

Staff Discussion Paper/Document d'analyse du personnel 2017-16

# Central Bank Digital Currency: Motivations and Implications



by Walter Engert and Ben S. C. Fung

Bank of Canada staff discussion papers are completed staff research studies on a wide variety of subjects relevant to central bank policy, produced independently from the Bank's Governing Council. This research may support or challenge prevailing policy orthodoxy. Therefore, the views expressed in this paper are solely those of the authors and may differ from official Bank of Canada views. No responsibility for them should be attributed to the Bank.

Bank of Canada Staff Discussion Paper 2017-16

November 2017

# **Central Bank Digital Currency: Motivations and Implications**

by

**Walter Engert<sup>1</sup> and Ben S. C. Fung<sup>2</sup>**

<sup>1</sup> Office of the Superintendent of Financial Institutions  
Ottawa, Ontario, Canada K1A 0H2  
[walter.engert@osfi-bsif.gc.ca](mailto:walter.engert@osfi-bsif.gc.ca)

<sup>2</sup> Currency Department  
Bank of Canada  
Ottawa, Ontario, Canada K1A 0G9  
[bfung@bankofcanada.ca](mailto:bfung@bankofcanada.ca)

## **Acknowledgements**

We thank Neville Arjani, Jonathan Chiu, Theodoros Garanzotis, Hanna Halaburda, Scott Hendry, Shuji Kobayakawa, Tim Lane, Ohad Lederer, Stephen Murchison, Francisco Rivadeneyra, Bjorn Segendorf, Richard Wall, Warren Weber, Carolyn Wilkins, Stephen Wright and seminar participants at the Bank of Canada, the Third International Workshop P2P Financial Systems 2017 (London, UK), the Bank Negara Malaysian Monetary Policy Conference (Kuala Lumpur, Malaysia), the Hong Kong Monetary Authority and the Bank for International Settlements Asian Office for helpful comments and suggestions. The views expressed in this paper are solely those of the authors. No responsibility for them should be attributed to the Bank of Canada or the Office of the Superintendent of Financial Institutions.

## Abstract

The emergence of digital currencies such as Bitcoin and the underlying blockchain and distribution ledger technology have attracted significant attention. These developments have raised the possibility of considerable impacts on the financial system and perhaps the wider economy. This paper addresses the question of whether a central bank should issue digital currency that could be used by the general public. It begins by discussing the possible motivations for a central bank to issue a digital currency. The paper then sets out a benchmark central bank digital currency (CBDC) with features that are similar to cash. The implications of such a digital currency are explored, focusing on central bank seigniorage, monetary policy, the banking system and financial stability, and payments. Finally, a CBDC that differs from the benchmark digital currency in a significant way is considered.

*Bank topics: Bank notes; Digital currencies; Financial services; Payment clearing and settlement services*

*JEL codes: E, E4, E41, E42, E5*

## Résumé

L'arrivée des monnaies numériques comme le bitcoin ainsi que la chaîne de blocs ou technologie du grand livre partagé sous-jacente suscitent beaucoup d'intérêt. Ces évolutions laissent entrevoir la possibilité d'incidences notables sur le système financier et peut-être même sur l'ensemble de l'économie. Dans la présente étude, nous nous penchons sur la question de savoir si les banques centrales devraient émettre une monnaie numérique à l'intention du grand public. D'abord, nous discutons des raisons qui pourraient les motiver à le faire. Ensuite, nous décrivons une monnaie numérique de référence émise par une banque centrale dont les caractéristiques se rapprochent de celles de l'argent comptant. Nous examinons les conséquences d'une telle monnaie, notamment pour les recettes de seigneurage de la banque centrale, la politique monétaire, le système bancaire, la stabilité financière et les paiements. Enfin, nous envisageons une monnaie numérique émise par une banque centrale qui serait considérablement différente de la monnaie numérique de référence.

*Sujets : Billets de banque ; Monnaies numériques ; Services financiers ; Services de compensation et de règlement des paiements*

*Codes JEL : E, E4, E41, E42, E5*

## 1. Introduction

The emergence of digital currencies such as Bitcoin and the underlying blockchain and distribution ledger technology have attracted significant interest. These developments have raised the possibility of considerable impacts on the financial system and perhaps the wider economy. As a result, over the past few years, public authorities and central banks around the world have been monitoring developments in digital currencies and studying their implications. And a question that has been raised frequently is whether central banks themselves should issue digital currency that could be used by the general public.<sup>1</sup> This paper discusses the possible motivations for a central bank to issue digital currency, and explores the implications of such a step.

A central bank typically issues two types of liabilities: physical bank notes and electronic central bank deposits, also known as reserves or settlement balances. Anyone can hold and use bank notes—that is, cash—one of the main payment methods used by consumers and accepted by merchants.<sup>2</sup> Of course, bank notes do not pay interest. They are also bearer instruments and as a result, the parties involved in a cash transaction can remain anonymous: there is no need for a trusted third party to keep a record of the transfer of cash from one party to another. A transaction using bank notes is also final and irrevocable.

In contrast to bank notes, access to central bank reserves is typically limited to qualifying financial institutions that operate in the large-value payments system. For example, in Canada, only members of Payments Canada that satisfy certain technical requirements (related to large-value payments processing capabilities) are eligible to have accounts at the Bank of Canada, with corresponding central bank overdraft facilities. These accounts are maintained on the books of the central bank, and transfers of reserve balances across these accounts are used to settle claims among participants. These transfers correspond to nearly all non-cash transactions in the economy. And since these electronic transfers are in central bank liabilities through accounts on the central bank's ledger, they are virtually risk-free, and are final and irrevocable.

Recent technological developments have led to suggestions that a central bank could consider providing digital currency to the public through centralized accounts on its books. Conceptually, this would extend provision of reserves, currently accessible only to certain financial institutions, to the general public. In this case, the central bank can be seen as a “narrow bank” providing accounts to the general public, and allowing account holders to use the balances in these accounts to make payments over the central bank's ledger. Alternatively, a central bank could issue a digital currency in a decentralized manner, similar to how physical cash is distributed. In this paper, we consider this kind of set-up for a central bank digital currency (CBDC).

CBDC, at the most basic level, is simply monetary value stored electronically (digitally, or as an electronic token) that represents a liability of the central bank and can be used to make

---

<sup>1</sup> In the early 1990s, with the emergence of electronic money (e-money) such as Mondex, observers wondered if there would be significant effects on central banking and the broader economy. Most studies concluded that there was little impact on central banking and the economy (see, for example, Fung, Molico and Stuber 2014), but the idea of central bank issuance of e-money was not generally raised in that context (Freedman 2000).

<sup>2</sup> For a comprehensive discussion of the use of bank notes in Canada, see Fung, Huynh and Stuber (2015).

payments.<sup>3</sup> In this paper, we consider a CBDC that is available to the general public and not restricted to major participants in the payments system, as is the case with central bank reserves (described above). Therefore, the interest here is different than in some recent experiments focused on innovations in large-value payments systems, such as Project Jasper in Canada or Project Ubin in Singapore, which explore applications of distributed ledger technology to existing large-value payment systems.<sup>4</sup> Also, we consider that a central bank issues CBDC in addition to bank notes and central bank reserves, and not as a replacement for bank notes.

The focus here is on the economics of CBDC—in particular, on the motivations for issuing CBDC and its economic implications. Much of the paper is concerned with projecting the plausible or likely outcomes of specific CBDC designs; of course, this is subject to considerable uncertainty given the complexity and interconnected nature of possible effects. We also assume that the technological means to issue and use CBDC would be effective, and acceptable to the central bank. Thus, the analysis in this paper is not technology-specific. Finally, this paper does not discuss the potential costs to the central bank from issuing a CBDC, including set-up and operating costs, or reputational risks associated with a digital currency.

The rest of the paper is organized as follows. The next section discusses the possible motivations for a central bank to issue a digital currency to the general public. Section 3 describes the features of a benchmark CBDC modelled on cash, and section 4 considers the implications of this particular design. In section 5, a key feature of the benchmark CBDC is changed and the implications of the revised CBDC design are examined. Conclusions are in section 6.

## **2. Motivations for Central Bank Digital Currency**

A CBDC available to the general public might be (and has been) motivated in various ways; this section assesses six possible reasons why a central bank might consider issuing a digital currency.

### **2.1 Ensure adequate central bank money for the public and preserve central bank seigniorage revenue**

As illustrated in Figure 1, the use of bank notes relative to other payment methods in Canada has declined consistently for the past 25 years, and similar trends are evident in other countries. This has led some observers to project a “cashless society” in the future. This is especially the case in Sweden, where bank notes have been declining for a number of years (Figure 2a).<sup>5</sup> Skingsley (2016) argues that in Sweden, “there is currently a need among the general public and companies to have access to central bank money and this need will still be there in the future.” As more bank branches are becoming cashless, the Swedish public is finding it increasingly difficult to access central bank money. Therefore, the Riksbank “will need to take an active stance on whether or not to issue a digital currency...”

