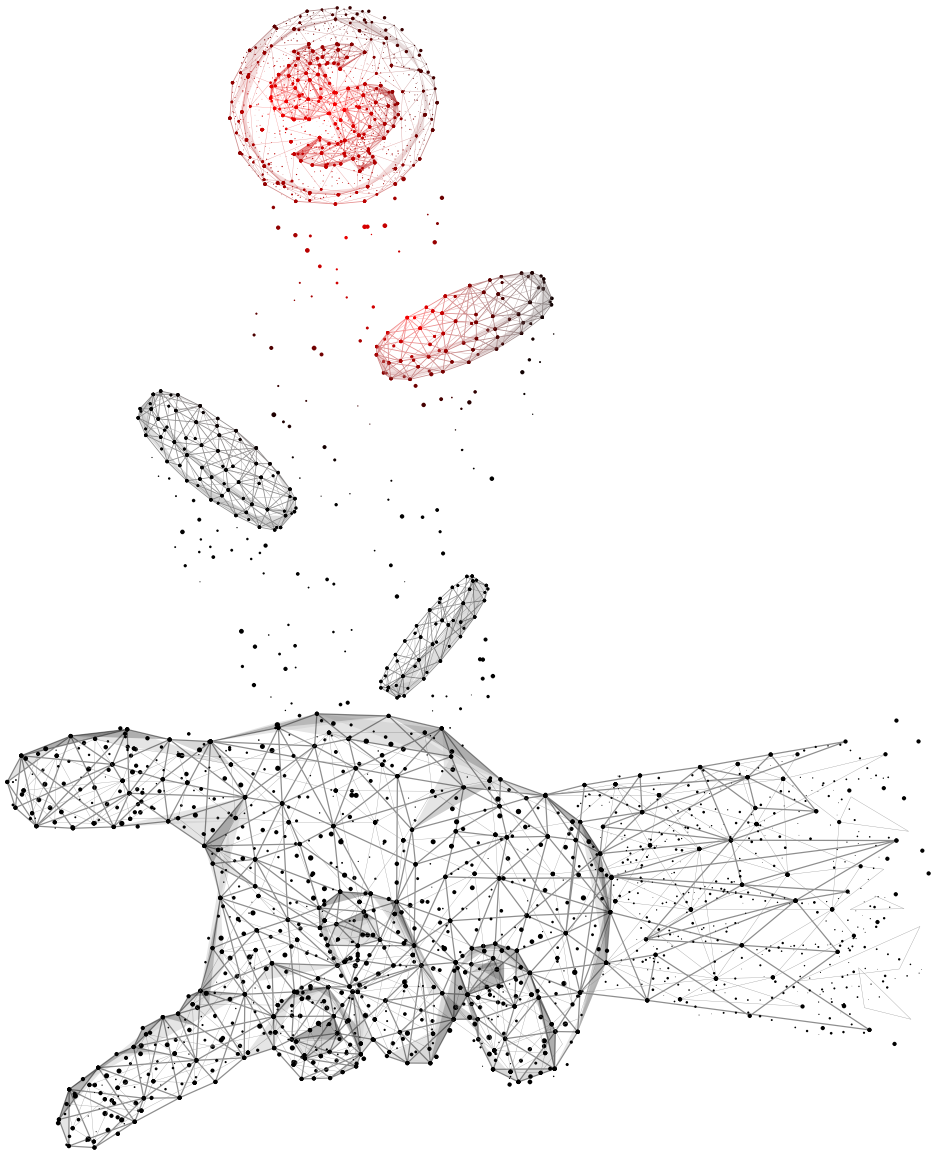
Centre for International
Governance Innovation

CIGI Papers No. 261 — February 2022

Retail Central Bank Digital Currency

Has Its Time Come?

Pierre L. Siklos



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About the Author

Pierre L. Siklos is a CIGI senior fellow who specializes in macroeconomics, with an emphasis on the study of inflation, central banks and financial markets. He also conducts research in applied time series analysis. His research has been published in a number of international journals, and he has been a consultant to a variety of institutions and central banks. His work has been widely cited in several macroeconomics and econometrics textbooks. Pierre has also been a visiting lecturer at several universities in Europe and North America as well as in Australia and New Zealand. His research has been funded by domestic and international agencies.

In 1999, he was an Erskine Fellow at the University of Canterbury in New Zealand, and in 2009, he was a William Evans Fellow at the University of Otago in New Zealand. Pierre was Wilfrid Laurier University's (WLU's) University Research Professor for the academic year 2000–2001, the director of the Viessmann European Research Centre at WLU from 2005 to 2014, and a member of the Czech National Bank's Research Advisory Committee between 2012 and 2018. In 2008, Pierre was chair of the Bundesbank Foundation of International Monetary Economics at the Freie Universität Berlin in Germany.

He is a guest professor at the Westfälische Wilhelms-Universität Münster in Germany, a research fellow of the South African Reserve Bank and Stellenbosch University in South Africa and is the Fondation France-Japon/ Banque de France Fellow for 2021–2022.

Acronyms and Abbreviations

AEs	advanced economies
BIS	Bank for International Settlements
CBDC	central bank digital currency
COVID-19	coronavirus disease 2019
DeFi	decentralized finance
ECB	European Central Bank
EMEs	emerging market economies
FSA	financial stability authority
FSB	Financial Stability Board
G7	Group of Seven
G20	Group of Twenty
GFC	global financial crisis
OECD	Organisation for Economic Co-operation and Development
UMPs	unconventional monetary policies

Executive Summary

Many central banks are making final preparations for the introduction of a central bank digital currency (CBDC). Trials are already in place in countries large and small, both systemically and in economic terms, with a few small countries introducing basic versions of CBDC. This paper considers the retail type of CBDC, defined as a digital currency that primarily complements notes and coins, but with the possibility that it can also be held as deposits in financial institutions, the central bank or both. Some critical open questions still need to be addressed if CBDCs are to gain wide acceptance among the public. The following questions are considered: First, if retail CBDCs are intended to complement cash, then what are the current drivers of cash holdings around the world? Second, are current forms of governance, notably the relationship between the central bank and government on the one hand and the private sector financial system on the other, adequate in a world where CBDCs are in circulation?

