-Money, Canadian Public Policy
- Bordo & Levin (2017) Central Bank Digital Currency and the Future of Monetary Policy, Hoover.
- Garratt & van Oordt (2019) Privacy as a Public Good: A Case for Electronic Cash, BoC WP.
- Rogoff (2016) The Curse of Cash, Princeton.

The Economics of Payment Arrangements

Types of payments arrangements

Two broad types of arrangements distinguished by identification requirements:

- **Account-based:** is the *individual* really who he says he is, i.e. the owner of the account?
- **Token-based:** is the *object* real or counterfeit?

See: Kahn et al. (2020)

Trade-offs: costs, risks and privacy

Account-based systems track *individuals*

- Cost structure: issuer verifies identities, monitors behaviour of participants. Liability usually lies on the issuer/operator
- Users relinquish some degree of anonymity

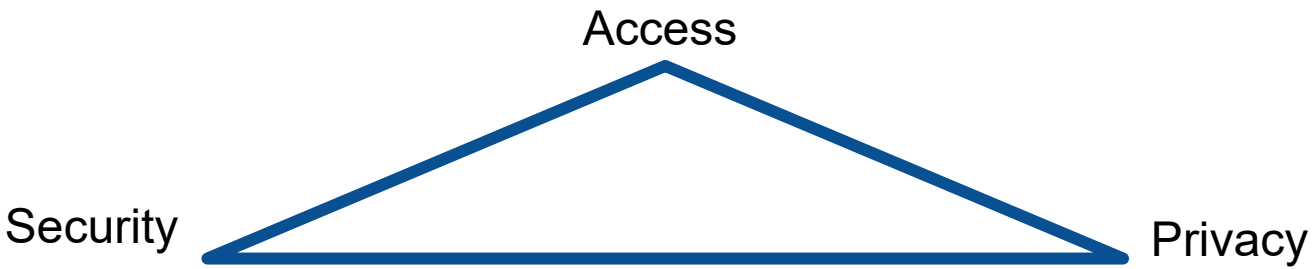
Token-based systems track the history of *objects*

- Verification can be bilateral (cash) or distributed (Bitcoin)
- Cost structure: issuer cares about the cost of counterfeiting tokens more than the cost of verification of transactions

Account vs tokens: depends on identification requirements

- What is the cost of identifying an individual/object in a transaction? Determines costs and access policies
- Who manages the system and/or has access to the records? Determines safety and privacy issues

Key tradeoff: access, security and privacy



Payments arrangements as record-keeping systems

Record-keeping has two dimensions: access to the records and the protocol to update the records