Another possible concern for central banks arising from declining bank notes is a threat to their core revenue stream—seigniorage. Central bank seigniorage is a function of the value of bank notes outstanding (multiplied by the prevailing interest rate, less costs of note production and

---

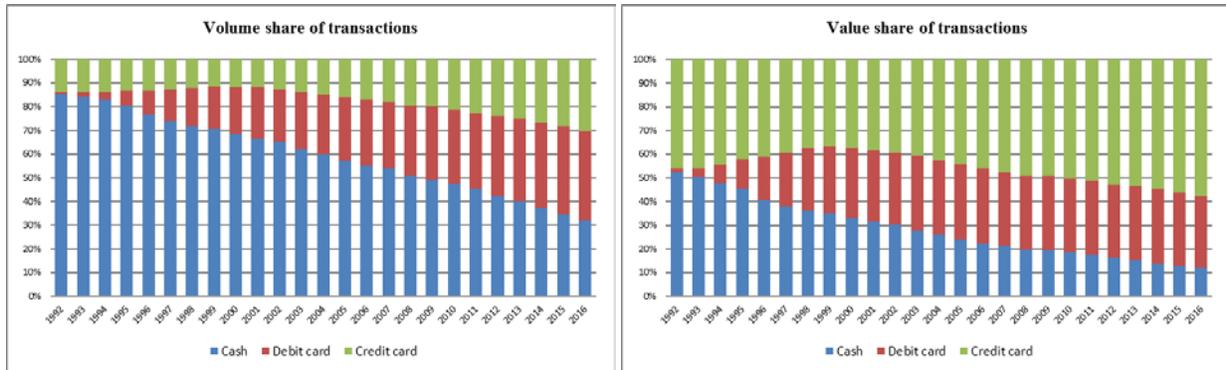
<sup>3</sup> For other definitions of CBDC, see, for example, Barrdear and Kumhof (2016) and Mersch (2017a).

<sup>4</sup> For more on Project Jasper and lessons to date, see Chapman et al. (2017).

<sup>5</sup> There has been considerable media discussion of the prospect that Sweden could become the first cashless society in the world. See also Segendorf and Wilbe (2014).

distribution.) Therefore, seigniorage would decline as value of bank notes falls, and seigniorage would be especially affected if higher-denomination notes declined since they generate more revenue than smaller-value notes. The issue here is that if seigniorage declines significantly, a central bank might need to rely on government funding, and this could ultimately undermine its autonomy.

**Figure 1: Relative use of payment methods in Canada**



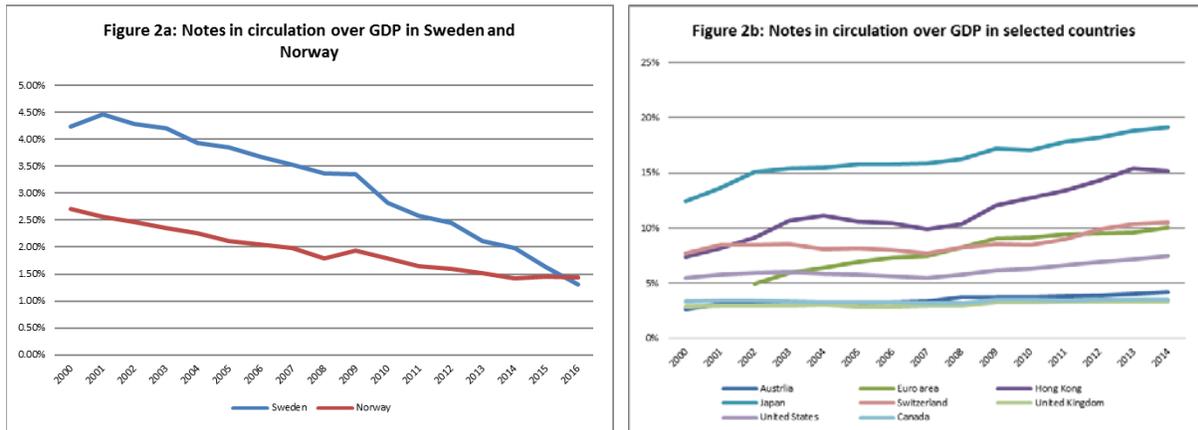
Sources: Canadian Bankers Association, Interac Association and authors' own calculations

In most economies, however, notwithstanding the declining *relative* importance of bank notes illustrated in Figure 1, the value of bank notes outstanding—in absolute terms and relative to gross domestic product (GDP)—is not declining, as shown in Figure 2b (Arango et al. 2012).<sup>6</sup> Moreover, the distribution of notes in Canada has been shifting toward higher denominations, which generates more seigniorage, other things being equal. As a result, and despite historically low interest rates in recent years, the amount of central bank seigniorage in Canada has varied between \$1 and \$2 billion per year over the past two decades.

Accordingly, seigniorage in Canada has not been at risk. Similar propositions hold in most other countries, with the exception of Sweden and Norway. And it seems unlikely that this secular pattern in Canada will materially change in coming years (Fung, Huynh and Stuber 2015). Zurbrügg (2017) provides a similar perspective for Switzerland.

<sup>6</sup> See also Mersch (2017b).

**Figure 2: Notes in circulation as a share of GDP**



Sources: Norges Bank, Sveriges Riksbank and the Bank for International Settlements

But even if the demand for bank notes were to decline significantly, leading to a decrease in bank notes outstanding and thus threaten seigniorage, issuance of CBDC is not the only possible response, as there are other ways for a central bank to sustain its revenues (Fung, Molico and Stuber 2014). For example, a central bank could charge higher fees for the various services it provides to financial industry participants. A central bank could also impose non-interest-bearing reserve requirements on bank deposits or other types of stored-value payment schemes (like prepaid online balances or cards). However, such requirements are generally regarded as a distortionary tax and were phased out in Canada in the 1990s. Finally, a central bank could expand its balance sheet by buying government bills and bonds with reserves (similar to quantitative easing), to the extent that monetary policy objectives were not compromised and financial markets were not distorted.<sup>7</sup>

In sum, preserving seigniorage does not provide a compelling motivation to issue CBDC in Canada (or in most other advanced economies), based on recent trends. More generally, however, further research could consider whether a sound financial system requires a central bank liability (which is both liquid and risk-free) accessible to the general public, like bank notes or CBDC. Related to this, there might be a concern that if private cryptocurrencies became widely adopted and displaced central bank money, there could be adverse implications for central bank monetary policy and for financial stability. Currently, this prospect does not appear to be a pressing matter. For example, Bitcoin adoption and holdings appear to be low in Canada and in the United States, although adoption could accelerate over time (Henry, Huynh and Nicholls, forthcoming).

<sup>7</sup> To provide perspective on the potential size of asset purchases needed to fund central bank operations, consider the case of Canada. In 2016, the Bank of Canada's total expenses were \$460 million, and net interest revenue was \$1.5 billion, with notes in circulation at \$80 billion. This means that the relevant net interest rate was 2 per cent. Assuming an interest rate spread between central bank deposits and government bonds of 1 per cent, and that half of the expenses noted above are related to bank note issuance, the Bank of Canada would need to issue \$25 billion in deposits in order to buy bonds to earn seigniorage sufficient to cover its expenses. Outstanding Government of Canada bills and bonds at May 2017 were \$693 billion. So, the Bank of Canada would have to purchase around 4 per cent of federal government debt to cover its expenses.

Looking ahead, therefore, ongoing monitoring and research regarding these issues would be prudent.

## **2.2 Reduce the lower bound on interest rates, and support unconventional monetary policy**

A common perspective following the financial crisis of 2008–09 is that the major economies were in a liquidity trap, where a chronic shortfall of demand required very low real interest rates to move aggregate demand toward potential output. And, in practice, several countries have set modestly negative policy interest rates.

- The Swiss National Bank (SNB) reduced its interest rate on sight deposits to  $-0.75$  per cent in January 2015.
- In Sweden, the Riksbank lowered its repo rate to  $-0.1$  per cent in February 2015, and currently its benchmark interest rate is  $-0.5$  per cent.
- The Bank of Japan has maintained its policy interest rate at  $-0.1$  per cent since January 2016.
- The European Central Bank (ECB) benchmark refinancing rate has been zero since March 2016, and the rate on its deposit facility, which banks use to make overnight deposits with the Eurosystem, was set at  $-0.1$  per cent in June 2014, and declined to  $-0.4$  per cent by March 2016.

It has been suggested, however, that the lower bound on interest rates has prevented the real interest rate from falling to the equilibrium negative level required to remedy the persistent shortfall in aggregate demand.

### *Is CBDC needed to reduce the effective lower bound?*

What if a central bank wanted to reduce the effective lower bound (ELB) on interest rates? Since bank notes can be held as an alternative to interest-bearing financial instruments, depositors and investors have ways to avoid instruments with a negative interest rate—ultimately by holding cash. But holding large amounts of cash generates costs related to storing physical cash and to making large payments, and creates security risks that lead to safekeeping costs in the form of vault fees and insurance (see, for example, McAndrews 2015 and Witmer and Yang 2016). The corresponding negative yield of holding cash generates the lower bound on (negative) interest rates.

Therefore, reducing the ELB requires increasing the costs of holding bank notes, or equivalently, reducing the usefulness of cash as a way to avoid negative interest rates (see also Agarwal and Kimball 2015 and Goodfriend 2016). This means eliminating bank notes or (more practically) at least large-denomination notes so as to increase the frictions related to holding and storing cash. In general, the more complete the elimination of bank notes, the lower the ELB, other things equal. Similarly, a central bank could increase cash-related frictions by suspending par convertibility of bank notes—that is, discounting (or taxing) the value of bank notes in exchange for other central bank liabilities.

But eliminating larger-denomination notes to reduce the ELB does not require a corresponding introduction of CBDC; the former does not logically require the latter. Reducing the ELB by eliminating the \$100 note, for example, and introducing CBDC are independent decisions. Put differently, increasing the frictions of holding large amounts of cash by eliminating large-

denomination notes would be sufficient to reduce the ELB; introducing CBDC would not be required.<sup>8</sup>

As a practical matter, complete elimination of bank notes is unlikely to be (politically) feasible; indeed, this seems a non-starter. In Canada, given the income and geographical distributions of cash use, such a step would probably be regressive and have pronounced regional effects.<sup>9</sup> Further, if Canadian bank notes were eliminated (or discounted) to reduce the ELB, a plausible response by Canadian consumers and firms would be to switch to US bank notes for at least part of their economic activity.

In sum, reducing the ELB does not provide a compelling motivation to issue CBDC.

### *CBDC and unconventional monetary policy: “helicopter money”*

Given the ELB on interest rates, some central banks have engaged in quantitative easing in recent years, where the central bank has purchased financial assets, typically government bonds, directly from market participants. CBDC could support quantitative easing by facilitating a direct transfer of central bank funds to individuals and firms—so-called “helicopter money”—and so encourage aggregate demand (e.g., Dyson and Hodgson 2016).

However, a transfer of central bank funds to individuals and firms could be done without CBDC, although such methods might have larger administrative costs.

- In 2011, authorities in Hong Kong distributed part of the government’s fiscal surplus to the public through direct deposits into the bank accounts of eligible citizens and through cheques distributed via post offices.
- In the province of Ontario (Canada), a similar cash refund was provided to eligible Ontario residents in 2000 with cheques mailed through the postal service.
- In Canada, a central-bank-funded transfer could occur (in principle) electronically through bank accounts registered with the Canada Revenue Agency (CRA) for income tax purposes. (The CRA is phasing out the use of cheques in favour of direct electronic deposit for income tax purposes.<sup>10</sup>)

In sum, while CBDC could provide a way to directly transfer central bank funds to households and firms, there are other methods for authorities to conduct such or similar operations. And more generally, such operations are extremely rare (and, as a practical matter, of limited importance).

## **2.3 Reduce aggregate risk and improve financial stability**

The financial systems in Canada and other countries feature highly levered banks conducting liquidity and maturity transformation and operating at the core of the payment system. Banks issue claims (liabilities) that are used as both a store of value and means of payment. This is

---

<sup>8</sup> Broadbent (2016) also points out that materially negative interest rates “would require explicitly abolishing cash, not just introducing an electronic alternative.”

<sup>9</sup> On these points, see data reported in Fung, Huynh and Stuber (2015) and the discussion in Goodfriend (2016). The Swiss National Bank also has noted that it “has no plans whatsoever to do away with cash” (Zurbrügg 2017).

<sup>10</sup> Canada Revenue Agency website: <http://www.cra-arc.gc.ca/directdeposit/>

“inside money”—money claims backed by private credit (Lagos 2006). It is well known that under some conditions this set-up can be unstable, and in severe cases the stock of inside money can contract, with adverse negative externalities for the economy. This prospect, in turn, helps to motivate bank regulation, deposit insurance and other policy interventions.

To the extent that individuals and firms were to rely on CBDC as a means of payment and a store of value, overall risk and financial stability could benefit because CBDC (“outside money”) is essentially risk-free.<sup>11</sup> However, a shift from bank deposits to CBDC could also have an impact on bank funding and credit provision, which could affect financial stability as well. The overall impact of CBDC on financial stability would depend on the behaviour of economic agents over time, which probably depends also on the specific attributes of the CBDC. Accordingly, these aspects are considered further in later sections of this paper.

#### **2.4 Increase contestability in payments**

Most central banks have an interest in the efficiency of the payments system, which could be affected by CBDC in the following ways.

- CBDC could provide an alternative to bank notes, cheques, debit and credit cards, on-line transfers, etc. So, CBDC could provide for more contestability in retail payments.
- CBDC could also be used for large-value payments among banks and firms, and so could provide for more contestability in large-value payments as well.
- CBDC could also facilitate access to the central bank’s balance sheet for a wider range of financial institutions or even non-banks, thus making it easier for these firms to enter the payments industry, promoting contestability.

In principle, this motivation—increasing contestability and efficiency in payments—seems plausible or well-founded, but whether it is a sufficient motivation to issue CBDC depends on a more detailed assessment, which is provided below.<sup>12</sup>

#### **2.5 Promote financial inclusion**

Some have suggested that CBDC might improve financial inclusion (see, for example, Dyson and Hodgson 2016). Financial inclusion is, however, not a material problem in most advanced economies. For example, in Canada, over 98 per cent of Canadians report having a debit card, and so have a bank account (Fung, Huynh and Stuber 2015).<sup>13</sup>

Financial inclusion could be an important concern in some emerging economies. In those jurisdictions, CBDC could provide an accessible general purpose electronic payment method. But there are additional ways to achieve this: M-PESA in Kenya and other countries and *Modelo* in Peru are examples of payment mechanisms that increase inclusion without reliance on CBDC.

---

<sup>11</sup> See also Barrdear and Kumhof (2016), Dyson and Hodgson (2016), Raskin and Yermack (2016) and Stevens (2017) for discussions related to financial stability.

<sup>12</sup> Fung and Halaburda (2016) suggest that the benefits of CBDC in the context of retail payments are likely to be small. See also Barrdear and Kumhof (2016) for a discussion of how CBDC can promote competition in payment services.

<sup>13</sup> Moreover, debit card ownership is about 98 per cent across regions and demographics such as age, income, gender or education.

India's national biometric identity system could also support the provision of bank accounts to the general public.

In any event, financial inclusion does not provide a compelling motivation for CBDC in most advanced economies, including Canada.

## **2.6 Inhibit criminal activity**

It is occasionally observed that some portion of cash transactions, especially with larger-denomination notes, could be related to criminal activity. Therefore, eliminating cash—at least larger-denomination notes—might inhibit criminal activity (Rogoff 2016).<sup>14</sup> However, eliminating larger-value bank notes to inhibit criminal activity does not logically lead to, or require, a corresponding introduction of CBDC. And CBDC itself could also be well-suited for criminal activity if it were anonymous, as is cash. Thus, inhibiting criminal activity does not provide a compelling motivation for CBDC.

## **2.7 Summary**

Some of the motivations for CBDC considered here are not compelling, including reduction of the ELB on interest rates, and inhibiting criminal activity. Promoting financial inclusion could be an important consideration in some countries, perhaps especially emerging economies, but does not provide a motivation in the Canadian case. Based on current trends, there does not appear to be a meaningful concern in most countries considered here about preserving seigniorage or maintaining adequate central bank money for the general public. As noted, the role or need for such central bank money more generally is a topic for future research. However, improving financial stability (section 2.3) might provide a motivation for the issuance of CBDC, and increasing contestability in payments (section 2.4) seems most likely to provide a sound motivation to issue CBDC. A more complete assessment of these motivations depends on the specific nature of the CBDC, which is considered in the following sections.

## **3. A Benchmark Central Bank Digital Currency**

The effects of CBDC on monetary policy, the financial system and the wider economy could be significant; see, for example, Barrdear and Kumhof (2016), Mersch (2017a), Sams (2015) and Koning (2014). But the nature and extent of such consequences probably depend on the specific features of the CBDC (Fung and Halaburda 2016). Further, different CBDC designs—that is, different bundles of attributes—would generate different trade-offs along several dimensions. There is also uncertainty about the potential consequences, given the inherent complexity of the design issues, and the pervasiveness of possible effects. In other words, the effects of CBDC depend on the attributes of CBDC and are difficult to predict, and the significance of effects and uncertainty increase with the extent of innovation.

### **3.1 Features of the benchmark CBDC: Like cash**

Given the preceding considerations, the benchmark CBDC in this paper is designed to conform as much as possible to a familiar environment and mimic bank notes. This conservative approach

---

<sup>14</sup> Zurbrugg (2017) argues, however, that there is no indication that large Swiss denominations, specifically the CHF1,000 note, are used especially for criminal activity, and that these notes are regularly used in legitimate payment transactions, especially for large-value payments.

is more likely to avoid significant errors and lead to reliable analysis. Put differently, the benchmark CBDC here is designed to minimize disruption by having properties similar to its physical analogue, cash. Also, the benchmark CBDC complements—and does not replace—cash.

The main attributes of the benchmark CBDC are set out below. We assume that the central bank has access to the technology that would allow the issuance of a CBDC with this list of features. Table 1 compares the features of the three types of central bank money—reserves, bank notes and the benchmark CBDC—with reference to these attributes.

#### *Denomination*

- The benchmark CBDC is denominated in the sovereign currency; for Canada, the Canadian dollar.

#### *Legal tender*

- Like cash, the benchmark CBDC is legal tender.<sup>15</sup>

#### *Convertibility*

- The central bank would exchange reserves, bank notes and CBDC at par with financial institutions that have an account at the central bank, just as reserves and bank notes are exchanged at par today. This would lead to par exchange of bank notes and CBDC among the general public.

#### *Non-interest-bearing*

- Like cash, the benchmark CBDC does not bear interest.

#### *Central bank fees*

- The central bank does not charge fees for distributing/exchanging or storing CBDC, or for making payments using CBDC.
- Commercial banks could, however, decide to charge fees for services related to CBDC.

#### *Access to CBDC*

- Access is non-exclusive—anyone could use the CBDC—but access to related technology is required.
- CBDC is held and transferred with a chip card or a digital wallet available to any person or firm with the technology, through various devices, including personal computers, tablets and mobile phones with online capability.
- The digital wallet would be provided by designated private service providers that are certified or licensed by the central bank.
- As noted above, the underlying technology (like a digital ledger) is not specified here.

---

<sup>15</sup> The definition of legal tender varies across jurisdictions. In Canada, legal tender refers to the money approved for paying debts. And while bank notes are legal tender in Canada, there is no legal obligation for merchants to accept them.

### *Availability of CBDC*

- The benchmark CBDC would be available 24/7, like cash and other electronic payment methods.

### *Confidentiality of CBDC use*

- The benchmark CBDC is anonymous or pseudonymous, depending on the technology used. As a result, transactions using CBDC would be impossible to trace.
- The CBDC is subject to the risk of theft and loss, including through technological impairment. The latter could occur, for example if CBDC were stored on a hard drive that was reformatted or destroyed, or if a user lost the password/private key.
- Transactions are non-reversible, unless both transacting parties agree and engage in a reversing transaction.

### *Supply by central bank*

- The central bank supplies as much digital currency as the public is willing to hold.
- As a result, supply is demand-determined and perfectly elastic.

### *Distribution channel used by central bank*

- Similar to current bank note distribution in Canada, households and firms would purchase the benchmark CBDC at a regulated financial institution (e.g., a bank) with their deposits at those institutions or with bank notes. Bank customers could also withdraw CBDC from their bank accounts, which is conceptually similar to the withdrawal of cash.<sup>16</sup>
- These regulated financial institutions would have accounts at the central bank, or have accounts at clearing banks that have accounts at the central bank, where they could purchase the benchmark CBDC for customers directly or indirectly with their deposits or bank notes.
- Banks would have to comply with know-your-customer (KYC) and anti-money laundering (AML)/combatting the financing of terrorists (CFT) requirements for their CBDC operations, similar to bank notes today. However, once the benchmark CBDC is withdrawn from a bank, it would be anonymous to the issuer and the counterparty in a transaction.
- There would be no direct access to the central bank for households and firms to obtain, store or return the benchmark CBDC.

### *Finality and irrevocability*

- To be used for payments, benchmark CBDC transactions need to be confirmed nearly instantaneously, and the underlying transactions need to be settled irrevocably as quickly as possible.
- The timing of finality and irrevocability of benchmark CBDC transactions depends on the technological solution underpinning the CBDC.

---

<sup>16</sup> The choice of this distribution channel for the benchmark CBDC follows from the decision for this CBDC to mimic cash. This is reinforced by a concern that a central bank may not have the expertise (or interest) to open digital currency accounts for any (and all) interested parties and manage the range of related transactions.

### *CBDC payment network structure*

- The payment network for the benchmark CBDC is distributed and bilateral, and not tiered. The specific features and feasibility of these elements depend on the design of the digital wallet and ledger.
- A digital currency is closely affiliated with its network—the means by which authenticity and validity of the currency are maintained and the risk of counterfeiting is managed in a digital context (e.g., a distributed ledger). That is, a digital currency cannot exist independently of a network. Therefore, the validity and usefulness of a CBDC would be intricately connected to the digital wallet in which it is stored and the network over which it is transferred.
- As noted above, the focus here is on the economics of CBDC, so these technological considerations, including associated costs and risks to the central bank, are not considered further in this paper.

**Table 1: Attributes of central bank money—reserves, bank notes and the benchmark CBDC**

<b>Attribute</b>	<b>Reserves</b>	<b>Bank notes</b>	<b>Benchmark CBDC</b>
<b>Denomination</b>	CAD	CAD	CAD
<b>Legal tender</b>	No	Yes	Yes
<b>Convertibility: Exchange between reserves, bank notes and CBDC</b>	Par	Par	Par
<b>Interest-bearing</b>	Yes	No	No
<b>Central bank fees</b>	None	None	None
<b>Access</b>	Only financial institutions (FIs) that are direct clearers in large-value payment system can access reserves	Non-exclusive; anyone can use bank notes. No particular technology required	Non-exclusive; but access to related technology is required
<b>Availability</b>	Subject to operating hours of the large-value payment system	24/7	24/7
<b>Confidentiality of use</b>	All participating FIs are known to the central bank	Anonymous	Anonymous/pseudonymous
<b>Supply by central bank</b>	Discretionary decision by central bank, depending on its objectives	Perfectly elastic; demand-determined	Perfectly elastic; demand-determined
<b>Distribution channel used by central bank</b>	Participating FIs have accounts at the central bank, which are used for distribution of reserves	Through regulated FIs that have accounts at the central bank. FIs ensure anti-money-laundering (AML) and know-your-customer (KYC) compliance	Through regulated FIs that have accounts at the central bank. FIs ensure AML and KYC compliance
<b>Finality/irrevocability</b>	Final and irrevocable once the risk control tests are satisfied	Immediate, at time of transaction	Timing of irrevocability depends on the technological solution
<b>Payment network structure</b>	Centralized, settles on the book of the central bank	Distributed, bilateral; not tiered	Distributed, bilateral; not tiered

## **4. Implications of the Benchmark Central Bank Digital Currency**

This section considers the implications of the benchmark CBDC, focusing mostly on central bank seigniorage, monetary policy, the banking system and financial stability, and payments.

### **4.1 Central bank seigniorage**

Seigniorage from bank notes and the benchmark CBDC is equal to the face value of the instruments multiplied by the prevailing interest rate, less production and other costs. Thus, central bank seigniorage depends crucially on the demand for bank notes and CBDC.

#### *Demand for CBDC*

The benchmark CBDC has properties that are similar to cash, and its digital form is more desirable for some purposes. More specifically, CBDC would be superior to some current payment methods when transacting in physical venues or online when security or privacy is a particular concern for the purchaser. CBDC would also be less costly for consumers to use than cash (other things being equal), reinforcing its appeal as a payment instrument compared with bank notes.<sup>17</sup> These factors would generate demand for the benchmark CBDC. On the other hand, CBDC is subject to risk of theft and loss, which could discourage demand relative to existing electronic payment methods.

Acceptance of CBDC by (at least) some merchants seems likely. With no transaction fees charged by the central bank, the benchmark CBDC would probably be less expensive for merchants than cash and credit cards. For Canadian retailers, cash has the lowest (private) cost of all payment methods for transaction values up to \$20, while accepting debit cards is the least expensive for transactions greater than \$20 (Kosse et al. 2017). It follows that CBDC would probably be the least expensive payment method for merchants to accept for a range of transactions.<sup>18</sup>

While a commercial bank might charge a merchant to withdraw or deposit CBDC, it is likely that such fees would be lower than those for cash because CBDC is less costly to process, store and transport. In general, merchants prefer a payment method that is low-cost, as long as consumers are willing to use it. Given consumer willingness to use CBDC in some contexts, and the lower cost to merchants, merchant acceptance of CBDC seems likely.

In sum, while it is difficult to estimate how much benchmark CBDC would circulate, it is reasonable to expect that CBDC would be adopted as a retail payment method, particularly in certain contexts (noted above), and relative to bank notes as well.

CBDC might also be held as a store of value. In the current low-interest-rate environment in particular, corporate treasurers, for example, might prefer holding some amount of a sovereign

---

<sup>17</sup> Kosse et al. (2017) find that the costs of cash to consumers are mainly the time spent withdrawing cash from ATMs and making payments at the point of sale. This suggests that CBDC would present advantages to consumers relative to cash because of the potential time savings.

<sup>18</sup> According to Kosse et al. (2017), the costs of cash to merchants are largely the time spent counting cash and depositing it in a bank. Accordingly, CBDC would appear to offer savings, as it would require less time to process and manage.

currency in digital form as a risk-free store of value. While it is not practical to hold a large amount of physical cash as a store of value, it is relatively convenient to hold a large quantity of the benchmark CBDC—but the absence of interest on the benchmark CBDC would limit this.

Finally, since the benchmark CBDC is pseudonymous and digital, it could be attractive for criminal activity. While the withdrawal and deposit of CBDC at a bank would be subject to the usual AML requirements, it is easier to store CBDC (in a digital wallet) than cash, and CBDC is likely to be widely accepted, so there is less need to bring CBDC into the banking system. As a result, crime-related demand could be important.

#### *Demand for bank notes in a world with CBDC*

The demand for bank notes would likely decrease with the issuance of the benchmark CBDC. As discussed above, CBDC is superior to bank notes for some types of transactions. And research indicates that electronic payment methods that are as convenient as cash—such as contactless cards—are reducing the use of cash for payments (see Fung, Huynh and Sabetti 2013; and Chen, Felt and Huynh 2017). On the other hand, some demand for cash as a payment method is likely to persist, possibly for a prolonged period: certain demographic groups prefer cash because it provides personal financial privacy and does not require the adoption of a new technology or a change in habits. Cash is also a particularly important payment method during disruptions caused by power outages or natural disasters.

#### *Summing up*

Overall, there would probably be some substitution of the benchmark CBDC for bank notes, and some substitution of CBDC for competing electronic payment methods, particularly in certain contexts where personal security and privacy are especially valued. As a result of the latter, the sum of the value of bank notes in circulation and CBDC would likely be larger than the value of bank notes in circulation currently. Other things being equal, this would increase seigniorage revenue somewhat. But this assessment does not include the production costs (fixed and variable) of CBDC. Further, if a central bank provides both bank notes and CBDC, total cost to the central bank could increase, in part because there would be smaller gains from economies of scale.

## **4.2 Monetary policy**

Central banks typically do not vary bank note supply to implement monetary policy; that is, bank notes are not considered to be a monetary policy tool. Indeed, in many countries, including Canada, bank notes are supplied passively to meet public demand. As discussed in section 3, the benchmark CBDC (which does not pay interest) is supplied in the same way as bank notes, so it would not have material implications for the implementation of monetary policy. More fundamentally, the central bank would remain the ultimate (monopoly) supplier of reserves, bank notes and CBDC, so it could continue to set related terms and conditions of these instruments and therefore control monetary policy.

Regarding unconventional monetary policy and reducing the ELB on interest rates, as discussed above, it is the elimination of cash, not the introduction of CBDC, that is relevant. Indeed, issuing the benchmark CBDC itself would improve agents' ability to store value and escape from negative interest rates, and so would *raise* the ELB. More specifically, Witmer and Yang (2016) estimate that the ELB in Canada is likely to be around –50 basis points; with the benchmark CBDC, the ELB probably would increase somewhat, toward zero. In addition, the effectiveness

of helicopter money might be reduced if a significant fraction of CBDC were held by non-residents. (The benchmark CBDC is anonymous and thus the central bank cannot target such actions toward residents only.)

### **4.3 The banking system and financial stability**

It follows from the preceding discussion of the demand for CBDC that some displacement of bank deposits and other conventional savings instruments would be expected. However, since the benchmark CBDC does not pay interest, a significant shift to CBDC from conventional financial instruments seems unlikely. Also, like cash, the benchmark CBDC is subject to risk of theft and loss, which would also discourage significant holdings of CBDC, other things being equal.

At the same time, if there were a material impact on deposits, for example, banks would respond by increasing interest rates on their liabilities or bundling superior services on such accounts relative to CBDC to maintain their funding. As a result, the steady-state impact of the benchmark CBDC on bank deposits and other claims would likely be small, but balances could shift (more readily) toward CBDC in stress periods, with attendant volatility and potentially significant disruptions of the financial system. This endogenous aspect is probably more important for interest-bearing CBDC, which is considered in section 5.4.

### **4.4 Contestability and efficiency in payments**

#### *Retail payments*

Fung and Halaburda (2016) argue that digital currency would benefit retail payment efficiency in two ways, which would also apply to the benchmark CBDC. First, CBDC would have lower user costs than cash, which could prompt substitution from cash to CBDC for retail and person-to-person payments. However, relatively low-cost electronic person-to-person payment methods, such as Interac e-Transfer in Canada, already exist and consumers are increasingly making use of such payment methods.<sup>19</sup>

Second, CBDC would facilitate transactions that are currently foregone because of frictions that inhibit some types of transactions. For example, some consumers avoid online purchases because of security and privacy concerns when providing their credit card information. The benchmark CBDC would facilitate such online transactions because it is anonymous, and because potential losses from fraud to the consumer would be limited to only the amount of the single, specific transaction. Also, smaller merchants often avoid selling online because of card fees, especially for small-value transactions; CBDC would facilitate small-value online transactions given a relatively low (or no) associated fees. (As noted in Table 1, the central bank charges no fees for CBDC.)

As a result of these considerations, the benchmark CBDC would provide for some increased contestability with other electronic payment methods, possibly in terms of reduced costs, and, in particular, in terms of enhanced privacy. However, Fung and Halaburda (2016) also conclude

---

<sup>19</sup> Interac e-Transfer is a person-to-person payment scheme in Canada that allows a sender to initiate a funds transfer from the sender's bank account to the receiver's bank account by sending an email to the receiver. It is typically free to receive and increasingly becoming free to send. The use of e-Transfer has grown significantly in recent years: according to Interac, Canadians made 158 million e-Transfers worth \$63 billion in 2016, an increase of over 40 per cent from 2015.

that foregone transactions due to such frictions are not material, so that the benefit from the benchmark CBDC in this respect would likely be small.

*Large-value payments: CBDC and real-time gross settlement*

This section considers the impact of the benchmark CBDC on large-value payments, particularly where the existing large-value payment system is based on a real-time gross settlement (RTGS) design—the most common set-up for large-value payments globally. In effect, the benchmark CBDC would provide for a general, open-access RTGS where any agent can settle its large-value payments in CBDC with finality in virtually real time (depending on the technology used), bilaterally, directly and in central bank funds.

To do so, firms would have to pre-fund their CBDC payments (as in RTGS), which could be done by selling goods or interest-earning assets. That is, to fund their payment needs, agents could exchange assets for CBDC in the market (e.g., sell bonds for CBDC), or at a commercial bank (sell deposits for CBDC). Financial intermediaries could manage this process for those agents that did not want to invest in the needed technology; banks would provide the interface with the CBDC network and related asset/liability management. To deal with mismatches in payment flows—an important consideration—these agents would also need liquidity support. As a result, banks would also provide CBDC funding or overdraft facilities to help manage their payment flows.

In comparison, firms settling in an RTGS system as direct participants or indirectly through a direct participant on an agency basis (tiering)—including non-clearing financial firms and non-financial firms—would have the benefit of liquidity-saving (queuing) mechanisms attached to the RTGS system and central bank lending facilities that provide overdrafts at the policy overnight rate. Since any gross settlement system is demanding and expensive in terms of funding and liquidity needs, RTGS systems universally have queuing mechanisms that match and offset payment orders to reduce liquidity requirements before settlement (e.g., Martin and McAndrews 2008). Put differently, such liquidity-saving mechanisms significantly reduce payment flows by conditioning the release of queued payments on the receipt of offsetting or partially offsetting payments, so that gross payment orders are transformed to some netted amount before entering the RTGS system for settlement. This quasi-netting process substantially reduces funding liquidity requirements and related costs from what would otherwise prevail.<sup>20</sup> Further, as noted, RTGS participants benefit from (collateralized) central bank funding, which is priced at around the overnight policy rate and is relatively inexpensive. Such large-value payment systems are also subject to (significant) economies of scale and network effects, which incentivizes pricing to encourage (indirect) access and wider participation in the RTGS system.

---

<sup>20</sup> It is conceivable that agents preferring CBDC for their large-value payments could use netting algorithms to similarly net payment orders to reduce liquidity needs, but the capacity for netting such flows would be much smaller than would be available in a centralized (RTGS) system with more participants and larger payment flows. (For a related discussion of the application of centralized queuing in the context of Project Jasper, which explores the use of distributed ledger technology for large-value payments, see Payments Canada, Bank of Canada and R3 2017.)

Finally, an RTGS system provides a high degree of security to participants because it is a closed (“permissioned”) system with a trusted central bank at its core (at least in Canada).<sup>21</sup>

These various features would tend to make participation in the RTGS system, directly or indirectly through an agent, more attractive than CBDC for large-value payments.

#### **4.5 Summary**

Generally speaking, the benchmark CBDC seems unlikely to have significant implications for central bank seigniorage revenue, monetary policy or the banking system. A noteworthy qualification is that the benchmark CBDC would seem likely to increase the ELB somewhat. The benchmark CBDC could promote contestability and provide for some efficiency gains in retail payments, but there are unlikely to be material benefits for large-value payments.

Regarding other considerations, it seems likely that the benchmark (anonymous) CBDC would facilitate criminal activity unless some additional restrictions were imposed on its use. This could include a limit on the amount of CBDC held in each digital wallet—but an enterprising criminal would obtain multiple wallets. Alternatively, CBDC transactions in excess of a threshold value could be required to satisfy user identification requirements; this would eliminate anonymity for such transactions. These kinds of restrictions, however, would reduce the demand for CBDC, decreasing seigniorage (other things being equal), and increase the cost of using CBDC for making payments in general.

Finally, the benchmark CBDC could promote financial inclusion, although this would require access to and use of the underlying technology, which could be a constraint for some individuals. As noted above, however, financial inclusion is not a concern in most advanced economies, including Canada.

### **5. Interest-Bearing Central Bank Digital Currency (I-CBDC)**

Central banks might prefer to consider a digital currency with some different features than the benchmark CBDC considered above. For example, full anonymity of CBDC seems to be a non-starter (because of concerns related to criminal use), and the benchmark CBDC is not interest-bearing. This section considers a CBDC that differs significantly from the benchmark digital currency and that could lead to more substantial implications: the payment of interest, which, in turn, leads to other changes in the design of the CBDC.

#### **5.1 I-CBDC and (no) anonymity**

Paying interest on CBDC raises a range of practical and operational questions, including how interest should be calculated (e.g., daily interest based on daily closing balance), when and how interest would be credited to the corresponding I-CBDC, etc. Paying interest also raises complications about preserving the anonymity of the beneficial owner of CBDC. An important constraint in this regard concerns taxation. For income tax purposes, the central bank (at least in

---

<sup>21</sup> Banks have long preferred to use more-or-less exclusive mechanisms to settle interbank payments, largely because of the greater security that such arrangements can provide. For example, in the late 19th century, the Canadian government began to issue special large-denomination Dominion notes, called “Bank Legals,” in response to bank demand (Fung, Hendry and Weber 2017). These notes were designated by the government exclusively for interbank payments. Individuals or non-banks were not legally able to transact with these notes, nor redeem them for gold.

Canada) would be required to provide information about the identity of the recipient of interest income to tax authorities. The central bank would also be required to withhold tax on interest income credited to non-resident holders of I-CBDC.<sup>22</sup> As a result, anonymity—one of the main attractions of bank notes—would not be fully possible with I-CBDC.<sup>23</sup> It should be noted, however, that the identity of the I-CBDC owner and the parties involved in an I-CBDC transaction could still be anonymous to other parties, aside from the central bank.

This erosion of anonymity would reduce the appeal of I-CBDC for those transactions where (complete) privacy was desired. On the other hand, this loss of anonymity would help address concerns about the use of CBDC for criminal activity. More generally, such a provision could constrain access to I-CBDC to those individuals and firms who have verifiable identification (e.g., a tax identification code, social insurance or a business registration number).<sup>24</sup>

## **5.2 I-CBDC and central bank seigniorage**

Paying interest on I-CBDC would directly reduce seigniorage in proportion to the level of interest rates. At the same time, paying interest would increase the demand for CBDC, especially relative to bank notes, while the erosion of anonymity (discussed above) would tend to reduce demand for I-CBDC relative to bank notes. Whether a sustained shift from commercial bank deposits and other conventional claims to I-CBDC would occur—and so benefit seigniorage—depends largely on how financial institutions respond to the existence of I-CBDC, which is considered in section 5.4.<sup>25</sup>

## **5.3 I-CBDC and monetary policy**

As noted above, the central bank would remain the ultimate (monopoly) supplier of reserves, bank notes and CBDC (interest-bearing or not), so the central bank could set related terms and conditions, and therefore control monetary policy. So, again, paying interest on CBDC should not compromise or fundamentally affect a central bank's ability to influence short-term interest rates to achieve price stability, although implementation tactics could change.

In principle, one would expect that the interest rate paid by the central bank on reserves would be the same as the interest rate paid on I-CBDC, as each reflects the setting of monetary policy. These liabilities are also close substitutes in some contexts. Further, a spread between the interest

---

<sup>22</sup> In Canada, any entity that makes certain payments, including interest income, to a resident of Canada is required to report such income to the Canadian Revenue Agency and to prepare a corresponding record for the income recipient. These records identify the types of investment income that residents of Canada must report on their income tax returns. The tax authorities in Canada also require an individual or organization to withhold income tax of 25 per cent or the percentage established under a tax agreement on amounts paid or credited to non-residents.

<sup>23</sup> This argument may not apply in economies such as Hong Kong where interest income is not subject to income taxes.

<sup>24</sup> A central bank could consider issuing both an anonymous benchmark CBDC (with a cap on the maximum amount that could be held) along with an I-CBDC (with no cap on balances). Analysis of such an approach is for future research.

<sup>25</sup> Barrdear and Kumhof (2016) argue that interest-bearing CBDC would lead to a large increase in demand for central bank liabilities, which would lead to an increase in seigniorage, and, in turn, to larger residual transfers to the government. They also note that with such a large shift into CBDC, the central bank would need to hold more government bonds on its balance sheet. This increased demand for government bonds, other things being equal, would increase bond prices and lower associated bond interest rates, thus reducing government funding costs.

rates on reserves and I-CBDC would provide arbitrage opportunities for clearing banks, which would tend to attenuate any difference between the interest rates on these central bank liabilities, as explained below. (The following abstracts from market frictions and nuances related to floors and ceilings in a corridor-type policy rate system, as in Canada.<sup>26</sup>)

- If the overnight rate on reserves was less than the interest rate paid by the central bank on I-CBDC, then clearing banks would borrow reserves from other clearing banks and especially from the central bank and invest the proceeds in I-CBDC to earn the spread. Other things being equal, this would tend to increase the overnight rate on reserves or decrease the yield on CBDC until the spread disappeared. To the extent that the central bank lends reserves indefinitely to sustain the overnight rate below the rate paid on I-CBDC, then clearing banks could earn the related spread indefinitely.
- If the overnight rate on reserves was greater than the interest rate paid by the central bank on I-CBDC, then clearing banks would borrow I-CBDC in the market and invest the proceeds in reserves to earn the spread. Other things equal, this would tend to reduce the overnight rate or increase the market yield on CBDC until the spread disappeared.

As a result of these considerations, it appears that consistency between the interest rate on central bank reserves and the interest rate on I-CBDC should be expected. Thus, the overnight rate (which would be equivalent to the rate on I-CBDC) would determine short-term bank and market interest rates in the first instance, and together with expectations, affect longer-term rates across the yield curve.<sup>27</sup>

Paying interest on CBDC would create a yield differential between I-CBDC and bank notes, which would increase the demand for I-CBDC relative to bank notes. However, if the policy rate were negative—to encourage aggregate demand in a liquidity trap (as discussed above)—I-CBDC holders would tend to convert their I-CBDC into bank notes, other things equal, which would limit the central bank’s efforts to sustain negative rates below the effective lower bound. As a result, to achieve its objectives in this case, the central bank would need to discourage conversion of I-CBDC into cash by suspending par convertibility of bank notes, or by restricting the supply of bank notes. Alternatively, the introduction of I-CBDC could be accompanied by the (partial) elimination of bank notes.

A possible monetary policy benefit of I-CBDC is the ability to directly influence interest rates affecting consumers and investors by adjusting the interest paid on CBDC. In normal conditions (a positive interest-rate environment) it is not clear that this is a material benefit. Historically, central banks have been able to exert significant and predictable (indirect) influence on consumer rates by changing the policy rate. For example, the Bank of Canada’s adjustment of its overnight rate target is transmitted effectively to short-term market rates, and across the yield curve through expectations. This, in turn, causes the commercial bank prime rate and other lending and deposit rates to change. The link between the policy rate, consumer and market rates has been

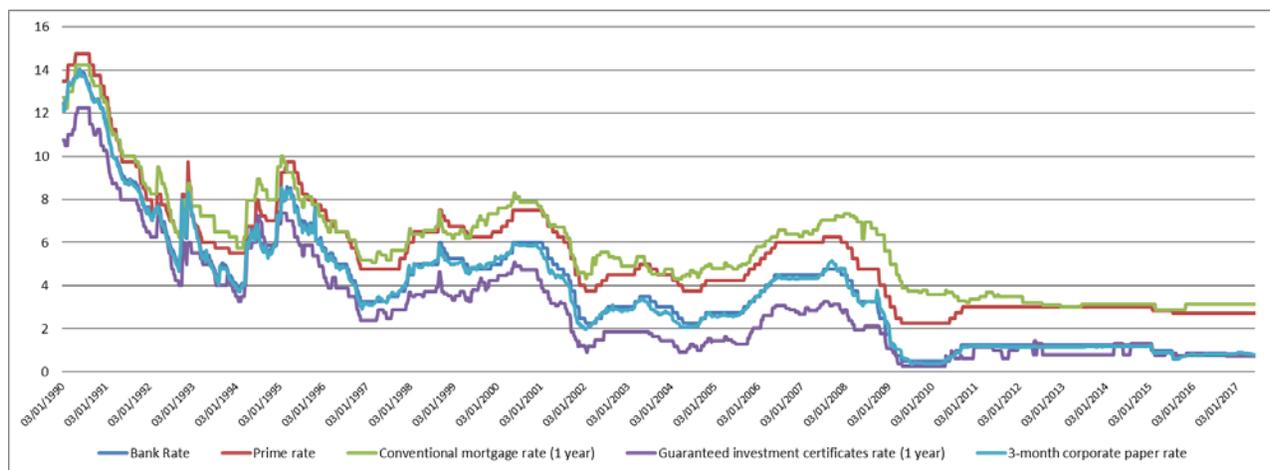
---

<sup>26</sup> For background on this type of monetary policy implementation framework, see Engert, Gravelle and Howard (2008).

<sup>27</sup> This could imply a one-time jump in consumer deposit rates. Historically, consumer deposit rates in Canada typically have been lower than the policy rate (Figure 3). As discussed below, commercial banks would have to offer deposit rates that were competitive with the rate on I-CBDC, other things being equal.

reliable and the transmission lag short, as illustrated for Canada in Figure 3.<sup>28</sup> So I-CBDC is not needed to provide a stable, predictable influence on consumer and market interest rates.

**Figure 3: Selected interest rates in Canada**



Source: Bank of Canada

However, such close links between the policy rate and consumer and market interest rates might not hold in a negative interest rate environment, largely because commercial banks could be unwilling to pass on negative rates to all their customers. For example, in Sweden and Switzerland, while the policy interest rate has been negative for some time, commercial bank deposit rates have remained above zero.

However, when a central bank reduces the interest rate on I-CBDC, especially as part of an effort to generate negative interest rates, the central bank could be seen as (more) directly impairing the welfare of those who rely on interest income from a safe investment, including those members of society who might be less financially sophisticated and have few financial alternatives. This could generate reputational risk and might invite political interference.<sup>29</sup>

#### 5.4 I-CBDC, the banking system and financial stability

In general, financial claims such as bank deposits are held for a number of reasons: safe-keeping of wealth, to earn income and to make payments. I-CBDC would allow agents to simultaneously meet all three objectives. Therefore, it seems likely that I-CBDC would provide meaningful competition for financial intermediaries offering conventional financial services such as bank deposits, which also meet all three objectives. However, without anonymity, the principal attraction of I-CBDC compared with bank deposits is its risk-free nature. And with the

<sup>28</sup> Clinton and Howard (1994) study the stability of the relationships between the monetary policy instrument and consumer and market interest rates, and conclude that the links of the interest-rate channel of transmission—from policy instruments through short-term rates to short-term bond rates and administered rates—is essentially stable.

<sup>29</sup> See also Stevens (2017) and Raskin and Yermack (2016) for more on this aspect.

introduction of I-CBDC, there would be a range of endogenous, competitive responses from financial institutions.

- To maintain their funding, banks would offer an incremental spread above the (policy) rate on I-CBDC to reflect the marginal credit risk, other things being equal. In Canada, this incremental spread would likely be small.<sup>30</sup>
- Bank deposits are also associated with a range of services (e.g., mortgage finance, consumer and business loans, wealth management, financial advice, underwriting, etc.) that would not be offered with CBDC. And banks (and other service providers) are likely to bundle such services to compete more effectively with I-CBDC.
- To offset increased funding and other costs, banks would probably undertake cost-reduction exercises and raise lending rates and fees. The incidence of the latter changes would fall most on those customers on both sides of bank balance sheets with the fewest competitive options—that is, those with the lowest price elasticity of demand. For example, banks would raise interest costs more for certain borrowers, such as smaller businesses, and on credit cards, and compress net returns to less sophisticated depositors less likely to switch financial service providers.<sup>31</sup>
- Banks might also go up the asset risk curve to earn higher (nominal) returns to compensate for the need to compete with I-CBDC.
- Increased funding costs and lower profitability could also lead to a contraction in the amount of bank intermediation and lending.
- At the same time, a more credible run threat—into I-CBDC—under financial stress might imply more *ex ante* market discipline, constraining incremental risk-taking by banks to some extent or motivating more capital to buffer shocks. This, in turn, could result in lower returns to banking, and some contraction of intermediation.

Overall, it seems that a plausible equilibrium is that banks would be able to compete effectively with I-CBDC through the channels noted above, so that agents would generally rely on bank deposits in normal times to earn higher spreads and to benefit from associated financial services, but under stress, agents could (more) easily shift to (risk-free) I-CBDC, possibly leading to disturbances to the financial system and the wider economy. In sum, compared with the status quo, I-CBDC could generate a redistribution of returns away from financial intermediation, perhaps a (modest) contraction of intermediation, and increased volatility.

## 5.5 I-CBDC and contestability in payments

I-CBDC would provide for more contestability in payments than the benchmark CBDC because it is interest-bearing. As discussed above, banks (and other service providers) would be expected

---

<sup>30</sup> Aside from considerations related to probability of default and loss given default, deposit insurance is typically available for Canadian-dollar deposits with a term of five years or less, up to \$100,000.

<sup>31</sup> The competitive responses of banks to I-CBDC might compromise reliance on banks to distribute CBDC on behalf of the central bank (as set out in Table 1). In other words, since CBDC competes directly with bank products, banks might introduce frictions (e.g., fees) to inhibit the use of CBDC. Competition between banks could be sufficient to mitigate this risk, but the central bank (or other authorities) might also have to consider other interventions to discourage anti-competitive outcomes.

to respond by increasing interest on payments balances or bundling services to maintain market share. This, in turn, would provide incremental benefits to retail payment users. On the other hand, I-CBDC would not be anonymous (as noted above), which would impair its appeal for some retail transactions.

For large-value payments, as discussed above, RTGS offers three significant benefits over CBDC: liquidity-savings mechanisms; access to central bank overdrafts; and a high degree of security. It seems doubtful that an I-CBDC would overcome these structural features in the context of large-value payments. Further, in certain large-value payment systems, such as in Canada, excess reserves deposited with the central bank earn interest, which could ameliorate costs to users of the RTGS system generally. Again, banks would be expected to respond to I-CBDC in order to maintain market share in this context as well. Overall, it seems unlikely that the payment of interest on CBDC would lead to material benefits in large-value payments relative to an RTGS system.

## **5.6 Summary**

A key implication of paying interest on CBDC is that complete anonymity would not be possible, which would reduce the demand for I-CBDC, other things being equal, but this would also address concerns about CBDC use for criminal activity. From a narrow (or technical) perspective, I-CBDC does not appear to have material implications for monetary policy, and the interest rates paid on central bank reserves and on I-CBDC are likely to be similar, not least because of arbitrage opportunities. However, I-CBDC might increase risk of political interference and lead to reduced central bank autonomy under some conditions.

Banks and other financial intermediaries would compete with the issuance of I-CBDC, so that compared with the status quo, I-CBDC could lead a redistribution of returns, perhaps a (modest) contraction of intermediation, and increased financial volatility. More specifically, households and firms could generally rely on bank deposits in normal times to earn (incrementally) higher interest revenue and to benefit from associated financial services, but under stress, could (more) easily shift to I-CBDC, generating volatility and perhaps presenting challenges for financial stability. Finally, I-CBDC is likely to provide for beneficial incremental contestability for retail payments, but seems unlikely to have a significant impact on large-value payments (RTGS) systems.

## **6. Conclusions**

Consideration of CBDC is a new challenge, which is complex and subject to significant uncertainty. A CBDC could have important consequences, which would depend on its specific attributes, and could include both benefits and costs. Accordingly, assessing CBDC requires careful analysis of motivations and potential implications, including an assessment of the risks that might arise from CBDC.

There are seven key conclusions from the present analysis.

(i) Some of the motivations for CBDC considered in this paper are not compelling, including reducing the ELB on interest rates and inhibiting criminal activity. Further, based on recent trends, there does not appear to be a meaningful concern in most countries considered here, including Canada, for preserving seigniorage or maintaining adequate central bank money for the general public. Promoting financial inclusion could be an important consideration in some

countries, perhaps especially in emerging economies, but does not provide a motivation in the Canadian case.