Central banks and academics have argued that the economic and financial benefits of CBDCs can be positive. Indeed, CBDCs offer the prospect of generating benefits not available to holders of ordinary notes and coins. However, while cash provides a *convenience* yield, in part because of its widespread acceptability, the introduction of retail CBDC may well be associated with an *inconvenience* yield. Privacy loss, technical risks, cultural resistance and even climate-related implications stem from digital forms of currency. Hence, retail CBDC represents more than just an alternative form of cash. Policy makers are aware of the broader issues. Yet it appears that CBDC will be in circulation before many governance-related questions have been addressed. These developments are consistent with the well-known phenomenon whereby regulation and supervision lag the introduction of financial innovations.

The paper considers whether CBDC increases the potential for further overburdening central banks. The answer appears to be yes. Next, the main governance models where central banks play a role are contrasted and implications, once CBDCs are introduced, are discussed and potential solutions are suggested. At the global level, CBDC has the potential to disrupt current cross-border transactions. At the domestic level, policy makers must debate giving central banks even more authority, deliberately or by default, while central banks still grapple with how to simultaneously maintain price and financial stability. Finally, CBDC blurs the widely accepted distinction between fiscal and monetary policy since the digitization of money represents a potentially new avenue to transfer financial resources to the public.

In principle, all of the prospective challenges to CBDC introduction can be overcome by ensuring adequate transparency and accountability, and by establishing limits to the fiscal authorities' ability to interfere with monetary policy to deal with broader societal questions. An important worry is that the potential economic implications from the introduction of CBDC do not appear to have attracted much of the public's attention. The public is preoccupied with pandemic- and climate-related problems. Central banks, governments and the global community more generally, must educate the public with greater urgency for the changes to come. More importantly, a premium will be placed on how Group of Twenty (G20) member countries are able to align their regulatory, supervisory and sovereignty motives as they deploy CBDC. The challenges are great, as are the risks of global economic tensions. In other words, the spread of CBDC risks becoming the next economic shock.

Introduction

We tend to overestimate the effect of a technology in the short run and underestimate the effect in the long run.

—Roy Amara (quoted in Ratcliffe 2018)

Central banks in the world's largest economies are preparing the public for the formal introduction of a CBDC.[1] Demand for this form of currency is partly driven by normal historical forces that have, over time, produced greater sophistication in how financial transactions are conducted. The proliferation of digital forms of payment of

1 Perhaps the best-known early entry into the race to launch retail CBDC is the Bahamas. A few other small nations in the Caribbean have also launched CBDC. Nigeria has also introduced a CBDC for bank account holders. Advanced economies (AEs) are much more cautious and at the stage of outlining principles for CBDC while engaging in trials of various kinds (see Group of Seven [G7] Research Group 2021).

varying sophistication is, of course, not new, and the rapid growth of the so-called fintech industry is also evidence of the critical importance of the digitalization of finance. There is also the worry that monetary authorities might well be sidelined by private sector attempts to sidestep and create alternative means of payment forms that can approximate the critical means of payment function fulfilled by central bank notes and coins. Occasionally lost in the discussion is that "money," as it is conventionally understood, also fulfills a store of value function, which presumes that it is a safe asset that is held and trusted by the public.

This paper addresses two potential forms of retail CBDC likely to be introduced to the public.[2] The first is a digital equivalent to existing notes and coins in circulation. Henceforth, this will be referred to as a *narrow* CBDC. For the time being, the author ignores the further distinction that has implications for privacy due to the possibility that a narrow CBDC could be issued in account form or in token or voucher varieties (European Central Bank [ECB] 2019). In general, central banks have emphasized this kind of retail CBDC as the one to be initially introduced for both practical and economic reasons (for example, see Chen and Siklos 2021; Barrdear and Kumhof 2016; Auer and Böhme 2021). A second version would add a feature that would permit retail CBDC to also be deposited either in a central bank or in the banking system. Henceforth, the author will refer to this form of retail CBDC as a *broad* CBDC. Narrow CBDC would impact a narrow money supply aggregate (for example, *M0* or *M1*, which consist of currency and chequable deposits), while broad CBDC would impact a broader monetary aggregate (for example, *M2* or *M3*, which are *M0* or *M1* augmented by various interest earning deposits or financial instruments).[3] The Bank for International Settlements (BIS) (2021, graphs III.4 and III.5) provides a compendium of the main forms of CBDC being contemplated. In what follows, the author focuses purely on domestic considerations, although some mention of implications for cross-border transactions in digital form are mentioned in passing. This is the subject of a separate future study.

The foregoing developments appear to be taking place at a pace that is not necessarily the one chosen by central banks. Nevertheless, trials are already in place in countries large and small, both systemically and in economic terms. Canada is one of the countries preparing for CBDC[4] but with the proviso that a precise date for its introduction is unknown.

The range of technical, legal and economic issues being considered by observers increasingly focuses on the retail type of CBDC. At the wholesale level, large-value transfer systems and, hence, the digitalization of large transactions are largely a *fait accompli*. Hence, in what follows, the analysis only considers the retail type of CBDC and selected critical open questions that remain incompletely addressed. Two questions are examined: First, what is the potential economic impact of retail CBDC in relation to currently circulating cash? Second, are current forms of governance, notably the relationship between the central bank and government on the one hand and the private sector financial system on the other, adequate and appropriate in a world where CBDCs are in circulation? Both questions implicitly raise the possibility, as we shall see, that the quote at the beginning of this section contains an element of truth when it comes to the potential impact of retail CBDC.

Data from a variety of sources, including the World Bank, the International Monetary Fund, the Financial Stability Board (FSB), individual central banks (i.e., G20 central banks), the World Values Survey and Tufts University's Digital Evolution Index, as well as existing indicators of the degree of macro- and microprudential involvement by central banks developed by several academics, form the basis of an investigation of the connection between existing governance models and the oversight role of central banks in retail CBDC. The proliferation of data sources is partly necessitated by the difficulties in obtaining enough data to

2 This is distinct from wCBDC, that is, digital money used to settle large or wholesale transactions. The Swiss National Bank, for example, is already experimenting with this form of payment (see Banque de France, BIS and Swiss National Bank 2021).

3 The author does not examine so-called cryptocurrencies. There exists confusion between CBDC and stablecoins. Stablecoins are issued by the private sector and backed by physical assets (for example, gold) or financial assets (for example, dollars); existing cryptocurrencies are generally unbacked financial instruments. Currently, however, there is no legal restriction dictating the backing of stablecoins. See BIS (2019) and Barontini and Holden (2019) for additional details.

4 A useful Canadian source for the growing list of research papers and other materials about digital money is the Bank of Canada's Digital Currencies and Fintech site (see www.bankofcanada.ca/research/digital-currencies-and-fintech/). Eswar S. Prasad (2021) offers a highly readable account of how digitization is impacting the role of money and central banks.

properly assess the potential impact of retail CBDC. After all, apart from a few examples past and present (see footnote 1), there are currently few empirical assessments of the likely economic impact from the introduction of a digital currency.

The rest of the paper is structured as follows. The section titled "CBDC: Micro and Macro Considerations" highlights some of the regulatory, legal and technical questions around the introduction of retail CBDCs that remain incompletely resolved. The author then outlines the current state of play around CBDC by contrasting the demand for cash with recent developments in the use of digital forms of payment. The author also considers the implications of CBDC for the role and governance of central banks as well as suggests some potential avenues that can address some of the outstanding issues. A separate section titled "CBDC and Central Bank Mission Creep" asks whether the imminent introduction of CBDC necessarily implies a further broadening of the responsibilities of central banks, that is, a new form of mission creep. The bottom line is that the threat of further overburdening central banks is real. The conclusion summarizes the findings and provides some policy implications.

CBDC: Micro and Macro Considerations

In response to the global financial crisis (GFC) of 2008–2009, the oversight role at some central banks expanded (for example, see Siklos 2021; Lombardi and Siklos 2016). Yet a framework wherein responsibilities are shared with other public institutions is often the preferred option because this strategy ensures that the necessary checks and balances are in place and can deliver best practice in policy making. Stated somewhat differently, the choice revolves around whether the central bank should sit at the top of a pyramid of institutions responsible for monetary policy, financial stability and financial oversight more generally, or with responsibilities shared with other government-mandated institutions. The choice is often dictated by political economy considerations. The difficulty is that, as far as the author is aware, it has yet to be clearly established whether central banks have adequately adjusted to their role in ensuring financial system stability. Indeed, there continue to be differences of opinion about the precise role central banks ought to play in maintaining financial system stability (for example, see Bordo and Siklos 2019; Murray 2021). Nevertheless, the weight placed on avoiding another GFC has grown considerably since the GFC of 2008–2009. Given the potential role of retail CBDC as an additional instrument of monetary policy, together with financial stability implications of growing digitization, the central bank's authority in this sphere is once again in question.

Additional complexities arise when the monetary ecosystem includes retail CBDC. Why? By nature, supervision of retail payments is a *micro*prudential concern. Yet CBDC can, at least in theory, also be used by the monetary authority to influence the macroeconomy. This concept also reminds us that the arrival of retail CBDC has the potential to further deepen the blurring of fiscal and monetary policies (also see Bassetto and Sargent 2020) that began with the introduction of unconventional monetary policies (UMPs). Much has been written about the challenges arising from the mixing of fiscal and monetary policies (for example, see Bartsch et al. 2020). Forgotten, it seems, is that central banks are institutions within government, not separate from them. What is critical, then, is the "contract" between fiscal and monetary authorities. It has always been true that best practice in stabilization policy is a well-defined and coordinated relationship between the political and monetary authorities. It is also true that governments eventually get the monetary policy they want since they, and not only central banks, are ultimately accountable to the public. Hence, we are once again back to governance matters.

To the extent there are potential spillovers from the macro effects of CBDC in the realm of financial system stability, part of the response is to resort to *macro*prudential-type policies. Although most policy makers and central banks have emphasized the importance and potential benefits of macroprudential interventions, the evidence is far from clear that they have been as effective to date as promised (for example, see Forbes 2021). To be fair, such policies may well have prevented financial instability from some unknown source since the GFC. Regardless, a framework that gives the central bank a prominent role in retail CBDC implies a departure from an

earlier consensus wherein central banks were not usually thought to be best placed to simultaneously handle micro- and macroprudential concerns.

The deployment of retail CBDC has revived unresolved legal questions over privacy implications, the ownership and harvesting of retail data, as well as critical technical issues including denial of service attacks and interruptions of various kinds that would impact access and usage of retail CBDC because it is accessible only in digital form (for example, see Group of Thirty 2020). Although central banks are aware of these challenges, they have tended to be downplayed, including by many academics, who simply argue that solutions exist or will be developed to overcome existing problems. Nevertheless, to the extent that the digitization of finance at the retail level especially is reliant on artificial intelligence, warnings have been issued about disastrous economic consequences unless the authorities have proper regulation and supervision in place (for example, see Acemoglu 2021). Indeed, whereas privacy concerns tend to rest on the ability of private sector firms to monetize the content of data collected through digital means,[5] it is the ability of governments to collect and use digital data for socially beneficial reasons (for example, to reduce tax evasion, corruption), as well as for nefarious purposes (for example, control over currency transactions, increased individual surveillance; see, for example, Khalaf and Warrell 2021), that ultimately may be the more pressing concern.

As a result, there are unexplored governance consequences in giving central banks oversight authority over retail CBDC since institutions, both private and public, well outside the usual purview of central banking, will be impacted by the creation of retail CBDC. It is hard to see that central banks today have the required expertise or, indeed, are willing to take responsibility for all of the elements required to successfully introduce and manage a retail CBDC. Stated differently, digital forms of money require competence from several sources beyond ones traditionally taken on by the monetary authority alone. An implication is that the relationship between institutions impacted by the introduction of CBDC and existing decision-making structures, particularly in the event of stress or a crisis, needs to be revisited.

Next, central banks and academics have frequently touted the economic and financial benefits of CBDC. Indeed, some have praised the arrival of CBDC for its potential to provide benefits not available to holders of ordinary notes and coins. These include the potential to expand access to the financial system, speed and certification of payment settlements, the payment of interest on currency and lower transactions costs. However, if holding cash provides a "convenience" yield, the introduction of retail CBDC is also accompanied by an *inconvenience* yield associated with its usage. Privacy risks, piracy risks, risks of technical failures, cultural resistance and even climate-related implications from the arrival of digital forms of currency, imply that retail CBDC has implications that extend far beyond the mere creation of an alternative form of cash. These costs apply to both narrow and broad forms of retail CBDC considered in this paper. However, the precise form of retail CBDC will have different implications for the conduct of monetary policy and the maintenance of financial stability, as we shall see.

The potential costs of printing and maintaining paper money, typically assumed to be small and rightly so, are far from trivial in the case of a retail CBDC. On the one hand, while it is tempting to think of the software and related infrastructure required to introduce CBDC as a sunk cost, the speed with which updates and new generations of software and hardware are introduced, suggests something more akin to a variable cost. To be sure, a proper accounting of these costs is difficult.[6] On the other hand, there is one characteristic of retail CBDC that potentially adds to convenience that has been underemphasized to date. Retail CBDC holdings are a vehicle that can offset the loss of purchasing power in the event of moderate and persistent inflation. That is, the loss of purchasing power from the holding of notes can be easily overcome via compensation in digital form. Of course, this raises issues that have been discussed in the existing literature (for example, see Bordo 2021). History can also help since cash holdings in an inflationary environment can be examined.

5 Arguably, Europe's General Data Protection Regulation (see https://gdpr-info.eu/) is setting the standard for the protection of individual privacy rights, although legal tests are ongoing. For the state of play globally, see https://unctad.org/page/data-protection-and-privacy-legislation-worldwide.

6 Many central banks began to shift to printing polymer banknotes. Gordon Menzies's (2004) study is an interesting attempt that examines the challenges of estimating the costs and benefits relative to conventional paper notes.

Inflation, perhaps because it has been "dormant" for so long, is generally not considered as a factor. As this is written, this may change since inflation around the globe has been rising due to the coronavirus disease 2019 (COVID-19) pandemic. What remains in doubt, however, but is outside the scope of this paper, is the extent to which the current surge in prices is temporary. If it is not temporary, this may have a profound impact on the deployment of CBDC, especially if the public believes that monetary policy must accommodate a looser fiscal policy. Moreover, payment of interest of any kind on narrow CBDC effectively implies that it is no longer a perfect substitute for notes. Will society accept this turn of events if there is resistance, or is it impractical to eliminate all circulating notes and coins? On the one hand, estimating this inconvenience (or net convenience) yield is difficult. It is well known, of course, that private financial institutions would not welcome this change and, with growing pressure to permit some form of open banking around the globe, the challenge for central banks would become that much greater. Indeed, the prospect of a broad CBDC, especially if the public has direct access to the central bank, is likely to be seen as a step too far that blurs commercial and central banking functions. On the other hand, competitive pressures from fintech firms may well raise the convenience yield of retail CBDC under a regime where central banks provide narrow CBDC only. However, this still does not address the overall governance-related issues discussed above. The role and overall authority of the central bank are not left untouched by the introduction of retail CBDC.

Retail CBDC: State of Play

The evidence and discussion that follows focuses on the experience of the G20. This reflects, in part, the group's role and influence in the future direction of global collective action. In addition, of course, the G20 consists of economies that, when combined, represent more than 80 percent of the globe's GDP and a similarly large share of trade in goods and services. Equally important is that G20 membership consists of countries whose level of financial development varies considerably. This implies that any issues, challenges and tensions surrounding the development, introduction and governance of CBDC are likely to be magnified. While central banks are unlikely to introduce CBDC at the same time, the combination of first-mover advantage, as well as the likelihood that the AEs will set out in advance the rules of the game, may well lead to a rush of retail CBDC being introduced. These tensions also perfectly capture the unavoidable conflict between the desire to collaborate, if not cooperate, across countries and the pressures to act individually as a means of establishing the primacy of sovereignty.

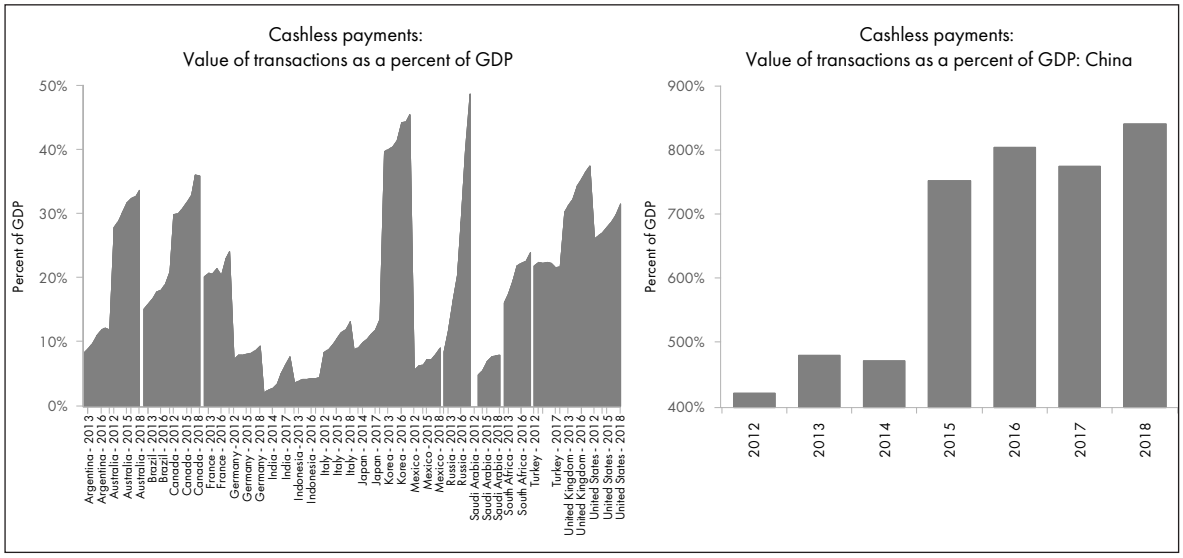
There is growing evidence over time, in the United States and elsewhere, of what has been called the "cash paradox" (Williams 2012; Ashworth and Goodhart 2020). This phenomenon refers to the continued strong demand for notes in circulation even as the intensity with which digital alternatives to cash (for example, debit and credit cards) have proliferated.[7] That said, a consensus explanation for the paradox continues to elude researchers, in part, because it is likely that several phenomena, some purely economic in nature (for example, inflation), others more structural (for example, aging, wealth and income inequality), are likely simultaneously in play.[8] As we shall see below, challenges around the introduction of CBDC cannot ignore the existing drivers of the demand for cash.

Naturally, in view of the questions most germane to this study, of equal interest are changes in payments that are of the cashless variety. Figure 1 clearly illustrates the growth in digital forms of payments as a percent of GDP (left side) for the 2012–2018 period for which we have data. Note that China is excluded for reasons that will soon become apparent. Two striking phenomena stand out from the data. First, the growing importance of cashless transactions varies considerably both in terms of the levels and rates of change over time. Levels of cashless transactions are relatively modest, to date, in countries such as India, Indonesia and Mexico, to give three examples. That said, the push toward digitalization outside

7 Cash, of course, also includes coins in circulation, which are included in some of the calculations discussed below. However, for simplicity, the author equates cash with notes, which represent the overwhelming proportion of currency in circulation outside banks. Many of these developments preceded the arrival of the COVID-19 pandemic.

8 The author (Siklos 2021) also notes the role of note denomination in generating this paradox, since the desire to hold cash reflects not only a transactions demand but also the store of value function of money. The cash paradox is not a universal phenomenon. Sweden, for example, has largely escaped this trend.

Figure 1: The Importance of Cashless Payments (G20, 2012–2018)



Source: Data is annual and from the BIS *Red Book*, a publication of the Committee on Payments and Market Infrastructures (see www.bis.org/statistics/payment_stats.htm).
Notes: The bars are for the countries shown over the 2012–2018 period. For each country, a particular year is identified (for example, 2018 for the United States).

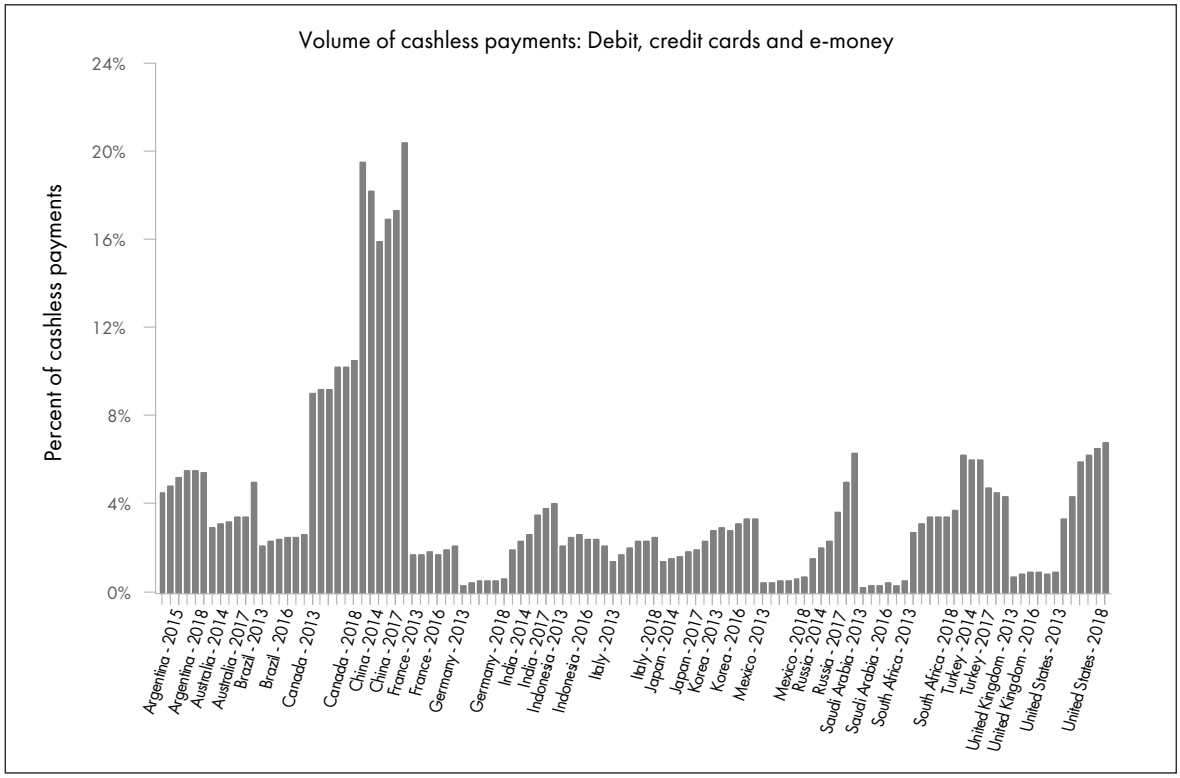
the AEs is likely to change rapidly.[9] Similarly, in a few AEs (for example, Germany, Italy), the intensity of cashless payments lags behind other members of the same group such as Australia, Canada and the United Kingdom. Second, the usual divide between AEs and emerging market economies (EMEs) in discussions about economic performance and policy recommendations does not apply to explain the rising importance of digital payments. Indeed, to highlight this development, the bar chart on the right in Figure 1 shows that the value of cashless transactions as a percent of GDP in China far exceeds the value of those transactions elsewhere in the G20. China, like Russia and Turkey, to give two additional examples, also displays a preference for cashless payments that rivals that found in many AEs.

Cashless payments, of course, come in many forms. Since some of the debate over the impact from the potential introduction of CBDC is around strong substitutes for cash, namely, debit and credit cards, as well as e-money, Figure 2 displays the relative importance of these forms of digital payments, as a percent of all cashless payments, again for the G20. As before, China stands out from the other G20 members, although it is noteworthy that retail forms of payment continue to effectively represent a relatively small proportion of all cashless payments. Perhaps this explains, in part, the tremendous interest and potential for digital forms of retail payments, in future, to play a larger economic and financial role. It is also worth pointing out that growth rates in retail forms of cashless payments, although clearly visible, are nowhere as impressive as some of the growth rates exhibited in all forms of cashless payments (see Figure 1). Finally, there is again no apparent AE versus EME divide: there are examples from both groups where growth is either strong (for example, China, Russia and the United States) or modest over time (for example, Australia and the United Kingdom).

As noted earlier, developments in digital forms of payment cannot ignore what is happening to the demand for cash. Indeed, since most central banks have tended to emphasize a preference for thinking about CBDC as an alternative or a complement to cash instead of as a conventional financial asset that generates a return over time, a better understanding of what has been driving cash holdings, at the global level, may be instructive. This is also a useful exercise

9 A good example is the Government of India's involvement in encouraging digital payments domestically but with an eye to spreading the homegrown technology's usage internationally. See Government of India, Ministry of Information and Broadcasting (2021).

Figure 2: Relative Importance of Selected Forms of Cashless Payments



Source: BIS *Red Book* (www.bis.org/statistics/payment_stats.htm).
Note: See note to Figure 1.

when dealing with the challenges central banks face when putting CBDC in circulation.

Decades ago, a popular exercise was to estimate models of the demand for money (for example, see Laidler 1993). While there continues to be interest in the topic, empirical research in the area has diminished considerably over time.[10] Yet the prospect of a CBDC must prompt policy makers to ask whether we have a good understanding of the determinants of cash demand as well as the motives for holding notes in circulation. Moreover, depending on the type of CBDC introduced, and the overall economic environment in which it is introduced, the role of cash as a transactions medium versus its potential as a store of value has become relevant again.[11] Crucially, CBDCs have the potential to greatly disrupt international payments systems because digital forms of payments promise to threaten the sovereignty of monetary policy, especially where economic performance and governance are weak. However, as Raphael Auer et al. (2021) point out, the potential for CBDC to be globally disruptive is not only unresolved but also research about its consequences remains in its infancy.

To provide some insights into what factors drive the demand for cash, Table 1 provides some estimates of the role of key economic and institutional factors in the G20 economies. The empirical estimates are divided into two related sections necessitated, in part, by how economics treats the issue of what determines the demand for cash. Whether cash is held for transactions, purchases or as a financial asset, holders will also

10 At least two reasons explain this development. First, it proved difficult to find a definition of the money supply that could yield a stable relationship between money demand and its determinants, although this has not prevented the search for stable functions (for example, see Lucas and Nicolini 2015). Second, since at least the early 1990s, interest in the behaviour of monetary aggregates was replaced by a focus on central bank policy rates to evaluate the stance of monetary policy. Interestingly, some of the more recent research is beginning to employ micro-level data (for example, at the bank level) to investigate what drives cash demand and how government interventions (for example, changes in tax and other financial regulations) impact how much cash is held and in what denominations. For example, see Attanasio et al. (2002), Benchimol and Qureshi (2019), and references therein.

11 Traditionally, money is thought to fulfill three functions: a unit of account, a medium of exchange and a store of value.

Table 1: Governance, Capacity and Cashless Payments (2012–2018)

Dependent variable: Cashlesspp/100				
Variable	Coefficient	Std. error	T-statistic	Prob.
C	-4.04	2.20	-1.84	0.07
Econfree	-0.53	0.50	-1.05	0.30
Legal	0.86	0.46	1.84	0.07
Finopen	0.50	0.11	4.44	0.00
Contracts	0.20	0.20	1.03	0.30
AE	-4.37	0.99	-4.43	0.00
User	0.04	0.01	3.28	0.00
Period fixed effects? Yes				
R-squared	0.64	No. of cross-sections	17	
Adjusted R-squared	0.60	No. of observations	112	
F-statistic	14.88			
Prob. (F-statistic)	0.00			

Sources: Data for cash, cashless and cashlesspp is from the BIS *Red Book* (see www.bis.org/statistics/payment_stats.htm). The governance indicators are from the Fraser Institute's *Economic Freedom of the World* annual reports (see www.fraserinstitute.org/studies/economic-freedom). Data is from the World Bank's World Development Indicators (see https://datatopics.worldbank.org/world-development-indicators/). Data is annual. Estimation is via panel least squares.
Notes: Cashlesspp is the total volume of cashless payments per 100 inhabitants. Seventeen countries represent the 19 members of the G20 (euro-area data consists of the mean of data for France, Germany and Italy). C = currency in circulation; econfree = economic freedom summary index; legal = legal system and property rights; finopen = financial openness; contracts = legal enforcement of contracts. AE is a dummy variable identifying advanced G20 economies (Australia, Canada, European Union, Japan, Korea, the United Kingdom and the United States). "User" is the percent of the population using the internet.

consider the purchasing power of cash. As a result, the demand for cash is generally expressed in real terms, that is, nominal cash holdings deflated by the price level.[12] The author uses annual data for a sample, where data is available, from 1980 to 2020.[13]

Traditionally, transactions demand is driven by real income, that is, nominal income deflated by the price level, while the store of value function is influenced by the opportunity cost of holding cash. The latter is very difficult to translate into practice for several reasons. First, while bank deposits are an obvious alternative, there are severe limitations in obtaining data that is comparable across countries. Moreover, deposit rates usually change infrequently and are often influenced by the regulatory environment in which banks operate. Often then, a symbolic interest rate is used such as yield on a risk-free rate.[14] This is the strategy adopted below.

But there are other forces at play that are also relevant for the debate about the form in which CBDCs are introduced. Beyond the usual risk of loss, cash offers the convenience of purchasing goods and services when the opportunity

12 Just as currency in circulation has risen over time, real cash holdings have also risen over time in every G20 country. See the appendix.

13 The appendix provides more details about data availability for each country in the data set. For some of the variables, only annual data is available and data availability becomes an even greater constraint if one tried to start the sample before 1980.

14 A yield on a short-term government instrument is a good example. However, comparability across the G20 countries can also be problematic, not to mention data availability for a sufficiently long sample. Where available, the author used a deposit interest rate. Elsewhere, a comparable rate is the interest rate on the policy instrument used by a central bank. Where data limitations exist, a short-term government bond, such as a three-month Treasury bill, did not impact the conclusions.

to settle transactions digitally is unavailable (for example, the merchant does not have the required equipment, or there are climate-related interruptions in network access). Moreover, cash transactions are private whereas digital ones need not be and, depending on the rule of law, provide an opportunity for governments to access information for tax collection purposes. Indeed, legal restrictions often exist on transaction amounts deemed to legally settle payments.[15] While all of these factors suggest that holding cash offers a kind of convenience yield that provides an incentive to hold a non-interest earning asset, a CBDC may also generate some inconveniences (loss of privacy and anonymity, loss through hacking) that may require compensation (insurance against loss, greater security, facilitating cross-border transactions). Hence, central banks are wise to argue that digital and physical forms of cash will both continue to be in demand and, hence, are likely to co-exist. This still leaves the option for central banks to create at least two classes of currency, thereby providing the central bank with an opportunity to create a new instrument of monetary policy since digital cash holdings can earn interest or incur a penalty. The author returns to this issue in the next section.

Monetary theory (for example, see Laidler 1993) postulates that an equilibrium relationship exists between the three variables. In other words, real balances, income and an interest rate are linked to each other such that when income rises or interest rates fall, individuals will want to hold more cash and vice versa when these variables change in the opposite direction. In theory, changes in income and interest rates will also influence the demand for cash to maintain the equilibrium relationship.[16] We can express the equilibrium, or "long-run" relationship, using arrows to express the sign of the relationship between the drivers of real cash balances and their determinants as follows:

> Core equilibrium real cash holdings determinants: income ↑; interest rate ↓

If economic theory has a well-established narrative, together with supportive empirical evidence, about what drives the demand for cash in the long run, there is much less agreement on its short-run determinants. Historically, the threat to cash holdings has often been how useful these are for transactions purposes as well as the degree to which cash holdings are protected against loss of purchasing power. The latter, of course, is a threat to the store of value function of money. Inflation is often used as an indicator of the attractiveness of holding cash. Nevertheless, inflation control is ultimately also ensured by institutional arrangements created to prevent excessive inflation. This usually includes a monetary policy regime that is expected to control inflation together with a fiscal authority that supports this goal.[17] Since the demand for cash will be determined by how much confidence society has in its current and future value, the results discussed below resort to two proxies for the institutional setting in which cash circulates in the countries considered.[18] They are the size, in relation to a country's GDP, of defaults in government or sovereign debt and what has been called "contract intensity." The latter is an oft-used indicator of the enforceability of contracts and the security of property rights that was proposed by Christopher Clague et al. (1999). Contract intensity is defined as the fraction of a country's money supply held as bank deposits.[19] Clearly, other drivers of cash holdings are conceivable, including ones that are more directly related to technological developments over the past

15 This point is underscored by two lawyers in the US Federal Reserve System (Cheng and Torregrossa 2021) who explain that once one goes beyond Federal Reserve notes, legal rights become murky but are definitely no longer secured against the "full faith and credit" of the sovereign (the US government in this case).

16 In other terms, we expect these variables to be cointegrated, which is the statistical equivalent of the equilibrium condition described. In the short term, deviations from equilibrium are expected to be stationary, that is, a series without trend and a constant variance.