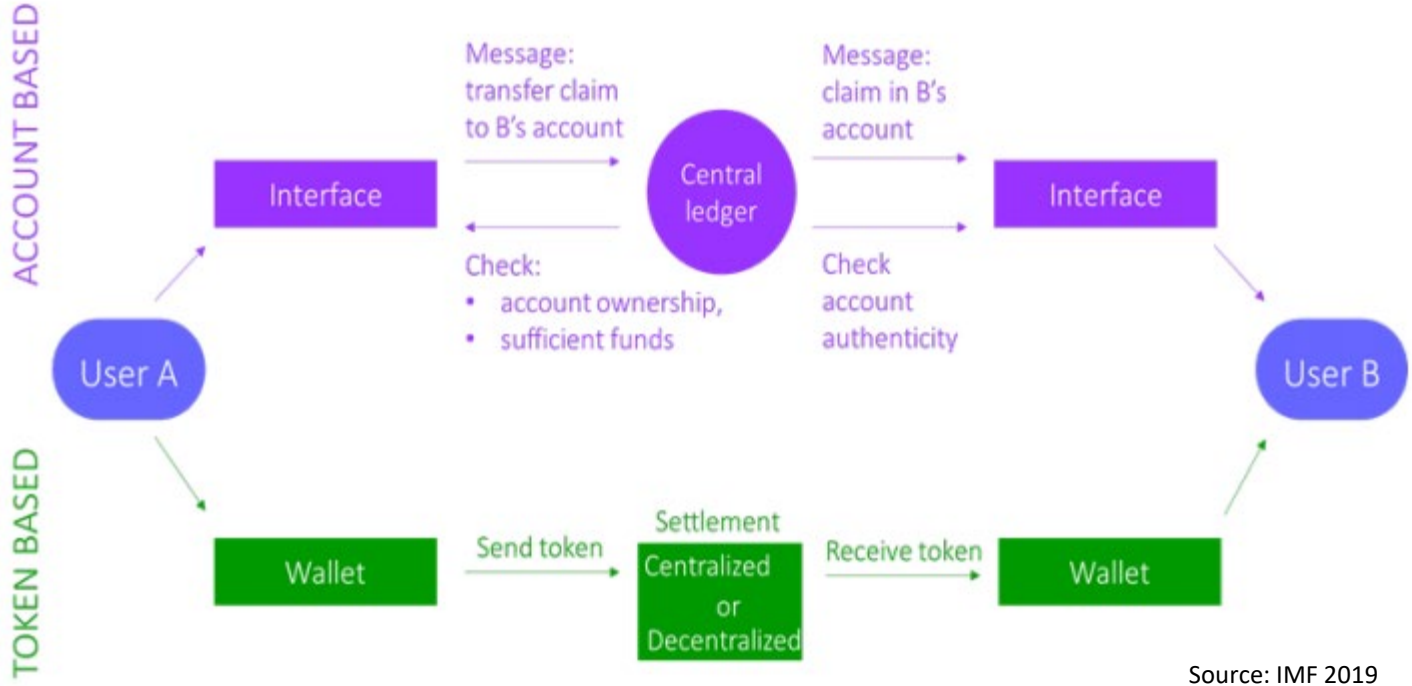
Updating \ Access	Centralized	Decentralized
Centralized	Account-based systems (HVPS, CCPs, etc.)	Hybrid systems
Decentralized	Not applicable	Token based-systems (Bitcoin, cash)

Further Reading

- Abadi & Brunnermeier (2018) Blockchain Economics, Princeton.
- Kahn & Roberds (2009) Why pay? An introduction to payments economics, JFI.

Potential Designs of a CBDC

CBDC schemes



Source: IMF 2019

CBDC schemes

1. Account-based scheme: universal accounts at the central bank

2. Token-based schemes
   - Decentralized: transactions verified via DLT
   - Centralized: transactions verified by the central bank

3. Hybrid schemes
   - Delegated schemes with custodians and intermediaries

1. CBDC account-based scheme

- Proposal: retail accounts at the central bank
- Requires: i) account opening; ii) processing of transactions; and iii) management of relationships with the public
- Central banks do not have the comparative advantage in any of these functions
  - Would compete directly with commercial bank deposits
  - Would require dealing frequently with the public

2.1 CBDC token with decentralized verification

- Proposal: develop/choose tech to issue, store and transfer tokens using a decentralized ledger of tokens
- Examples: mostly theoretical, CADcoin, Fedcoin
- Challenges:
  - Why use decentralized verification when we already have a trusted central party?

2.2 CBDC token with centralized verification

- Proposal: develop/choose tech to issue, store and transfer tokens using a centralized ledger of tokens
- Example: ‘digital cash’ sacrificing some anonymity, speed or safety
- Challenges:
  - Can we develop or choose the appropriate technology?
  - Counterfeiting risk (cyber) in digital is potentially catastrophic

3. CBDC tokens with delegation of functions (tiering)

- Proposal: delegate distribution of tokens and/or verification of transactions to special set of institutions.
- Accounts would emerge: need to identify owners of tokens for AML/KYC (examples Cambodia, China)
- Challenges:
  - Would current intermediaries have incentives to distribute tokens?
  - For institutions tokens could be inferior to reserves

A note on synthetic CBDC (sCBDC)

- Synthetic CBDC has been proposed as simpler to implement
  - Vehicle (narrow bank) manages customers deposits = c.b. tokens
  - Customer does not directly hold the liability of the central bank

- How much does this matter?
  - Carries some small risk (liquidity, fraud)
  - Could allow faster innovation (c.b. does not need to lead in tech)
  - But is not central bank money and might lead to market power

CBDC schemes: summary

- Central bank accounts would likely be expensive, expose the central bank, and directly compete with commercial banks
- An **ecosystem** with digital tokens, *if appropriately designed*, could:
  - provide wide access and maintain compliance
  - maintain some degree of privacy
  - become a platform in itself (maybe aiding in interoperability)
  - increase contestability of payments platforms
- How about DLT?
  - Open question, but not strictly necessary

Further reading

- Adrian & Mancini Griffoli (2019) The Rise of Digital Money, IMF.
- Auer & Boehme (2020) The technology of retail central bank digital currency, BIS.
- Garratt, Martin, McAndrews & Nosal (2015) Segregated balance accounts, FRBNY.
- Kiff et al. (2020) A Survey of Research on Retail Central Bank Digital Currency, IMF.
- Mancini Griffoli et al. (2018) Casting Light on Central Bank Digital Currencies, IMF.

