

# Cash, COVID-19 and the Prospects for a Canadian Digital Dollar

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by Walter Engert and Kim P. Huynh

Currency Department  
Bank of Canada, Ottawa, Ontario, Canada K1A 0G9  
[wengert@bankofcanada.ca](mailto:wengert@bankofcanada.ca), [khuynh@bankofcanada.ca](mailto:khuynh@bankofcanada.ca)

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## Abstract

We provide an analysis of cash trends in Canada before and during the COVID-19 pandemic. Focusing on the pandemic period, we explore the implications on demand for, use of and access to cash. We find that cash demand has been strong pre-pandemic and increased sharply during the pandemic. While cash use fell initially due to the decreased number of in-person shopping opportunities, it recovered as containment measures eased. We explore the potential two scenarios for issuance of central bank digital currency or Canadian digital dollar. We discuss the Canadian experience in maintaining cash as an efficient and accessible method of payment and store of value.

*Topics: Bank notes, Central bank research, Coronavirus disease (COVID-19), Digital currencies and fintech, Econometric and statistical methods*

*JEL codes: C, C1, C12, C9, E, E4, O, O5, O54*

## Résumé

Nous présentons une analyse des tendances relatives à l'usage de l'argent comptant au Canada avant et durant la pandémie de COVID-19. Nous nous concentrons sur la période de la pandémie et examinons son incidence sur la demande de billets de banque, l'usage de l'argent comptant et l'accès à celui-ci. Nous constatons que la demande d'argent comptant était forte avant la pandémie et qu'elle a grimpé en flèche durant la pandémie. En effet, l'usage de l'argent comptant a chuté initialement en raison de la baisse du nombre d'occasions d'effectuer des achats en personne, mais la demande s'est redressée avec l'assouplissement des mesures sanitaires. Nous explorons les deux scénarios possibles concernant l'émission d'une monnaie numérique de banque centrale ou d'un dollar canadien numérique. Nous discutons ensuite de l'expérience canadienne en ce qui a trait au maintien de l'argent comptant comme mode de paiement et instrument de réserve de valeur à la fois efficace et accessible.

*Sujet(s) : Billets de banque, Recherches menées par les banques centrales, Maladie à coronavirus (COVID-19), Monnaies numériques et technologies financières, Méthodes économétriques et statistiques*

*Codes JEL : C, C1, C12, C9, E, E4, O, O5, O54*

# 1. Introduction

The Bank of Canada, like other central banks, provides bank notes and carries out various roles related to payment systems. This includes regulatory oversight of financial market infrastructures and supervision of retail payment service providers.<sup>1</sup> In the recent period, these responsibilities have also meant analyzing the effects of the COVID-19 pandemic on various methods of payment.

Notably, the pandemic shock occurred in the broader context of a long-term trend away from cash as a method of payment toward electronic methods of payment. And the emergence of alternative digital currencies such as bitcoin and related technologies has also generated significant interest. In this regard, a frequent question raised by academics and policy-makers is whether central banks should issue a digital currency that the public could use for regular transactions. We review these inter-related topics and set out some lessons based on our experience and ongoing research. We also look forward and highlight strategic issues the Bank faces in these areas.

In Section 2, we consider how the pandemic affected various methods of payment and the demand for cash in Canada. We also consider long-term trends and show that the demand for cash has been strong for decades even as cash use for payments has been declining in favour of electronic methods of payment. Most other advanced economies also witness this phenomenon.

In Section 3, we focus on central bank digital currency (CBDC). We assess two scenarios that the Bank has indicated could lead to issuing a Canadian digital dollar:

- the transformation to a cashless society
- the widespread use of an alternative digital currency in Canada

The evidence available at the time of writing suggests that these scenarios are unlikely to occur in the coming years. Nevertheless, conditions could change rapidly. Bank staff will continue to monitor and analyze ongoing developments. In Section 4, we discuss some considerations related to the possible adoption and use of a CBDC, if conditions were to warrant its issuance.

Finally, one of the lessons from our experience is the importance of maintaining cash as an efficient and accessible method of payment and store of value. So, in Section 5, we discuss several measures that the Bank is pursuing to sustain cash in the Canadian economy. In Section 6, we present our conclusions.

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<sup>1</sup> See Bank of Canada, "[Regulatory Oversight of Designated Clearing and Settlement Systems](#)" and "[Retail payments supervision](#)."

## 2. The evolution of cash and other methods of payment in Canada<sup>2</sup>

We begin our analysis by studying the effects of the COVID-19 pandemic on the value of bank notes in circulation (NIC) and on payment methods used during the pandemic. We also provide a broader perspective by considering how the related trends have changed over a longer time frame.

### (a) The pandemic's effect on bank notes in circulation

**Chart 1** shows that the value of NIC increased significantly in the early months of the pandemic, and this growth slowed materially only in July 2020. As a result, the value of NIC at the end of 2020 was significantly larger—by 16%—than it was one year earlier.

To gauge the pandemic's impact on the value of NIC, we construct a simple projection (or counterfactual) of 2020 NIC based on what could have been expected if the COVID-19 shock had not occurred. That is, we calculate what the path of NIC would have been after early March if NIC value had increased at the average of weekly growth rates experienced from 2017 to 2019. The dashed line in **Chart 1** presents the expected path of NIC in 2020 without the COVID-19 shock.

Our findings suggest the pandemic doubled the increase in the value of NIC that could have been expected over this period in a typical year. **Chart 1** illustrates this with the much larger gap at the end of 2020 between the solid blue 2020 line and the green 2019 line compared with the difference between the dashed blue line (2020 without the COVID-19 shock) and the green line. **Chart 2** shows that the elevated level of NIC continued in 2021. Our analysis also indicates that the extraordinary increase in the value of NIC during this period was driven more by demand for large-denomination notes, which are generally associated with precautionary motives, rather than for small-denomination notes, which are typically used for transactions.

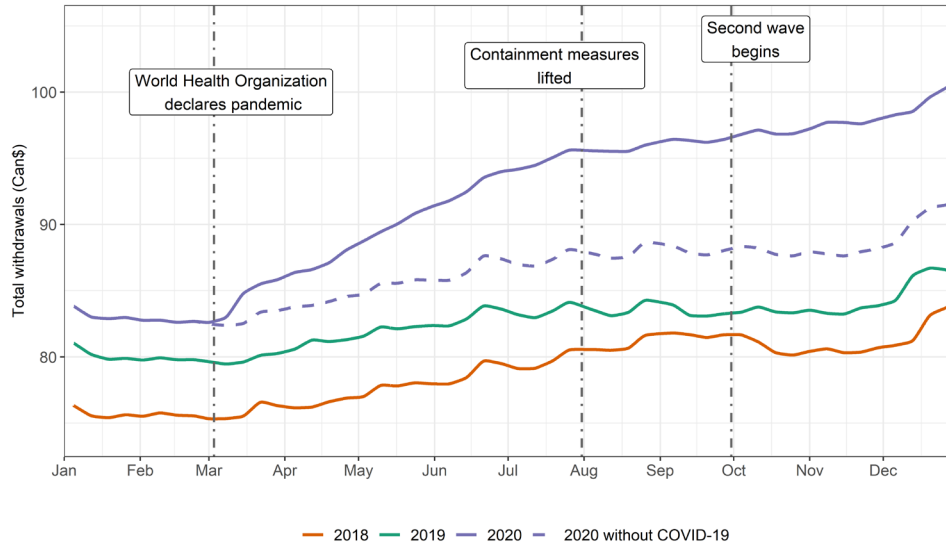
**Chart 3** depicts another perspective on the pandemic's effect. This chart shows the ratio of NIC to nominal gross domestic product (GDP), which is a conventional measure of the demand for cash. Since the 1970s, this measure has been relatively stable, ranging between 3% and 4% of GDP in Canada until 2020, when it increased to around 5%. This increase reflects both the significant growth of NIC discussed above and the temporary slowdown of GDP early in the pandemic. **Chart 3** also shows the persistence of elevated cash demand into 2021.

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<sup>2</sup> Chen et al. (2020, 2021a, 2021b, 2022) provide detailed analysis of the impact of the pandemic on cash demand and methods of payments. This section is based on that research.

Other advanced economies—including Australia, Germany, New Zealand, the United Kingdom and the United States—show evidence of trends during the pandemic like those seen in Canada.<sup>3</sup> Further, several authors have emphasized that the demand for cash typically increases during stress or crisis periods—a phenomenon observed over time in various countries and episodes (Bech et al. 2018; Engert, Fung and Hendry 2019; and Rösl and Seitz 2021).

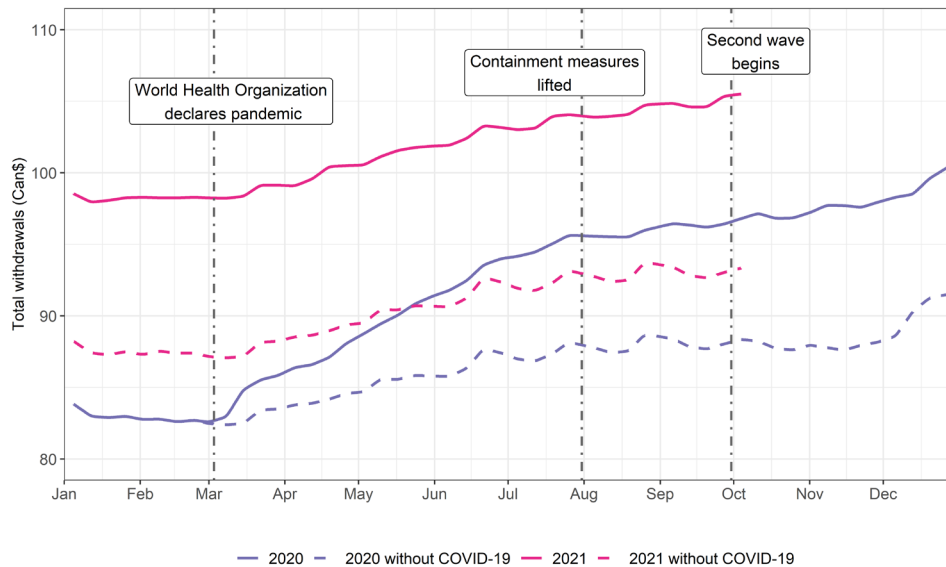
Chart 1: Canada—The value of bank notes in circulation, by year: 2018–20



Note: The estimate of “2020 without COVID-19” refers to a counterfactual scenario for 2020, constructed using the average growth rate of NIC from 2017 to 2019. The dates indicated by the dashed vertical lines pertain to 2020. The dates indicated by the first two dashed lines (“World Health Organization declares pandemic” and “Containment measures lifted”) are from Cavalli et al. (2020), and the date indicated by the third dashed line (“Second wave begins”) is based on a statement by the Government of Canada.

<sup>3</sup> For more on this, see Rösl and Seitz 2021; Guttman et al. 2021; Hawkesby 2020; Caswell et al. 2020; and Foster and Greene 2021.

Chart 2: Canada—The value of bank notes in circulation: 2020 and 2021

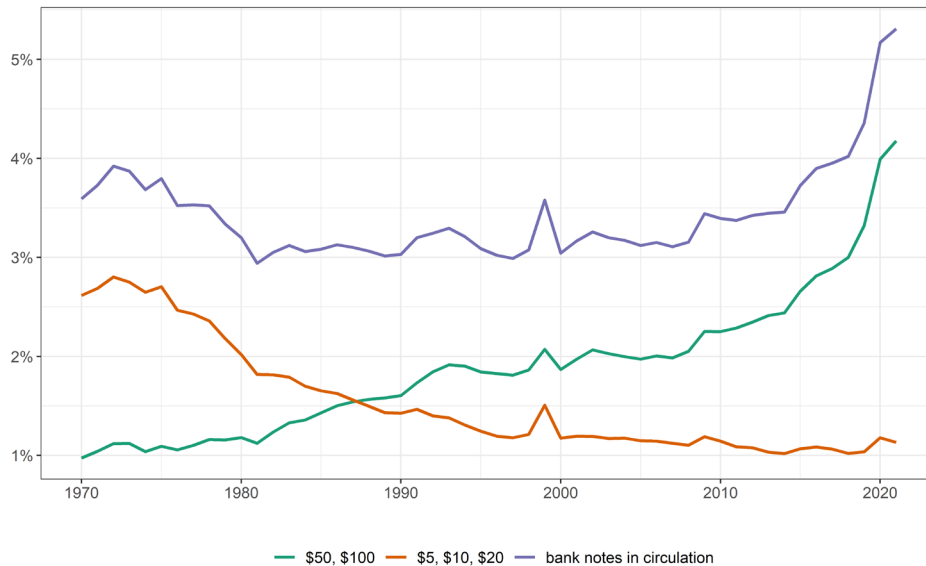


Note: The estimate of “2020 without COVID-19” refers to a counterfactual scenario for 2020, constructed using the average growth rate of NIC from 2017 to 2019. The estimate of “2021 without COVID-19” refers to a counterfactual for 2021, constructed using the average growth rate of NIC from 2017 to 2019. The dates indicated by the dashed vertical lines pertain to 2020. The dates indicated by the first two dashed lines (“World Health Organization declares pandemic” and “Containment measures lifted”) are from Cavalli et al. (2020), and the date indicated by the third dashed line (“Second wave begins”) is based on a [statement by the Government of Canada](#).

## (b) Long-term trends in cash demand

Chart 3 shows that the demand for small-denomination bank notes (\$5, \$10 and \$20)—typically transactions notes—has generally been declining in Canada for almost 50 years. At the same time, the demand for large-denomination notes (\$50 and \$100)—generally seen as non-transactional notes—has been increasing for most of that period. This has offset the decline in demand for small-denomination notes. These developments also correspond with a shift of consumer preferences away from cash toward electronic methods of payment (discussed below).

Chart 3: Canada—The value of bank notes in circulation as a percentage of nominal GDP



So we see that cash use for payments has declined, but the ratio of bank notes in circulation to nominal GDP—cash demand—has been strong for decades. This outcome could have been encouraged by the sustained low interest rate environment in recent years, which means holding cash had a low opportunity cost. Anecdotal evidence also shows that an increase in foreign demand for Canadian bank notes might have contributed to the strong demand for large-denomination notes in recent years.<sup>4</sup> More generally, understanding this long-standing dichotomy between declining cash use for payments and sustained cash demand over many years—the so-called cash puzzle—is a research topic of significant interest.

### (c) Methods of payment

We can learn more about Canadians' payment behaviour during the pandemic from a series of surveys that the Bank of Canada conducted in 2020 in collaboration with Statistics Canada and Ipsos, the survey provider. This work comprises two parts:

- consumer surveys of cash holdings and use
- a payments diary that provides greater detail about methods of payment<sup>5</sup>

<sup>4</sup> For more on this, see Engert, Fung and Segendorf (2019, pp. 22–24). The authors also consider the role the underground economy and the demand for cash play in foreign demand for Canadian bank notes (pp. 26–28).

<sup>5</sup> The methodology we use has undergone extensive testing and analysis. We designed it to minimize selection bias, and we cross-validated the weighted estimates cross-validated with Statistics Canada surveys. Finally, we reduce total survey error by using a range of data cleaning and editing. For more on this, see Chen et al. (2020, 2021a, 2021b).



## Key insights from consumer surveys

**Table 1** reports the various payment methods used by Canadians in 2020 at both physical points of sale and online. We see that a significant percentage of Canadians reported using cash for transactions throughout this period. Cash use for payments was inhibited early in the pandemic when:

- containment measures restricted consumer access to physical stores
- concerns existed about the risk of virus transmission through bank notes<sup>6</sup>

By late 2020, however, almost 60% of Canadians reported using cash for transactions during the survey week. At the same time, the percentage of Canadians who relied on electronic methods of payment, especially contactless cards, increased early in the pandemic, and this was sustained. These results suggest that Canadians relied heavily on electronic payment methods during the pandemic, but a significant proportion also continued to use cash.

**Table 1: Percentage of Canadians using different payments methods during the survey week**

Method of payment	April 2020 BoC survey (% of Canadians)	July 2020 BoC survey (% of Canadians)	November 2020 BoC survey (% of Canadians)
Cash	36	54	59
Debit	52	62	62
Credit	62	67	71
Interac e-Transfer	38	38	39
Mobile	8	12	11
Pre-paid card	11	12	12

Note: This table reports use of all payment methods during the survey week and includes in-store and online payments. Respondents could select multiple answers, so shares do not sum to 100. BoC is the "Bank of Canada." For information on survey methods, see Chen et al. (2020, 2021a, 2021b).

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<sup>6</sup> In May 2020, the Bank of Canada issued an [announcement](#) to encourage retailers to continue to accept cash to ensure that all Canadians have access to the goods and services they need.

As noted above, merchants had concerns about cash acceptance early in the pandemic. These concerns moderated through 2020, and merchant acceptance of cash has generally been stable for most of this period. For instance, our survey data (**Table 2**) indicates that 12% of Canadians reported that they were unable to use cash at a merchant's point of sale in April 2020, at the beginning of the pandemic. This proportion fell to 9% in our July survey. This was sustained in our November survey, which was conducted during the second wave of the pandemic. Similarly, reports of news media stating that merchants were not accepting cash declined significantly through the pandemic to relatively low levels. Looking ahead, in 2022 Bank staff will conduct a comprehensive survey of merchant acceptance of cash and other payment methods.

Finally, around 80% of Canadians have consistently reported during the pandemic that they have no plans to go cashless in the next five years.

**Table 2: Indicators of merchant acceptance of cash in Canada**

Percentage of Canadians reporting the following	April 2020 BoC survey	July 2020 BoC survey	November 2020 BoC survey
I saw a sign that stated a merchant was not accepting cash	22	16	17
I heard news reports that merchants stated cash was not accepted	16	6	5
I was not able to use cash at merchant's point of sale	12	9	9

Note: For information on survey instruments and methods, see Chen et al. (2020, 2021a, 2021b). BoC is the Bank of Canada.

## Key insights from the payment diaries

The November 2020 survey included a payment diary to provide more detailed information on a range of topical issues.<sup>7</sup> Results from payment diaries also featured in earlier Method of Payment surveys conducted by Bank staff in 2009, 2013 and 2017. Accordingly, we can compare results from the diary components of several surveys to provide a perspective on the transaction shares of various methods of payment over time.

**Table 3** presents the transaction shares of various methods of retail payment, in terms of volume (number) of payments, including both in-store and online transactions. It shows that consumers paid using cash for more than one-fifth of the total volume of purchases in November 2020. We also see that the cash share of payments has been declining over the last decade, from 54% in 2009 to 33% in 2017 (Henry et al. 2018) and 22% in 2020—consistent with the declining demand for small-denomination bank notes discussed above. The main corresponding increase has been in the share of credit card purchases, which went from 39% in 2017 to 47% in 2020. Of course, the growth of online shopping probably contributed to the decline of cash use shown **Table 3**. Not surprisingly, we also see a surge in contactless

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<sup>7</sup> The payment diary tool is time- and resource-intensive and was not included with the surveys we conducted earlier in the pandemic, when the timeliness of core results was a priority.

payments, which we estimate accounted for almost 80% of the number of credit card purchases and about 70% of the number of debit card purchases in 2020. We find similar trends in the payment value shares (Chen et al. 2021a).

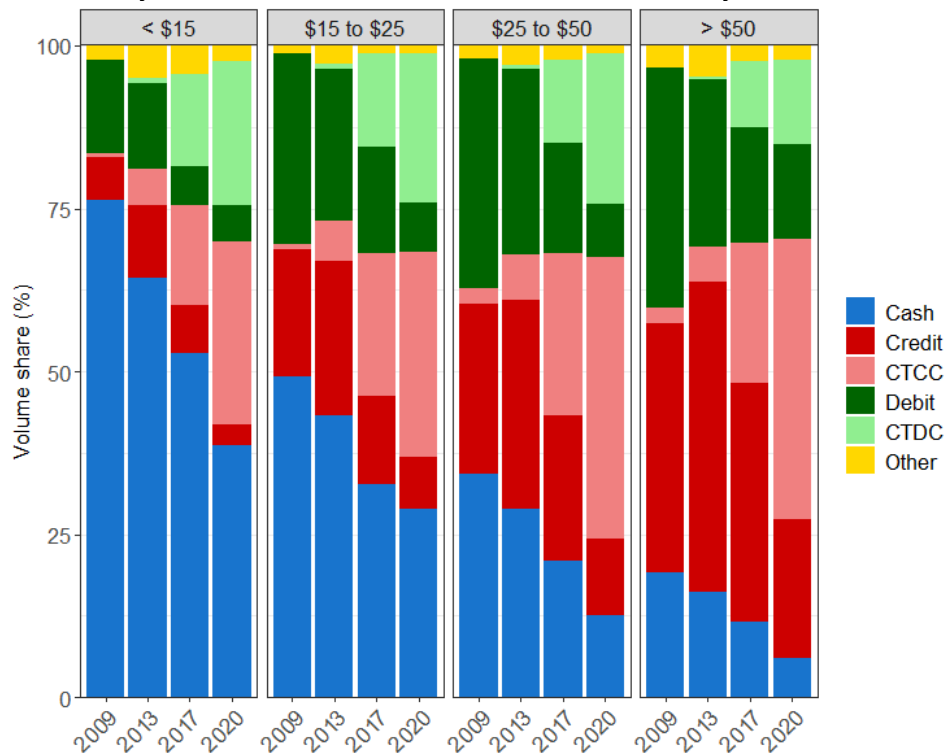
Table 3: Transaction shares (volume) of different methods of payments in Canada—2009 to 2020

	Cash (%)	Debit (%)	Credit (%)	Other (%)	CTDC (%) of debit	CTCC (%) of credit
2009	54	25	19	2	.	5
2013	44	21	31	4	2.9	19.3
2017	33	26	39	3	50	52
<b>November 2020</b>	<b>22</b>	<b>29</b>	<b>47</b>	<b>2</b>	<b>70</b>	<b>78</b>

Note: Transactions include both in-store and online purchases. Contactless debit card (CTDC) and contactless credit card (CTCC) shares are calculated as a percentage of the overall debit and credit shares, respectively.

**Chart 4** presents the payment shares according to the value of the transaction from 2009 to 2020, again including both in-store and online transactions. Cash has typically been used more for low-value transactions, which is also evident in the 2020 data. While cash shares have declined in all categories of transaction amounts, 40% of the volume of transactions below \$15 is still made using cash, which is greater than any other payment method. Credit card use in every transaction category has increased from 2009 to 2020 and dominates for larger transaction amounts. By comparison, debit card use has increased for low-value transactions but declined for high-value transactions. **Chart 4** also illustrates the growing share of contactless debit payments and contactless credit payments across all transaction categories. Notably, as the spending limit on contactless transactions at the point of sale increased over time, we see the share of contactless cards growing rapidly for high-value transactions.

Chart 4: Payment shares over time in Canada—volume, by transaction value



Note: Transactions include both in-store and online transactions. CTDC means “contactless debit card,” and CTCC means “contactless credit card.” The dark red denotes the share of payments made using a credit card, excluding CTCC, while the light red denotes the CTCC share; similarly dark green is the share of debit card payments excluding CTDC, while light green is CTDC.

We also recently studied cash use in Canada according to various demographic characteristics. The same patterns found in previous surveys remain apparent in the most recent data. For instance, older, less-educated or lower-income individuals more often use cash to pay than other Canadians do. People in each of these demographic groups use cash to pay for at least 25% of their total purchases. Respondents with a university education rely on credit cards the most—and debit cards the least—compared with other educational cohorts.

### 3. Conditions for issuing a central bank digital currency

In the preceding section, we saw how demand for cash and use of various methods of payment in Canada have evolved. A related issue of significant interest to many central banks concerns the potential development of a new payment instrument and store of value—a CBDC. In February 2020, Deputy Governor Timothy Lane outlined in a speech (Lane 2020) two scenarios that could warrant introduction of a CBDC by the Bank of Canada:

- the emergence of a cashless society
- the widespread use of alternative digital currencies

If either of these scenarios were to emerge, the Canadian government would ultimately decide whether the Bank would issue a CBDC. This would likely require amending the Bank's governing statute and perhaps other legislation to enable it to issue a CBDC.<sup>8</sup> In the remainder of this section, we assess the application of the two conditions noted above in the Canadian context.<sup>9</sup>

### (a) A cashless society

In this scenario, the concern is that the use of cash for payments could be reduced to a significantly low level—or, as a practical matter, virtually eliminated—due to the cumulative effect of Canadians' individual choices over time. However, it is important to emphasize that the Bank is committed to supplying cash if Canadians demand it. That is, the Bank will not unilaterally stop supplying bank notes. Therefore, if the volume of cash transactions were to fall to a significantly low level, it would not be because of the Bank's decisions. It would result from the behaviour of most consumers, merchants and distributors of cash (such as banks and other operators of automated banking machines). At the same time, overall cash demand might behave differently than the trend in cash use, as shown above. However, this might not substantially mitigate a potential decline of cash as a viable method of payment.

If cash is no longer a functional method of payment for a wide range of transactions, some people or communities might face difficulties adapting because of their socio-economic constraints or their geographical remoteness. A particular concern is the risk of excluding such people from economic activity in a cashless environment if available electronic methods of payment were not accessible or useful for them. In that case, a CBDC might address these concerns with features to remedy the exclusion of such groups. As well, or alternatively, private-sector payment service providers could be incentivized to provide solutions to include these groups.<sup>10</sup> More generally, in a cashless environment, concerns could exist about adequate competition in retail payments and about the provision of a simple and completely risk-free method of payment, which might be particularly beneficial in crisis periods (Engert, Fung and Hendry 2018). A striking example is the Swedish government's initiative to increase reliance on cash as a backup during a crisis. To this end, in 2018 the Swedish Civil Contingencies Agency provided every Swedish household with a copy of a booklet entitled *If Crisis or War Comes*

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<sup>8</sup> See the [Bank of Canada Act](#).

<sup>9</sup> Over time, ongoing research and evolving conditions might lead to other scenarios or motivations that could warrant the issuance of a digital currency. This could involve consideration of market failures and whether a CBDC is the best policy solution under the circumstances.

<sup>10</sup> Such efforts might focus on cohorts that are unbanked (not having a bank account) or underbanked. The proportion of the unbanked population in Canada is, however, quite small. The 2017 Methods-of-Payment Survey conducted by the Bank of Canada found that 99% of respondents have a bank account (Henry, Huynh and Welte 2018), indicating that almost all Canadians can access banking services. The same result is reported in the Global Findex Database by the World Bank (2017). With respect to the underbanked, a standard definition is consumers "[lacking full use of banking facilities](#)." This, in turn, requires an assessment of whether being underbanked is driven by lack of consumer demand or insufficient supply of banking services—a subject of ongoing research at the Bank of Canada.

(Swedish Civil Contingencies Agency 2018), to help Swedes better prepare for a range of calamities, including serious accidents, extreme weather, information technology dysfunction and military conflict. The booklet also points specifically to disruptions in payment networks. Accordingly, the agency recommends, among other things, that citizens hold a buffer of cash at home.

What is the evidence? Is Canada at the point where cash is not viable as a method of payment for a wide range of transactions? As seen above, the trend toward less cash use for payments has been long-standing. Nevertheless, many Canadians continued to use cash for transactions, even during the pandemic (**Table 1**). As well, Canadians use cash for a significant share of payments, especially for low-value transactions (**Table 2** and **Chart 4**). We saw this during the pandemic in 2020 when cash accounted for over one-fifth of the volume of all transactions (in-store and online). Correspondingly, cash remains widely accepted by merchants in Canada. Further, although cash use for payments has declined, cash demand has been stable, and even increased sharply during the pandemic, as we saw above.<sup>11</sup>

The evidence summarized above indicates that Canada is not a cashless society. It also shows that there is little imminent risk that the use of bank notes will decline to a point where Canadians no longer have the option of using them for a wide range of transactions. Similarly, in his comprehensive review of the broader research literature on cash, Shy (2022) observes that “all the predictions made in the past about the ‘end of cash’ turned out to be wrong” (p. 54), and he concludes that “the feeling now among researchers is that cash is not going away” (p. 60). The simulations in Huynh, Nicholls and Shcherbakov (2019, 2022) also suggest that even substantial decreases in the user cost of payment cards and increases in the user cost of cash might not lead to a cashless society in the foreseeable future. An implication for research and policy is that other aspects, such as privacy, finality or uncertainty, might play a role in sustaining some level of merchant acceptance as well as use of and demand for cash by consumers.

Nevertheless, the long-term trend away from cash as a method of payment could lead to a decline of merchant acceptance over time and erode the broader demand for cash more generally. Accordingly, the Bank will continue to monitor and analyze these and related developments, including merchant acceptance of cash and consumer access to cash.

## (b) Alternative digital currencies

The second scenario that could warrant the Bank issuing a CBDC is if an alternative digital currency—issued by a foreign central bank or by a private entity—becomes widely adopted

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<sup>11</sup> In contrast to the Canadian case, in Sweden cash use for payments *and* cash demand have been falling for years. Engert, Fung and Segendorf (2019) compare the experiences of Canada and Sweden and find that the reasons for Sweden’s relatively unique outcomes are due to incentives and frictions in Sweden that inhibit the demand for bank notes, including cashless bank branches and Swedish legal tender rules. They do not result from payment innovations or technological advances, which are similar in Canada and Sweden.

and used in Canada. It is useful to note that almost all the money used in Canada is already digital; that is, electronic deposits in Canadian dollars intermediated in the banking system. For instance, cash is only 5% of a common measure of Canadian transactions money (M1+), with the vast majority being digital, transferable deposits.<sup>12</sup> Transfers of digital deposit money to effect payments occur through regulated systems and settle ultimately through transfers of reserves over accounts held by financial institutions at the Bank of Canada.<sup>13</sup>

An alternative digital currency probably would use settlement systems (distributed or centralized) beyond the reach of Canadian regulators. And critically, these instruments would be denominated in a unit of account different from the Canadian dollar. This would impair the Bank's ability to conduct monetary policy and provide liquidity support to protect financial stability if required. As a result, Canadian monetary sovereignty would be undermined.

What is the evidence?<sup>14</sup> Are digital currencies taking over in Canada? Certainly cryptocurrencies (such as bitcoin) and stablecoins (such as tether) have been the subject of substantial media attention. Further, in the case of tether, for example—by far the largest stablecoin by market capitalization—US federal (Faux 2021) and the New York state (*The Economist* 2021) regulators have shown interest. And some financial services firms that offer traditional fiat currency services are also providing customers with intermediated access to cryptoassets. As well, investors have been increasingly interested (Hughes 2021) in firms that have exposure to cryptoassets.

While most Canadians are aware of alternative digital currencies, there has been relatively low uptake, particularly as a method of payment. Surveys conducted by Bank of Canada staff indicate that while around 90% of Canadians are aware of bitcoin—by far the most popular cryptocurrency—only 3% to 5% of Canadians owned bitcoin from 2016 to 2020. In 2021, however, the percentage of Canadians who owned bitcoin increased sharply to 13% (Balutel et al. forthcoming). This increase corresponds with the efforts of some financial firms to promote cryptoassets as an investment class and to reduce the frictions associated with such investments, making it easier for the public to purchase and hold bitcoin and other alternative digital assets. The increase in the share of Canadians owning bitcoin in 2021 also corresponds to an unusually high personal savings rate in recent years and a sharp increase in household

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<sup>12</sup> See Bank of Canada, “[Banking and Financial Statistics](#).”

<sup>13</sup> The Bank of Canada, like other central banks, maintains a central ledger for the electronic settlement of large-value interbank transactions in Canadian dollars. Further, the Bank guarantees the exchange of commercial bank deposit money for central bank reserves at a fixed one-to-one rate in the interbank settlement process, which occurs each day through banks' reserve accounts at the Bank of Canada. As a result, the deposit-money of different banks is universally accepted at face value throughout the economy, and the public is indifferent to these various bank-based media of exchange. In other words, this process guarantees a [uniform currency, or par value exchange](#).

<sup>14</sup> The evidence summarized here regarding uptake and use of alternative digital currencies is based largely on a series of recent papers prepared by Bank staff, particularly Henry, Huynh and Welte (2018), Henry et al. (2019), and Balutel et al. (2021, 2022 and forthcoming).

wealth (Statistics Canada 2021), including holdings of financial assets and record amounts of mutual fund purchases and investments in foreign securities (Statistics Canada 2022).

Individual holdings of bitcoin appear to be modest. From 2018 to 2019, the median value of Canadian bitcoin holdings decreased from around \$500 to \$225 and then increased to about \$500 in 2021. These figures mask a significant distinction between the holdings of recent bitcoin investors and longer-term bitcoin owners, which corresponds with the recent increase in the share of Canadians who own bitcoin. The median holding of investors who acquired bitcoin in 2021 is \$250, while the median holding of earlier investors is \$2,000. And consistent with the rising price of bitcoin in recent years, a decreasing proportion of Canadian bitcoin owners own more than 1 bitcoin, while the share of owners with less than 1 bitcoin has increased sharply in the last few years.

In the Bank's most recent survey, only 9% of Canadian bitcoin owners report that they had acquired bitcoin with the intention of using it as a payment method (Balutel et al. forthcoming). In practice, around 70% of bitcoin owners stated that they never, rarely or only sometimes used bitcoin to pay a merchant or for a person-to-person transfer in 2021. The remaining owners, around 30%, report they used bitcoin to pay at least a few times a month in 2021. In sum, the evidence indicates that making payments with bitcoin is not a significant motivation or use for Canadian bitcoin owners. Correspondingly, these surveys show that the most common motivation for owning bitcoin by far is investment, while an interest in the underlying technology also seems to be an important motivation for Canadian cryptoasset owners.

In addition to bitcoin, some Canadians own other cryptoassets. However, ownership of these alternatives appears to be low. For example, in 2021, only about 7% of Canadians owned ether, the most popular alternative to bitcoin. More generally, the total share of Canadians holding at least one alternative cryptoasset is 16%. (Ten percent of Canadians own both bitcoin and other cryptoassets, while around 6% own only alternatives to bitcoin.)

Regarding stablecoins, awareness of these digital instruments appears to be relatively low in Canada. For instance, only around 10% of Canadians are aware of tether or USD coin—the largest stablecoins in the world measured by market capitalization. Ownership of stablecoins is even lower: around 2% of Canadians own tether, USD coin or binance, for example. Global evidence shows that these arrangements are not currently used for mainstream payments on a significant scale. Instead, stablecoins are used mostly to facilitate trading in other cryptoassets for the purpose of investment. In other words, stablecoins are currently used mainly to set up investments in other cryptoassets, such as bitcoin. On these and related points, see Financial Stability Board (2020), Mizrach (2021) and Cecchetti and Schoenholtz (2021).<sup>15</sup>

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<sup>15</sup> Looking ahead, the economics of stablecoins suggests that these instruments are unlikely to play a significant role in the future of payments (Garrett et al. 2022). Further, under Canadian legislation, income tax liabilities are [determined and payable in Canadian dollars](#), which provide incentives to maintain the use of Canadian currency.



In sum, evidence shows that ownership of alternative digital currencies is limited in Canada. Further, their use for payments also appears to be limited, and the predominant motivation for their ownership is investment. As we saw in 2021, we might expect ownership of cryptoassets and stablecoins to increase further if financial firms continue to promote them as an alternative asset class and reduce frictions associated with investing in these assets. However, the recent collapse of various cryptoasset and stablecoin markets would probably impede these efforts.

## 4. Potential CBDC adoption

In an update of his 2020 remarks on CBDC, Bank of Canada Deputy Governor Lane recently noted that “our view remains unchanged: a digital currency is by no means a foregone conclusion” (Lane 2021). At the same time, he argued that “if the public does want a digital cash-like currency, there are good reasons that a central bank—a trusted public institution—should issue it. ... Only a central bank can guarantee complete safety and universal access, and with public interest—not profits—as the top priority.” In this regard, Lane suggested that a central bank is well-positioned to protect user privacy, while at the same time defending against criminal uses, because a central bank does not have commercial interests. Finally, given the increased pace of digitization of the economy that became apparent during the pandemic, the Bank decided that it is prudent to accelerate its work to prepare for the possibility of issuing a CBDC (Lane 2021).<sup>16</sup>

Bank of Canada staff have completed many research studies on a wide range of issues relevant to CBDC.<sup>17</sup> Looking ahead, part of the next phase of work on CBDC will also focus concretely on better understanding the potential adoption and usage of a CBDC by end users (BIS 2021).

### (a) Insights from recent research on adoption and merchant acceptance

In empirical research conducted at the Bank of Canada, Huynh, Nicholls and Shcherbakov (2019, 2022) develop models that feature a two-sided payment market that allows for the interaction between consumers and merchants. These authors estimate a structural, empirical model of a two-sided payment market to help understand the adoption and use of payment innovations. The results of that work indicate that merchants respond more to consumer behaviour than vice versa. So a key insight is consumer adoption and use of a CBDC is critical

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<sup>16</sup> Globally, a CBDC has been launched in The Bahamas, and CBDC pilot projects have begun in several jurisdictions, including China, the Eastern Caribbean Central Bank, Jamaica, Nigeria, Russia and Uruguay. Ecuador launched a central bank mobile money in 2014 and ended the program in 2018 due to a lack of users and transaction volume (White 2018). The Uruguayan central bank ran a pilot of digital money (e-Peso). The pilot was meant to test the technology from November 2017 to April 2018 and had a limit of 10,000 mobile users with a total issuance of UY\$20 million. A personal wallet was limited to UY\$30,000 while a registered business could hold up to UY\$200,000. (On April 30, 2018, Can\$1 was roughly equivalent to UY\$22.) The [2018 Article IV IMF consultation](#) declared the e-Peso pilot a success.

<sup>17</sup> See the following website [Digital currencies and fintech: research](#).

to generating a positive network externality with merchants. In other words, wide consumer adoption and use would be essential to encourage merchant acceptance and to establish a successful payment innovation. This also suggests that CBDC adoption strategies that focus primarily on merchant acceptance will not likely be successful. Similar findings about the dominant role of consumer behaviour in launching successful payment innovations have also been noted in other work, including Fung, Huynh and Kosse (2017) and studies on the implementation and adoption of m-pesa (private mobile money in Africa), such as Jack and Suri (2011).

Jiang (2020) provides similar lessons from a review of theoretical and experimental evidence. In Canada, a CBDC would need to compete with well-established payment mechanisms from the outset, which presents a significant barrier to entry. Therefore, a clear use case that attracts consumers is necessary for a successful, sustained adoption of a CBDC. Accordingly, this work suggests that a CBDC could initially find a niche as enhanced cash, which might improve on the cost of cash while also providing the capacity for electronic transactions. As a result, to improve the likelihood of success, Jiang (2020) argues that a CBDC should feature universal accessibility (be available to all consumers) and offer a high degree of (counterparty) privacy, with robust offline capabilities.

Huynh et al. (2020) analyze CBDC design and consumer demand assuming various levels of merchant acceptance. Accordingly, this work provides insight into how preferences in a two-sided payment market affect adoption of CBDC for point-of-sale transactions. The authors find that successful establishment of a CBDC in the contemporary payments landscape is more likely, but not assured, if the most highly valued features of cash—universal access, privacy, and ease of use—are combined with key features of a digital payment method, such as electronic debit capability.<sup>18</sup>

Miedema et al. (2020) consider the technology features and potential user experience of a CBDC. They argue that if the Bank of Canada were to issue a CBDC, its technology should aim for universal access, building on the Bank's history of designing universally accessible bank notes. This approach also draws on the insights discussed in the preceding work and emphasizes the primary role of consumer adoption and use, with merchant acceptance responding positively if a critical mass of consumers adopts CBDC over time. So, to develop a plausible value proposition for CBDC, these authors also suggest a technology setup that is cash-like but that also includes valued digital features. Further, since Canadians are already familiar with cash, consumer adoption could be more likely if the existing cash product (bank

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<sup>18</sup> Engert and Fung (2017) recommend that, given the complexity and uncertainty associated with introducing a CBDC, central banks inclined to issue a CBDC should proceed cautiously and incrementally, with a non-anonymous, non-interest bearing CBDC that is intermediated by financial institutions, notwithstanding likely low adoption rates, and learn from experience.

notes) is used as the delivery mechanism for digital enhancements—although such a product currently might not be technically feasible at a reasonable cost.

## (b) What is the value proposition of a CBDC?

The preceding points to broad features of a CBDC that might be necessary, but not sufficient, for successful adoption.<sup>19</sup> Questions remain, however, about the appropriate attributes of a CBDC and whether the instrument would be valued by consumers and merchants, given competing payment alternatives.

- Why would consumers adopt and use a CBDC? What benefits would be provided? What problems would a CBDC solve for consumers? What is the value proposition of a CBDC?
- Why would merchants undertake the investment and ongoing expense needed to routinely accept CBDC for transactions?
- What could we expect with regard to the adoption and use of a CBDC in Canada?
- What risks might arise from insufficient support from consumers, merchants and financial institutions?
- What are the implications of unrealistic design ambitions and adoption expectations for a CBDC?

Future work at the Bank of Canada and other central banks could seek to address these questions. Understanding these aspects would also help inform whether a CBDC would make a meaningful contribution to competition in payments.

## (c) Private and public interests

The preceding highlights the fundamental roles of private interests—consumers, merchants and financial institutions—in the market for payments, and in determining whether a payment innovation would be successful. Private interests, however, do not always fully coincide with public interests, so understanding the potential for long-term CBDC adoption also requires consideration of the interplay between them. For example, payment infrastructure providers might find the cost of providing universal, widespread access for a CBDC to be prohibitively expensive, or merchants might be uninterested in bearing the costs to facilitate acceptance of a CBDC that did not have widespread consumer adoption.

These considerations raise the question of balancing private and public benefits and costs. Would the net benefits for private parties be sufficient to drive CBDC adoption and use? How should the central bank respond if private net benefits were not enough to drive adoption of

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<sup>19</sup> In this regard, see also the [joint report](#) (October 2021) by the Bank of Canada, European Central Bank, Bank of Japan, Sveriges Riksbank, Swiss National Bank, Bank of England, Board of Governors of the Federal Reserve and Bank for International Settlements for discussion of CBDC user requirements and adoption considerations.

CBDC? These questions might be especially relevant if the public policy objective of a CBDC were to serve a particular socio-economic niche that was perceived to be underserved by existing payment options; that is, to enhance the intensity of financial inclusion. Similarly, the policy objective could be simply to make available a risk-free digital payment mechanism that was universally accessible but attracted little consumer and merchant interest in practice.

A key question in all these cases concerns the costs of developing a CBDC and its ongoing provision to the public. Would consumers and merchants be expected to pay any fees for using a CBDC? Would the central bank need to subsidize CBDC access and its use to gain perceived public policy benefits at the expense of reduced transfers to the federal treasury? <sup>20</sup>

## 5. Strategies to sustain cash

While cash demand has been stable in Canada for decades—and has even increased in recent years—cash use for payments has been declining. Part of the Bank of Canada’s response to these developments is to consider the scope for efficiency gains in how cash is supplied and distributed in order to maintain cash accessibility. As well, the Bank is paying attention to the potential development of frictions in the broader cash infrastructure that can needlessly impair cash accessibility and use. Finally, if the various distributors of cash in Canada were no longer meeting the needs of Canadians, the Bank’s approach to the cash distribution system could face implications, given the Bank’s statutory responsibility to make adequate arrangements for the supply of bank notes to Canadians.

### (a) Increasing the efficiency of bank note distribution and cash accessibility

The Bank of Canada, like other central banks, is the sole issuer of bank notes. In this capacity, the Bank collaborates with industry partners to distribute notes across the country. In this role, the Bank supplies financial institutions with the bank notes they need to meet public demand through a dedicated distribution system. More specifically, the Bank distributes bank notes to members of the Bank Note Distribution System (BNDS) at distribution centres located in 10 regional distribution points across Canada. (For more on the BNDS, see Bilkes 1997.)

Like other central banks, the Bank is studying ways to enhance the efficiency of the BNDS.<sup>21</sup> One approach might be to consider some rationalization of it to increase benefits from economies of scale. To that end, the Bank has been working with BNDS participants to identify areas for efficiency gains.

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<sup>20</sup> In 2020, the Bank of Canada [transferred \\$1.8 billion](#) to the Canadian federal treasury.

<sup>21</sup> The Banque de France, the Bank of England, the Central Bank of Ireland, the European Central Bank, the Netherlands Central Bank, the Reserve Bank of Australia, the Reserve Bank of New Zealand, the Swedish Riksbank and the US Federal Reserve System are developing, or have developed, strategies to enhance the efficiency of bank note supply and distribution and to improve cash accessibility for the public.

## (b) Avoiding frictions in the cash infrastructure<sup>22</sup>

As cash use for transactions declines and bank customers switch to online and mobile banking, banks in some countries are removing teller services from branches to reduce costs. This appears to be accompanied by a reallocation of branch space and staff to more valuable financial services. As a result, cash services are provided increasingly through networks of automated banking machines (ABM). Such an evolution of the cash ecosystem could entail reduced cash accessibility and accelerate movement to a cashless society, depending on how the cash infrastructure evolves.

For example, in Sweden, cashless bank branches were introduced in 2010 as a cost-reduction measure and then spread rapidly. At that time, only about 10% of Swedish branches were cashless. But this proportion increased sharply, so by 2014 well over one-half of Swedish bank branches were cashless.<sup>23</sup> Engert, Fung and Segendorf (2019), in comparing cash use and demand in Canada and Sweden, argue that the development of cashless branches in Sweden, along with relatively limited features of the Swedish ABM network, led to frictions that contributed to the rapid decline in cash demand in that country. In response to reduced cash accessibility, the Swedish Riksdag recently adopted legislation under which the major financial institutions were required to provide certain cash services throughout Sweden starting January 1, 2021. The purpose is to ensure a certain minimum level of access to cash services for consumers and companies.<sup>24</sup>

Major Canadian banks also seem to be experimenting with tellerless branches to align with a decrease in demand for cash services and to reduce cash-handling costs. Our research indicates that in Canada (so far), bank branches always have at least one or more ABM, and, importantly, these ABMs are multifunctional. Thus, at a tellerless bank branch in Canada, cash withdrawals and deposits, cheque deposits, bill payments and bank transfers can be made through in-branch ABMs or a 24-hour deposit box for business customers. These transactions, with the obvious exception of cash transactions, can also be conducted on-line and through mobile applications. In addition, bank customers can call their telephone banking centre to temporarily increase their daily ABM withdrawal limit, or they can ask staff at the branch for assistance. Many banks have also installed, or are in the process of installing, new ABMs that allow customers to choose among several denominations of bank notes. In addition, a built-in bank note scanner allows easy deposits of cash to a bank account. As a result, the transition to

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<sup>22</sup> We largely base this section on Engert and Fung (2019) and Engert, Fung and Segendorf (2019).

<sup>23</sup> See [Bank Statistics](#) on Swedish Bankers' Association's website.

<sup>24</sup> For more information, see Sveriges Riksbank, "[Obligation for major banks to provide certain cash services](#)." A concern with these Swedish provisions is that no requirements exist for deposit-taking services for the general public or for over-the-counter (teller) services. Regarding the latter, relying on ABMs for withdrawals implies restrictions on withdrawal amounts, which could erode the user value of cash

tellerless bank branches in Canada seems unlikely to increase the frictions or costs of accessing cash that could discourage cash demand in Canada.<sup>25</sup>

Another potential friction in the cash infrastructure concerns the impact of changing legal tender rules, where old bank note series are declared invalid. Depending on how such changes are conducted, the demand for, and use of, cash could face adverse effects. Changing legal tender rules has a greater impact the more frequently they occur and the more burdensome and variable the provisions are governing the exchange of old (invalid) notes for new notes. In that case, legal tender frictions can be expected to reduce the demand for bank notes, particularly as a store of value. Such frictions appear to have played a role in inhibiting the demand for cash in Sweden, for example (see Engert, Fung and Segendorf 2019).

The legal tender status of bank notes in Canada has been removed only rarely, and only for specific series of old notes, to ensure the security and usefulness of bank notes in circulation.<sup>26</sup> Further, redeeming and receiving value for notes whose legal tender status has been removed is straightforward. Such notes can be [redeemed at face value](#) at any financial institution branch in Canada (or by sending them to the Bank of Canada).<sup>27</sup> Looking ahead, the Bank continues to be mindful of the potential frictions that could be caused by frequent and burdensome changes to legal tender status for bank notes.

Finally, the Bank of Canada has an active research program studying various factors that could affect cash accessibility, including possible frictions arising from the evolution of banks' cash-distribution business models and various socio-economic considerations. See, for example, Chen and Strathearn (2020), Chen, Strathearn and Voia (2021), Chen et al. (2021a, 2022) and Chen and Felt (2022).

### (c) Investments to improve Canadian bank notes

Along with an interest in the efficiency of bank note distribution and cash accessibility, the Bank invests significantly in the continuous improvement of bank notes. For example, the Bank issued polymer bank notes in 2011 as part of its ongoing work to enhance bank note security, see Spencer 2011, and Fung and Shao 2011.<sup>28</sup> Accompanying this innovation were initiatives to provide education and outreach for the public, merchants and police on how to detect counterfeit notes. More generally, the Bank emphasizes the importance of working with BNDS members to foster efficiency and maintain high-quality bank notes so that they are easily

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<sup>25</sup> In Canada, banks apparently see their ABM networks as part of their branding and a means to attract and retain customers. Major Canadian banks each have their own branded ABMs to compete for customers, joined in a common network linking all banks' ABMs. See also Carbo, Perez-Saiz and Xiao (forthcoming).

<sup>26</sup> See Bank of Canada, "[About legal tender](#)."

<sup>27</sup> See Bank of Canada, "[Bank Note Redemption Service](#)."

<sup>28</sup> See Bank of Canada, "[Security Features on the Vertical \\$10 Note](#)."

verified for use. The Bank is also planning to issue a new \$5 note as part of its bank NOTE-able campaign<sup>29</sup>.

Another benefit of the polymer notes that the Bank issues is their reduced environmental impact, including fewer carbon emissions. The Bank conducted a life-cycle assessment undertaken to analyze the effects of changing the bank note substrate from cotton-based paper notes to polymer. That work found that polymer notes last at least 3.5 times longer than paper notes, so fewer polymer notes need to be manufactured and distributed to satisfy the public's demand for currency (Paskarathas et al. 2018). Further, based on nine internationally recognized metrics, earlier work found that polymer bank notes lead to a 32% reduction in global warming potential, and a 30% reduction in primary energy demand compared with traditional paper notes (Bank of Canada 2011).

Looking ahead, the Bank of Canada will continue to invest significantly in bank note design and innovation.

## 6. Concluding remarks

We provide an overview of a range of research and experience regarding cash and related considerations in Canada. Our key insights can be summarized as follows.

- A striking feature of the pandemic experience has been a notable increase of cash in circulation, particularly large-denomination bank notes, generally seen to be motivated mainly by precautionary factors. At the same time, cash use for payments was inhibited early in the COVID-19 pandemic but has since been recovering to earlier trends.
- Taking a longer perspective, we see that consumers have been moving away from cash use for payments for decades, driven by a shift to electronic payment methods, particularly contactless credit cards. Nevertheless, consumers continue to use cash for a significant share of transactions in Canada, especially for low-value payments, and bank notes remain widely accepted by merchants. Further, even as cash use for payments has declined over recent decades, cash demand—the ratio of bank notes in circulation to nominal GDP—has been resilient. Decreased demand for small-denomination (transactional) bank notes has been offset by increased demand for large-denomination (non-transactional) notes. Understanding the coexistence of declining cash use for payments and stable (or increasing) cash demand—which is a universal phenomenon that has persisted for decades—is a research topic of significant interest.
- The Bank has established two scenarios that could warrant the introduction of a CBDC in Canada:

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<sup>29</sup> See Bank of Canada, “The Next Bank NOTE-able Canadian.”

- the transformation to a cashless society
- the widespread adoption and use of alternative digital currencies

The current evidence indicates that neither of these scenarios seems likely to occur in the coming years. At the same time, the long-term trend away from cash use as a method of payment could lead to a decline of merchant acceptance over time and erode the broader demand for cash more generally. As well, efforts to promote investor awareness and access to cryptoassets could lead to an increased presence of such instruments in investment portfolios. Bank staff will continue to monitor and analyze relevant developments concerning these scenarios.

- The Bank is developing the capacity to issue a CBDC should that become warranted. The reasons for this are:
  - the required scale of any program to design, build and launch a digital currency
  - the possibility that conditions in the payment ecosystem could shift quickly given the ongoing pace of innovation

Part of this next phase of work is a pragmatic focus on understanding the potential adoption and use of a CBDC. This means exploring the value proposition for CBDC to complement ongoing research and development. Such work would also help inform whether a CBDC would make a meaningful contribution to competition in payments.

- One of the lessons from our experience concerns the usefulness of maintaining cash as a simple and risk-free method of payment and store of value, which might be particularly beneficial in crisis periods. The Bank continues to work to improve the efficiency of the cash infrastructure, to maintain cash accessibility and to make significant investments to provide high-quality bank notes that all Canadians can use with confidence.



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## References

- Balutel D., W. Engert, C. Henry, K. Huynh and M. Voia. Forthcoming. "Private Digital Cryptoassets as Investment? Bitcoin Ownership and Use in Canada, 2016–21." Bank of Canada Staff Discussion Paper.
- Balutel, D., M.-H. Felt, G. Nicholls and M. Voia. 2022. "[Bitcoin Awareness, Ownership and Use: 2016–20](#)." Bank of Canada Staff Discussion Paper No. 2022-10.
- Balutel, D., C. Henry, J. Vasquez and M. Voia. 2022. "Bitcoin Adoption and Beliefs in Canada." *Canadian Journal of Economics* 55, no. 4 (November).
- Bank for International Settlements (BIS). 2021. [Central Bank Digital Currencies: User Needs and Adoption](#). Report No. 3 (September).
- Bank of Canada. 2011. "[Life Cycle Assessment of Canada's Polymer Bank Notes and Cotton-Paper Bank Notes](#)." Prepared by PE Americas and Tryskele Sustainable Environment, Health & Safety.
- Bech, M., U. Faruqui, F. Ougaard and C. Picillo. 2018. "[Payments Are a-Changin' but Cash Still Rules](#)." *BIS Quarterly Review* (March).
- Bilkes, G. 1997. "[The New Bank Note Distribution System](#)." *Bank of Canada Review* (Summer): 41–54.
- Carbo, S., H. Perez-Saiz and H. Xiao. Forthcoming. "Competition, Geographic Proximity and Pricing in the Retail Banking Industry." Mimeo.
- Caswell, E., M. Hewkin Smith, D. Learmonth and G. Pearce. 2020. "[Cash in the Time of Covid](#)." Bank of England *Quarterly Bulletin* 2020 Q4.
- Cavalli, G., B. Lake, A. M. McGahan and E. Pepe. 2020. *Policy Report: Mobility and Proximity in Canada During the COVID-19 Pandemic*. Toronto, Ontario: University of Toronto, Munk School of Global Affairs & Public Policy.
- Cecchetti, S. G. and K. L. Schoenholtz. 2021. "[Stablecoin: The Regulation Debate](#)." *Money & Banking* (blog), December 13.
- Chen, H., W. Engert, M.-H. Felt, K. P. Huynh, G. Nicholls, D. O'Habib and J. Zhu. 2021a. "[Cash and COVID-19: The Impact of the Second Wave in Canada](#)." Bank of Canada Staff Discussion Paper No. 2021-12.
- Chen, H., W. Engert, K. P. Huynh, G. Nicholls, M. Nicholson and J. Zhu. 2020. "[Cash and COVID-19: The Impact of the Pandemic on the Demand for and Use of Cash](#)." Bank of Canada Staff Discussion Paper No. 2020-6.

- Chen, H., W. Engert, K. P. Huynh, G. Nicholls and J. Zhu. 2021b. "[Cash and COVID-19: The Effects of Lifting Containment Measures on Cash Demand and Use.](#)" Bank of Canada Staff Discussion Paper No. 2021-3.
- Chen, H., W. Engert, K. P. Huynh and D. O'Habib. 2021. "[An Exploration of First Nations Reserves and Access to Cash.](#)" Bank of Canada Staff Discussion Paper No. 2021-8.
- Chen, H., W. Engert, K. P. Huynh and D. O'Habib. 2022. "[Identifying Financially Remote First Nations Reserves.](#)" Bank of Canada Staff Discussion Paper No. 2022-11.
- Chen, H., W. Engert, K. P. Huynh, D. O'Habib, J. Wu and J. Zhu. 2022. "[Cash and COVID-19: What Happened in 2021.](#)" Bank of Canada Staff Discussion Paper No. 2022-8.
- Chen, H. and M.-H. Felt. 2022. "Canadians' Access to Cash Before, at the Onset of COVID-19 and Beyond." Bank of Canada Staff Discussion Paper 2022-15.
- Chen, H., M.-H. Felt and C. S. Henry. 2018. "[2017 Methods-of-Payment Survey: Sample Calibration and Variance Estimation.](#)" Bank of Canada Technical Report No. 114.
- Chen, H. and M. Strathearn. 2020. "[A Spatial Model of Bank Branches in Canada.](#)" Bank of Canada Staff Working Paper No. 2020-4
- Chen, H., M. Strathearn and M. Voia. 2021. "[Consumer Cash Withdrawal Behaviour: Branch Networks and Online Financial Innovation.](#)" Bank of Canada Staff Working Paper No. 2021-28.
- Engert, W. and B. S. C. Fung. 2017. "[Central Bank Digital Currency: Motivations and Implications.](#)" Bank of Canada Staff Discussion Paper No. 2017-16.
- Engert, W. and B. S. C. Fung. 2019. "[Cashless Bank Branches in Canada.](#)" Bank of Canada Staff Analytical Note No. 2019-29.
- Engert, W., B. S. C. Fung and S. Hendry. 2018. "[Is a Cashless Society Problematic?](#)" Bank of Canada Staff Discussion Paper No. 2018-12.
- Engert, W., B. S. C. Fung and B. Segendorf. 2019. "[A Tale of Two Countries: Cash Demand in Canada and Sweden.](#)" Bank of Canada Staff Discussion Paper No. 2019-7.
- Engert, W. and K. P. Huynh. 2022. "Cash, COVID and the Prospects for a Canadian Digital Dollar." in *The Euro at 20: The Future of Our Money* edited by Johannes Beermann. Penguin Verlag.
- Faux, Z. 2021. "[Anyone Seen Tether's Billions?](#)" *Businessweek*.
- The Economist*. 2021. "UnTethered: [Tether is Fined by Regulators in New York.](#)"
- Financial Stability Board. 2020. [Regulation, Supervision and Oversight of "Global Stablecoin" Arrangements](#). October 7.
- Foster, K. and C. Greene. 2021. "[Consumer Behavior in a Health Crisis: What Happened with Cash?](#)" Policy Hub 2021-1, Federal Reserve Bank of Atlanta.

- Fung, B. S. C., K. P. Huynh and A. Kosse. 2017. ["Acceptance and Use of Payments at the Point of Sale in Canada"](#). *Bank of Canada Review* (Autumn): 14–26.
- Fung, B. S. C. and E. Shao, 2011. ["Modelling the Counterfeiting of Bank Notes: A Literature Review"](#). *Bank of Canada Review* (Autumn): 29–35.
- Garratt, R., M. Lee, A. Martin and J. Torregrossa. 2022. ["The Future of Payments is Not Stablecoins"](#). Federal Reserve Bank of New York *Liberty Street Economics*, February 7.
- Guttmann, R., C. Pavlik, B. Ung and G. Wang. 2021. ["Cash Demand During COVID-19"](#). *Reserve Bank of Australia Bulletin*, March.
- Hawkesby, C. 2020. ["Working Together to Be 'On the Money'"](#). Speech to the Royal Numismatic Society of New Zealand, Annual Conference, Wellington, New Zealand, October 19.
- Henry, C. S., K. P. Huynh, G. Nicholls and M. Nicholson. 2019. ["2018 Bitcoin Omnibus Survey: Awareness and Usage"](#). Bank of Canada Staff Discussion Paper No. 2019-10.
- Henry, C. S., K. P. Huynh and A. Welte. 2018. ["2017 Methods-of-Payment Survey Report"](#). Bank of Canada Staff Discussion Paper No. 2018-17.
- Hughes, S. 2021. ["A Proxy for Holding Bitcoin': Crypto Firms Set to Go Public as Market Hits US\\$3 Trillion"](#). *Financial Post* (November 8).
- Huynh, K. P., J. Molnar, O. Shcherbakov and Q. Yu. 2020. ["Demand for Payment Services and Consumer Welfare: The Introduction of a Central Bank Digital Currency"](#). Bank of Canada Staff Working Paper No. 2020-07.
- Huynh, K. P., G. Nicholls and O. Shcherbakov. 2019. ["Explaining the Interplay Between Merchant Acceptance and Consumer Adoption in Two-Sided Markets for Payment Methods"](#). Bank of Canada Staff Working Paper No. 2019-32.
- Huynh, K. P., G. Nicholls and O. Shcherbakov. 2022. ["Equilibrium in Two-Sided Markets for Payments: Consumer Awareness and the Welfare Cost of the Interchange Fee"](#). Bank of Canada Staff Working Paper No. 2022-15.
- Jack, W. and T. Suri. 2011. ["Mobile Money: The Economics of M-PESA"](#). National Bureau of Economic Research Working Paper No. 16721.
- Jiang, J. 2020. ["CBDC Adoption and Usage—Some Insights from Field and Laboratory Experiments"](#). Bank of Canada Staff Analytical Note No. 2020-12.
- Lane, T. 2020. ["Money and Payments in the Digital Age"](#). Remarks to CFA Montréal FinTech RDV2020. Montréal, Quebec, February 25.
- Lane, T. 2021. ["Payments Innovation Beyond the Pandemic"](#). Remarks to the Institute for Data Valorisation, Montréal, Quebec, February 10.

- Paskarathas, R., L. Graaskamp, E. Balodis and T. Garanzotis, and. 2018. "Canada's polymer versus paper substrate cycle." *Central Banking* (March 1).
- Miedema, J., C. Minwalla, M. Warren and D. Shah. 2020. "Designing a CBDC for Universal Access." Bank of Canada Staff Analytical Note No. 2020-10.
- Mizrach, B. 2021. "Stablecoins: Survivorship, Transactions Costs and Exchange Microstructure." Available on SSRN <https://dx.doi.org/10.2139/ssrn.3835219> (Updated: June 8, 2022).
- Rösl, G. and F. Seitz. 2021. "Cash and Crises: No Surprises by the Virus." Institute for Monetary and Financial Stability Working Paper No. 150. Goethe University Frankfurt.
- Shy, O. forthcoming. "Cash Is Alive: How Economists Explain Holding and Use of Cash." *Journal of Economic Literature*.
- Spencer, C. 2011. "Paying with Polymer: Developing Canada's New Bank Notes" *Bank of Canada Review* (Spring): 1–7.
- Statistics Canada. 2021. "The Daily—Distributions of Household Economic Accounts for Wealth of Canadian Households, Fourth Quarter 2020."
- Statistics Canada. 2022. "The Daily—Canada's International Transactions in Securities, December 2021."
- Swedish Civil Contingencies Agency. 2018. *If Crisis or War Comes*.