(ii) Increasing contestability in retail payments seems to be the most credible motivation to issue CBDC, and the overall impact depends importantly on the specific attributes of the CBDC. I-CBDC would provide for more contestability in payments than the benchmark CBDC, which does not pay interest. Banks (and other service providers), however, could respond to I-CBDC by increasing interest on payments balances or bundling services to maintain market share, which would provide incremental benefits to customers, other things being equal. And these developments could have wider implications for the financial system (see below). Further, to the extent that promoting contestability in retail payments was the primary motivation to issue CBDC, authorities should probably also consider whether there were other ways to achieve this goal, including through regulatory avenues or by acting as a catalyst, and assess which strategy would be most effective (Fung and Halaburda 2016). As for large-value payments, it seems unlikely that CBDC would lead to material benefits relative to an RTGS system.

(iii) Some of the attributes of the benchmark CBDC discussed above are problematic—most notably anonymity, which would facilitate criminal activity. As a practical matter, complete anonymity seems to be undesirable for central bank digital currency.

(iv) As noted, CBDC, especially if interest-bearing, would motivate endogenous responses by financial intermediaries to compete with CBDC to retain market share and funding. A plausible outcome is that banks would be able to compete effectively with CBDC so that households and firms would generally rely on bank deposits and related products in normal times. In stress periods, however, they could (more) easily shift to CBDC. As a result, compared with the status quo, CBDC (especially if interest-bearing) could lead to some redistribution of returns away from financial intermediaries, perhaps a (modest) contraction of intermediation, and increased volatility (other things being equal).

(v) It follows that designing a CBDC with a focus on a particular attribute, in pursuit of a specific policy objective, is likely to have implications on other margins; indeed, interdependence of effects should be expected.

(vi) The analysis in this paper is based on an assumption that the technological means to issue and transfer CBDC—e.g., a digital wallet and the distributed ledger technology—would be feasible and acceptable to the central bank. Similarly, this paper does not focus on the costs involved in issuing CBDC (including central bank reputation risk). From a benefit-cost perspective, including these considerations in the analysis would reduce the appeal of CBDC.

(vii) Finally, given the complexity and uncertainty associated with introducing CBDC, central banks inclined to issue CBDC should proceed cautiously and incrementally, perhaps with a non-anonymous CBDC that mimics bank notes—similar to the benchmark CBDC discussed above—withstanding likely low adoption rates, and learn from experience.

Looking ahead and with a view to future research, it could be useful to examine the implications of a CBDC with different attributes than the benchmark or I-CBDC considered in this paper. Ongoing monitoring and research regarding the adoption and possible implications of private cryptocurrencies also would be useful, as would further work on the interaction of CBDC, monetary policy and financial stability in various institutional settings. Further, to the extent that demand for bank notes decreases over time (contrary to the evidence in most countries, as shown

in Figure 2), an interesting question is whether a central bank liability that is accessible to the general public, like cash or CBDC, is desirable from a social-welfare perspective. Is it sufficient for a central bank to supply only reserves to qualified financial institutions? Put differently, is a “cashless society” a sound outcome?

## References

- Agarwal, R. and M. Kimball. 2015. "Breaking Through the Zero Lower Bound." 15/224. IMF Working Paper.
- Arango, C., K. P. Huynh, B. Fung and G. Stuber. 2012. "The Changing Landscape for Retail Payments in Canada and the Implications for the Demand for Cash." *Bank of Canada Review* (Autumn): 31–40.
- Barrdear, J. and M. Kumhof. 2016. "The Macroeconomics of Central Bank Issued Digital Currencies." Bank of England Staff Working Paper No. 605.
- Broadbent, B. 2016. "Central Banks and Digital Currencies." Speech to the London School of Economics, London, 2 March.
- Chapman, J., R. Garratt, S. Hendry, A. McCormack and W. McMahon. 2017. "Project Jasper: Are Distributed Wholesale Payment Systems Feasible Yet?" Bank of Canada *Financial System Review* (June): 59–69.
- Chen, H., M.-H. Felt and K. P. Huynh. 2017. "Retail Payment Innovations and Cash Usage: Accounting for Attrition by Using Refreshment Samples." *Journal of the Royal Statistical Society: Series A (Statistics in Society)* 180 (2): 503–530.
- Clinton, K. and D. Howard. 1994. "From Monetary Policy Instruments to Administered Interest Rates: The Transmission Mechanism in Canada." Bank of Canada Technical Report No. 69.
- Dyson, B. and G. Hodgson. 2016. "Why Central Banks Should Start Issuing Electronic Money." Available at <http://www.positivemoney.org>.
- Engert, W., T. Gravelle and D. Howard. 2008. "The Implementation of Monetary Policy in Canada." Bank of Canada Staff Discussion Paper No. 2008-9.
- Freedman, C. 2000. "Monetary Policy Implementation: Past, Present and Future – Will Electronic Money Lead to the Eventual Demise of Central Banking?" *International Finance* 3 (2): 221–27.
- Fung, B. and H. Halaburda. 2016. "Central Bank Digital Currencies: A Framework for Assessing Why and How." Bank of Canada Staff Discussion Paper No. 2016-22.
- Fung, B., S. Hendry and W. Weber. 2017. "Canadian Bank Notes and Dominion Notes: Lessons for Digital Currencies." Bank of Canada Staff Working Paper No. 2017-5.
- Fung, B., K. P. Huynh and L. Sabetti. 2014. "The Impact of Retail Payment Innovations on Cash Usage." *Journal of Financial Market Infrastructures* 3 (1).
- Fung, B., K. P. Huynh and G. Stuber. 2015. "The Use of Cash in Canada." *Bank of Canada Review* (Spring): 45–56.
- Fung, B., M. Molico and G. Stuber. 2014. "Electronic Money and Payments: Recent Developments and Issues." Bank of Canada Staff Discussion Paper No. 2014-2.
- Goodfriend, M. 2016. "The Case for Unencumbering Interest Rate Policy at the Zero Bound." Paper presented to the Jackson Hole Economic Policy Symposium, 26 August.
- Henry, C., K. P. Huynh and G. Nicholls. Forthcoming. "Bitcoin Awareness and Usage in Canada." Bank of Canada Staff Working Paper.
- Koning, J. P. 2014. "Fedcoin." <http://jpkoning.blogspot.ca/2014/10/fedcoin.html>.
- Kosse, A., H. Chen, M.-H. Felt, V. Dongmo Jiongo, K. Nield and A. Welte. 2017. "The Costs of Point-of-Sale Payments in Canada." Bank of Canada Staff Discussion Paper No. 2017-4.
- Lagos, R. 2006. "Inside and Outside Money." Federal Reserve Bank of Minneapolis Research Department Staff Report 374.

- Martin, A. and J. McAndrews. 2008. “An Economic Analysis of Liquidity-Saving Mechanisms.” *Federal Reserve Bank of New York Economic Policy Review* 14 (2): 25–39.
- McAndrews, J. 2015. “Negative Nominal Central Bank Policy Rates – Where Is the Lower Bound?” Remarks at the University of Wisconsin, Madison, 8 May 2015.
- Mersch, Y. 2017a. “Digital Base Money: An Assessment from the ECB’s Perspective.” Speech at the Farewell Ceremony for Pentti Hakkarainen, Deputy Governor of Suomen Pankki - Finlands Bank, Helsinki, 16 January.
- . 2017b. “Why Europe Still Needs Cash.” Remarks for Project Syndicate, 27 April.
- Payments Canada, Bank of Canada and R3. 2017. “Project Jasper: A Canadian Experiment with Distributed Ledger Technology for Domestic Interbank Payments Settlement.” White paper. Available at [https://www.payments.ca/sites/default/files/29-Sep-17/jasper\\_report\\_eng.pdf](https://www.payments.ca/sites/default/files/29-Sep-17/jasper_report_eng.pdf)
- Raskin, M. and D. Yermack. 2016. “Digital Currencies, Decentralized Ledgers, and the Future of Central Banking.” NBER Working Paper 22238.
- Rogoff, K. 2016. *The Curse of Cash*. Princeton University Press.
- Sams, R. 2015. “Which Fedcoin?” <https://cryptonomics.org/2015/02/05/which-fedcoin/>.
- Segendorf, B. and A. Wilbe. 2014. “Economic Commentaries: Does Cash Have Any Future as Legal Tender?” *Sveriges Riksbank Economic Commentary*, no. 9.
- Skingsley, C. 2016. “Should the Riksbank Issue E-Krona?” Remarks to FinTech Stockholm 2016, 16 November.
- Stevens, A. 2017. “Digital Currencies: Threats and Opportunities for Monetary Policy.” National Bank of Belgium *Economic Review* (June): 79–92.
- Witmer, J. and J. Yang. 2016. “Estimating Canada’s Effective Lower Bound.” *Bank of Canada Review* (Spring): 3–14.
- Zurbrugg, F. 2017. “Cash - Tried and Tested, and with a Future.” Speech to the World Banknote Summit, 27 February.