Implications: banking, financial stability, security

Potential implications of a CBDC

- Banks are desintermediated:
  - CBDC is a safe store of value and efficient means of payment, competes with bank deposits
- Balance sheet of central bank swells
- Aggregation of balances endanger consumers' balances
- Capital flows
  - Attract foreign flows putting pressure on exchange rates
- Criminals find ways to use it for illicit activities

CBDC, banks and financial stability

Banks have market power in the deposit market

- CBDC forces banks to: increase deposit rates, increase fees, take more risk

Complicated effects: could lead to higher or lower deposits/lending

- Lower level of bank deposits in equilibrium

Digital bank runs:

- In crisis times, rapid move from deposits to CBDC

See: Chiu et al. (2020)

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CBDC ecosystem: aggregation and security

Even in a direct CBDC model, an ecosystem with public *and* private components would emerge:

- Tokens are stored in addresses secured by private keys
- This aggregation poses risks to individuals (theft of keys, forgetting keys)
- Accounts are likely to emerge to manage the risks of aggregation

Key tradeoff: security vs convenience from aggregation of balances

Form:	Tokens	$\rangle$	Address	$\rangle$	Wallet	$\rangle$ Account
Security:			Private key		Wallet password	Acc. password

Further reading

- Andolfatto (2020) Assessing the Impact of Central Bank Digital Currency on Private Banks, EJ.
- Kahn, Rivadeneyra & Wong (2020) Eggs in One Basket: Security and Convenience of Digital Currencies, St. Louis Fed WP 2020-032A.
- Keister & Sanches (2020) Should Central Banks Issue Digital Currency?, Philly Fed.

Conclusions and some open questions

Conclusions: potential form of a CBDC

Account-based system:

- Requires management of relationships with the public
- Not a new possibility, and directly competes with bank deposits

Token-based system with tiering:

- Allows simpler delegation of operations (onboarding, KYC, etc.)
- Could be basis for a platform

Conclusions: broader trade-offs

- **Payments systems:** efficiency likely to improve
- **Financial intermediation:** uncertain effect at this point; need to consider threat to commercial deposits and the response of banks
- **Competition:** could enable new entrants and applications
- **Cyber risk:** hacking can have catastrophic consequences; paper money does not have such risks

Open questions

- Bank of Canada has not decided to issue a CBDC, instead developing capabilities to issue if needed
- Open questions:
  - How to ensure privacy and compliance of AML/KYC
  - Distribution model: who and how should distribute CBDC
  - Integration with existing payment systems
  - Off-line: for how long and how much
  - Use of DLT

Thanks / Merci!

References: I

- Abadi & Brunnermeier (2018) Blockchain Economics, Princeton
- Adrian & Mancini Griffoli (2019) The Rise of Digital Money, IMF.
- Andolfatto (2020) Assessing the Impact of Central Bank Digital Currency on Private Banks, EJ.
- Auer & Boehme (2020) The technology of retail central bank digital currency, BIS.
- Bech & Garratt (2017) Central bank cryptocurrencies. BIS Quarterly Review, September.
- BIS Coalition (2020) CBDC: foundational principles and core features, Report.
- Bordo & Levin (2017) Central Bank Digital Currency and the Future of Monetary Policy, Hoover.
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- Kahn, Rivadeneyra & Wong (2020) Should the Central Bank Issue E-Money?, JFMI.
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- Mancini Griffoli et al. (2018) Casting Light on Central Bank Digital Currencies, IMF.
- Rogoff (2016) The Curse of Cash, Princeton.

Additional BoC resources

- Deputy Governor Timothy Lane's speech: Money and Payments in the Digital Age and Background note explaining our official position
- Bank's Digital Currencies and Fintech dedicated microsite: