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CBDC adoption and usage: some insights from field and laboratory experiments

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Abstract

This note discusses insights from historical launches of new payment methods and related laboratory experiments on the potential adoption and use of a central bank digital currency in the Canadian context.

Topics: Central bank research; Digital currencies and fintech

JEL codes: C9, E4, E58

Résumé

Cette note analyse les enseignements tirés du lancement de nouvelles méthodes de paiement dans le passé. Elle analyse également les expériences de laboratoire menées sur l'adoption et l'emploi éventuels d'une monnaie numérique de banque centrale au Canada.

Sujets : Recherches menées par les banques centrales; Monnaies numériques et technologies financières
Codes JEL : C9, E4, E58

Key messages

- A necessary condition to successfully initiate and sustain the adoption and use of a central bank digital currency (CBDC) is to ensure the CBDC has a clear niche in the payment landscape.
- A possible route is to design a CBDC as "enhanced cash"—to reduce the carrying and handling costs associated with cash and enable electronic transfers, while retaining cash's distinctive desirable features.
- Desirable design features of a CBDC could include universal accessibility, transparent and low per-transaction fees, a high degree of privacy and robust offline capabilities.
- Due to network effects, sustained adoption and use of a CBDC as a person-to-business (P2B) payment method would occur if, and only if, consumers and merchants both benefit from switching from the status quo. Enabling person-to-person (P2P) functionality could help capture the consumer side and promote P2B use.

A clear niche is important

The successful launch and sustained adoption and use of a new payment method—such as a central bank digital currency (CBDC)—requires a strong user case.[1] A new payment method without clear advantages over existing alternatives is highly unlikely to succeed. This is seen in the successes and failures of several new payment method launches.[2]

One notable success is the Octopus card, a stored-value smart card that is reloadable and contactless, designed for making electronic payments in online or offline systems in Hong Kong. Launched in September 1997 to collect fares for the region's mass transit system, the Octopus card has expanded into retail payments at most convenience stores, supermarkets and fast-food restaurants. Other common Octopus payment applications include parking meters, parking lots, gas stations, vending machines, public libraries and swimming pools. A fundamental reason for the Octopus card's success is its unique niche at the time of launch: compared with its onerous "ticket" precursor, the contactless card greatly sped up fare payments and alleviated bottlenecks in the mass transit system of a busy city.[3]

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[1] This note does not judge the optimal level of adoption and use. The focus is on what makes sustained adoption and use possible.

[2] So far, four official CBDCs have been launched. The first is Ecuador's *dinero electronico*, which failed after three years (2015–18), largely due to a lack of trust in the government's ability to issue claims in US dollars that it might become unable or unwilling to repay (Ecuador has been dollarized since 2000). Another case is the six-month pilot project for Uruguay's e-Peso, which tested the system's components, including production, digital vault, digital wallets, transactional system and infrastructure. Because of the project's limited scope, there is not enough information to determine whether the e-Peso would have been successful with a real launch. In December 2019, the Central Bank of The Bahamas started its central bank digital currency pilot (Project Sand Dollar), citing financial inclusion and access as the main motivation. Most recently, in April 2020, China's central bank launched a pilot program of its digital currency in four cities.

[3] M-Pesa in Kenya (launched in 2007) is another success story. It allows users to deposit money into an account stored on their cell phones, send balances using PIN-secured SMS text messages to other users (including merchants) and redeem deposits for regular cash. Users are charged a small fee for the service. M-Pesa fits Kenya well, given the ubiquity of cell phone use across both urban and rural parts of the country and the lack of penetration of regular banking services.

A notable failure is Mondex's stored-value card. In the early 1990s, Mondex conducted more than 50 trials of the card around the globe but had little success.[4] The fundamental flaw was that the Mondex card did not possess any clear advantages over physical cash—the instrument it aimed to replace. Its benefits included the potential to save the handling costs associated with bank notes and coins and to enable payments for e-commerce. It also maintained cash's capacity for offline transactions.[5] However, Mondex was perceived as inferior to cash in terms of privacy, trustworthiness and potential costs. Mondex's claim that transactions were private was subject to disputes. Further, Mondex balances were issued by private banks, and the coverage of deposit insurance for those balances was not clear. And although Mondex subsidized the card's use during the pilot project, it was unclear which fees would apply in the future.

Desirable design features

In Canada, a promising route could be to design a CBDC to mimic cash's desirable features with improved transaction capabilities. Canadians are served by a plethora of payment methods, including cash, (contactless) debit and credit cards, Interac e-Transfer, mobile payment apps such as Apple Pay and Google Pay, and online payment accounts such as PayPal. The penetration rates for bank accounts, mobile phones and internet access are very high. The central bank's comparative advantage could lie in providing a cash-like electronic payment instrument.[6]

In Canada, the share of cash used for transactions is decreasing due to the expansion of online shopping, the increasing relative ease of use of contactless payment cards, and the growing number of incentives provided for alternative payment methods (mostly credit cards). However, Canadians still value cash as a payment method in some situations because it offers certain distinct advantages over other payment methods. These advantages include:

- universal accessibility (everybody can use cash),
- no intermediation fees at the point of transaction,
- a high level of privacy, and
- the capacity for offline transfers.

Some users like the advantages of cash but cannot use it for virtual (electronic) transfers. A CBDC that is designed to mimic cash without the need for physical handling and that extends beyond face-to-face transactions could attract those users.[7]

In this section, we identify some use cases for a cash-like CBDC. We derive these cases from the digitization of each of the three desirable features of physical cash noted above.[8] We

[4] Mondex conducted trials in two Canadian cities: Guelph, Ontario in 1997 and Sherbrooke, Quebec in 1999. It also launched a pilot project in Hong Kong in September 1996, one year before the launch of the Octopus card.
[5] A user could load balances to a Mondex card through an automated teller machine and the card could then work offline without the need for connection to a bank account. As consumers spent, the money was deducted from their local card's account and transferred to the seller's account.
[6] Engert and Fung (2017) set out a benchmark CBDC with features similar to cash.
[7] One would think that earning interest through a CBDC could also boost its adoption and use. However, the experimental studies of Camera, Noussair and Tucker (2003) and Camera (2019) caution against the practice, as it could induce hoarding of CBDC and disrupt the payment system.
[8] Fung and Halaburda (2016) identify some new transaction types that are potentially enabled by a CBDC.

analyze how each feature appeals to consumers, assuming that the CBDC is accepted by merchants, and vice versa.

A CBDC with universal accessibility and no intermediation fees at the point of transaction could offer a transparent and relatively inexpensive digital payment option for frequent low-value transactions. In Canada, debit and credit cards (especially contactless cards) are an efficient means of payment for person-to-business (P2B) transactions. Interac e-Transfer, which allows Canadians to transfer money to each other through their bank accounts, has become increasingly popular for both person-to-person (P2P) and P2B payments since 2015. Compared with private electronic methods of payment, cash has greater accessibility—it can be used by everyone with or without access to the internet, bank accounts or mobile devices. Cash also has a relative cost advantage for frequent low-value transactions. At the point of transaction, a cash payment does not involve an intermediation cost.[9] In contrast, merchants pay their acquirers[10] processing fees, either a flat fee per transaction for sales using debit cards or a percentage for credit card sales. For consumers, most free or low-fee bank accounts grant a certain number of free transactions, but a penalty rate applies for each transaction beyond that limit. To avoid those penalty fees, consumers may prefer cash over debit and Interac e-Transfer for frequent low-value transactions. Small merchants, who tend to have little bargaining power in negotiating payment service fees, may prefer cash to avoid the fees associated with card payments.[11]

Like cash, a CBDC could be designed to be inclusive so that users do not need a bank, internet access or a phone to use it. For example, the central bank could provide the public with a free device to house a CBDC. Like cash, a CBDC is a liability of the central bank and is free to use by the public at the point of transaction. The central bank's seigniorage revenues could cover the costs of developing and maintaining CBDC devices, as well as creating the CBDC and ensuring its security.

A CBDC could have a potential niche as an electronic means of payment with enhanced privacy features. Users might prefer payment privacy to prevent others from improperly using their transaction history details. The experimental study by Borgonovo et al. (2019) suggests that people value privacy as an important feature of a payment method. As the use of electronic payments continues to rise and the costs of collecting, storing and analyzing online consumer data continue to decline, concerns about privacy could increase (see, for example, Hoofnagle, Urban and Li 2012; Garratt and van Oordt 2019; and Kahn 2019). Users could have greater choice about sharing information (or not) while making payments.

A CBDC with a high level of privacy could be useful for electronic transactions where privacy is a critical concern. A number of privacy-preserving techniques are based on cryptography (e.g., encryption of user data) and operational arrangement (e.g., distribution of decryption key fragments among multiple agents who do not have the incentive to collude). Enabling

[9] Acquiring and depositing cash still involves intermediation costs, as consumers and merchants rely on financial institutions for these services.

[10] Acquirers are typically financial institutions or banks that process debit or credit card payments on a merchant's behalf.

[11] According to the Bank of Canada's 2018 Merchant Acceptance Survey (Huynh, Nicholls and Nicholson 2019), small and medium-sized firms almost universally accepted cash, but only about 70 percent accepted debit and credit cards (the card acceptance rate is 58 percent for firms with 0–5 employees). According to the Bank of Canada's 2017 Methods-of-Payment Survey (Henry, Huynh and Welte 2018), more than 50 percent of transactions below $15 were conducted with cash. For P2P transfers, cash was still the dominant instrument: 89 percent of Canadians had used cash for P2P payments in the past year, followed by 54 percent for Interac e-Transfer (this rate was higher for young consumers aged 18–34 at 72 percent and lower for older consumers aged 55+ at 42 percent).

transaction modes that have strong privacy controls (e.g., through devices that do not rely on cell phones or the internet) could also help.[12] However, it is difficult, if not impossible, for online transactions with a CBDC or any electronic means of payment to replicate the same level of privacy offered by a cash transaction. Further, fully protecting electronic privacy would involve broader legal and regulatory interventions to condition and restrain the use of private information.[13]

A CBDC that enables offline transfers could complement existing payment methods that are sensitive to power outages and internet disconnections. Most existing card payments in Canada require an internet connection to verify card information. When the payment system breaks down due to power outages or internet failures, it is an inconvenience for consumers. For merchants, the stakes can be much higher because they risk losing sales and customers. Even if it is possible to read a debit or credit card offline and store transaction data, actual card processing is carried out only when the connection is restored. There is therefore a risk in accepting cards offline.[14] A CBDC with more robust offline capabilities could be useful as a backup payment method during power and internet failures. It could also be the main payment method for certain types of businesses, such as food trucks or outdoor farmer's markets.

Finally, it is difficult for a cash-like CBDC to replace existing payment methods, and it probably should not be intended to do so. Instead, a CDBC should aim to fill gaps in the payment landscape, particularly if a cashless environment were to evolve. It should coexist with other payment methods, making the payment system more robust and efficient.[15]

Launching considerations

Due to network effects, it is important that merchants and consumers both benefit from switching to a CBDC to achieve successful adoption and use for P2B payments. The previous section identifies areas where a cash-like CBDC could appeal to consumers and merchants, assuming that the other side is willing to accept or use it. The adoption of payment methods involves network effects. For the consumer, the benefits of adopting a new payment method increase if more merchants accept that payment method. The reverse also applies: merchants benefit from accepting the new payment method when more consumers use it.[16]

Due to network effects, a socially more efficient payment method might not have the chance to take off. Arifovic, Duffy and Jiang (ADJ, 2017) provide evidence for this in a controlled

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[12] These privacy measures could also help to alleviate the concern that CBDC could introduce state surveillance.

[13] See the Office of the Privacy Commissioner of Canada (OPC)'s submission to the Task Force of the Payments System Review. OPC also provides educational materials about privacy risks associated with electronic and digital payments.

[14] For example, in the case of Square (a payment service provider), the merchant could enable the offline mode to accept card payments when internet service is temporarily unavailable. However, Square clearly states on its website that, "By enabling Offline Mode, you're responsible for any expired, declined, or disputed payments accepted while offline."

[15] Huynh et al. (2020) explore the demand for payment services at points of sale using data from methods-of-payment surveys. Their analysis indicates that a new cash-like CBDC would have to be significantly better in terms of the perceived ease of use, cost, security and actual transaction cost to completely replace cash. In addition, both their work and the experimental study by Camera, Casari and Bortolotti (2016) suggest that rewards are an important factor for card adoption. Sophisticated reward/fee designs are obviously not a comparative advantage for a CBDC.

[16] See, for example, Rochet and Tirole (2002); Wright (2003); McAndrews and Wang (2012); Chiu and Wong (2014); and Li, McAndrews and Wang (2019).

laboratory environment. The new payment method in their study involves lower per-transaction costs relative to existing payment methods for both consumers and merchants. But merchants must pay a fixed acceptance fee—for example, to rent or purchase a terminal and set up and maintain a new account—and they must train employees to use the new system. Switching to the new payment method is socially optimal because it minimizes total transaction costs, but ADJ (2017) document strong network effects during the adoption process. In the case of high fixed adoption costs, merchants will be worse off relative to the status quo if the new payment method is fully adopted. In that case, merchants respond by initially accepting the new payment method, fearing a loss of business, but eventually learn over time to resist the new payment method and pull the economy back to the socially inefficient old payment method. During this process, there is also a large efficiency loss due to payment choice mismatch. One lesson from the ADJ study is that both sides of the payment system must benefit from switching to the CBDC relative to the status quo to achieve smooth and sustained adoption and use.

In a related work, Huynh, Nicholls and Shcherbakov (2019) explore the data from the 2013 Methods-of-Payment (MOP) survey and the 2015 Retailer Survey on the Cost of Payment Methods to study the role of network effects in the retail payment system. They quantify the importance of the feedback loop between consumers and merchants. One lesson from this work is that, since the strength of network effects can vary depending on whether they originate from consumers or merchants, an effective introduction of a CBDC should consider the elasticity of the response to adoption/acceptance incentives provided to each side of the market.

Enabling a CBDC for easy P2P transfers may help attract consumers and promote its use for P2B payments. This is a route followed by some notably successful payment systems, such as Swish in Sweden, WeChat Pay in China and, more recently, Interac e-Transfer in Canada. Swish (launched in 2012) was originally intended for transactions between individuals but soon started to be used for payments at flea markets and other small-payment events where a credit card reader was too costly or impractical. Small companies that wished to avoid credit card charges and simplify online payments soon followed suit. WeChat is a Chinese multi-purpose messaging, social media and mobile payment app. WeChat Pay is a digital wallet incorporated into WeChat that allows users to make mobile payments and send money between contacts. The use of WeChat Pay was popularized in January 2014, when WeChat introduced a feature for distributing virtual red envelopes, virtualizing the Chinese tradition of exchanging packets of money among friends and family during the Chinese New Year. Since then, WeChat Pay has quickly expanded into P2B payments. It has become the main electronic payment method for daily small transactions in China and a part of everyday life. In Canada, Interac e-Transfer has followed a similar route: it was first intended for P2P transfers but has expanded into P2B transactions as well (Interac e-Transfer is discussed further below).

Introducing a new payment method specifically for P2B payments could be more challenging, as it requires coordination between *both* sides of the market—consumers and merchants. One route is to design the CBDC as a universally accessible, relatively inexpensive and simple P2P payment method to capture a consumer base, which could set the stage for expansion into P2B payments.

To mitigate the threat from private digital currencies on the adoption of CBDC, government transaction policies favouring the Canadian dollar could be helpful. In addition to innovations in payments denominated in domestic currencies, there have also been many experiments with new private digital currencies, such as Bitcoin. Bitcoin's transactional use is low and hampered by violent fluctuations in its value. According to the Bank of Canada's 2018 Bitcoin Omnibus Survey (Henry et al. 2019), despite widespread public awareness (89 percent) of cryptocurrencies, only 5 percent of Canadians owned bitcoin and 4 percent of Canadians had used bitcoin in the previous year to make a purchase from a business. Libra, planned as a digital currency backed by financial assets to enable both domestic and cross-border money transfers, might achieve a more stable value than Bitcoin and provide more competition for a CBDC.

Within this context, the government can take some actions to mitigate the threat from private currencies. Jiang and Zhang (2018) study competition between two currencies in the laboratory where human subjects choose whether to accept domestic and foreign currencies. Their study suggests that without exchange rate risk and government intervention, both currencies could be readily accepted. However, government policies favouring government currency would significantly reduce the broader acceptability of the foreign currency. One lesson from this study is that to mitigate the threat from private digital currencies such as Libra, transaction policies favouring the Canadian dollar—for example, stipulating that taxes and government services must be paid in Canadian dollars—could be helpful.

CBDC in an evolving retail-payments landscape

Given the new developments in retail payments, a clear niche for a CBDC is even more important for its successful adoption and use. In Canada, the public sector is engaging in various new initiatives to enhance competition in retail payments. One such notable project is Real-Time Rail (RTR), a new platform to quickly process low-value payments. The RTR will be operated by Payments Canada and will be open to new payment service providers (PSPs). The entry of new PSPs through the RTR could promote innovation and competition and result in cheaper and more convenient payment services for end-users. On a related note, new developments in electronic payment technology, such as contactless cards, have sped up the processing time for each transaction, which effectively reduces the per-transaction cost for card payments. As a result, these contactless cards are also gaining ground over cash for small-value transactions.[17] Interac e-Transfer has also experienced rapid growth in recent years, as some banks have started offering unlimited free e-Transfer transactions with personal chequing accounts, and e-Transfer features like Autodeposit and Request Money have made it more convenient for consumers and merchants to use.

For sustained adoption and use, a CBDC must be designed not only to keep up with the developments in private electronic payment methods but also to excel in some aspects.[18] In view of the new developments in retail payments, it could become more difficult for a CBDC to be better than private electronic means of payment in terms of cost and ease of use. A CBDC's niche therefore lies in the distinctive, desirable features of physical cash relative to

[17] The Bank of Canada's MOP surveys suggest that the share of cash in small-value transactions has been steadily decreasing from more than 75 percent in 2009 to a little more than 50 percent in 2017; see Henry, Huynh and Welte (2018).

[18] According to an experimental study by Hossain, Minor and Morgan (2011), when platforms are primarily vertically differentiated, markets inevitably tip to the more efficient platform. They find strong evidence of coexistence when platforms are primarily horizontally differentiated, so there is no single efficient platform.

conventional (account-based) private electronic payment methods: **universal accessibility, transparent and lower per-transaction fees, a high degree of privacy, and robust offline capabilities.** It is conceivable that competition will induce private PSPs to improve along these dimensions over time. However, pursuing these objectives might not generate enough profit to become a priority for private PSPs. The Bank of Canada, with its mandate to contribute to the economic well-being of Canadians (as defined in the *Bank of Canada Act*), could be in a unique position to provide the public with a means of payment that offers features that might be insufficiently provided by the private sector.

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