17 Since the early 1990s, inflation control has been a deliberate policy, supported by giving the monetary authority autonomy from political influence, and is often underscored by a commitment to low and stable inflation often, but not always, via a policy of inflation targeting. Among the G20, 14 of 17 economies have an explicit form of inflation control since the early 1990s or 2000s. In 10 of 17 economies, inflation targeting defines the monetary regime in place by the end of the sample (2018–2020). See, for example, Siklos (2017).

18 Inflation was also considered. The results (not shown) suggest that it often takes the place of the chosen interest rate variable. This is perhaps not all that surprising since, in theory though not always in practice, nominal interest rates ought to reflect inflation (more precisely, expected inflation).

19 More precisely, (M2-C)/M2 where M2 is the money supply and C is notes and coins in circulation. There are a large number of money supply definitions. For example, the Bank of Canada publishes three measures depending on the type of deposit or financial asset (for example, mutual funds: see www.bankofcanada.ca/rates/indicators/key-variables/monetary-aggregates/) included. Issues of data comparability are also relevant when defining the money supply in a cross-country setting. Clague et al. (1999) use the M2 definition, which includes notes and coins in circulation together with demand and some savings deposits, and the source (i.e., the World Bank's World Development Indicators) attempts to ensure cross-country comparability. In the results reported later in this paper, M2 is also used.

two decades in particular. However, due to data limitations,[20] these are omitted, although other estimations (not shown) support the general conclusions discussed below.[21]

The top portion of Table 2 shows first estimates of the equilibrium, or long-run relationship, between income and the interest rate.[22] Results for the G20 economies[23] suggest that, statistically speaking, demand for cash rises one for one with a percent increase in real income. Moreover, a rise in interest rates reduces cash holdings and, keeping in mind that the logarithms of interest rates are used, the impact is such that a 100-basis-point rise in interest rates across the G20 results approximately in a six percent fall in demand for cash. These results establish that there exists an equilibrium relationship between real cash balances, income and the interest rate that theory predicts. Will this result persist in a world where narrow CBDCs circulate alongside traditional notes and coins? There is every reason to believe so. Indeed, the potential for the monetary authority to pay interest or charge a penalty for holding digital forms of cash may raise the interest sensitivity of the demand for cash. Of course, central banks as conservative institutions may decline, at first, to resort to exploiting the opportunity to use narrow CBDC as a policy instrument and tout other benefits of digital money instead. What if a broad CBDC is introduced? Interest sensitivity could be comparable to the narrow CBDC case, especially if the costs of switching from digital cash to bank accounts are effectively reduced. One complication is whether the public would be allowed to hold deposits at the central bank. In principle, deposits at a central bank can be viewed as just notes and coins in circulation in a different form. However, as noted earlier, the risk of disintermediation would impact deposits held in the banking system. This suggests another reason for the "contract" between the central bank and the government to be re-examined.

If the long-run properties of money demand persist, then we may also expect its short-run properties to provide continued insights into the prospective demand for narrow CBDC.[24] The bottom portion of Table 2 goes on to provide estimates of the short-run drivers of the demand for cash. Income continues to positively impact cash demand, but the response is considerably lower in the short-run than in equilibrium. In contrast, cash demand reacts relatively more strongly to an interest rate increase in the short run. Turning to the institutional determinants, a rise in defaults on sovereign debt increases cash holding, although the impact is economically negligible. In contrast, a decline in contract intensity, which implies a deterioration in contract enforceability and in the protection of property rights, translates into a rise in real balance holdings. Given how contract intensity is defined, this means that deposits in the banking system fall, which is an indication of a loss of faith in the financial system. The coefficient is economically large and strongly suggests that the institutional environment matters. There is also no difference according to whether the economy in the sample is an emerging market or not. Finally, the significance of the error correction term, that is, the residuals from the estimates of the equilibrium relationship between cash balances, income and the interest rate, represents a further confirmation of the existence of a long-run relationship between these variables. Therefore, changes in income and the interest rate generate compensating effects on cash balance holdings such that an equilibrium relationship is maintained.

Now, at least two objections can be levelled at the results so far.[25] First, if some societies, for a variety of economic and institutional reasons, hold larger amounts of cash on average over time, their short-run cash demand might respond quite differently to the drivers used in Table 1. Second, despite the addition of period fixed effects,[26] the

20 For example, data such as that which is reported in Figures 1 and 2 is only available since 2012. Similarly, data on the number of automated teller machines or connectivity to the internet is also available (for example, from the World Bank's World Development Indicators) but only for a sample that begins well after the first decade of the 2000s and is spotty for some G20 countries.

21 The usual strategy is followed to deal with at least some omitted variables. In particular, period fixed effects are added since some of the difficult-to-quantify factors will impact cash demand over time. The results discussed below also include a dummy variable that identifies the EMEs in the data set. Using fixed effects instead yielded almost identical results.

22 In keeping with fairly standard practice (for example, see Chen and Siklos 2021), both real income, proxied by real GDP, and the interest rate variable enter in log form (namely, more precisely, as log [100 + interest rate], where interest rate is in percent per annum).

23 Unless otherwise stated, the G20 consists here of 17 economies as euro-area data is used instead of separate data for France, Germany and Italy.

24 The same complications noted previously remain for the broad form of CBDC.

25 A third objection could be that the right-hand side variables are endogenous. Lagging these variables did not change the results much and taking into account endogeneity more formally.

26 This is done, in part, to account for factors that are not directly observed, or for which we have no data.

Table 2: Explaining the Demand for Cash in the G20 (1980–2020)

The Long Run

Demand for cash: Real currency balances	
Variable	Coeff. estimate (std. err.) [p-value]
Real GDP	1.03 (0.02) [0.00]
Interest rate	-0.06 (0.03) [0.07]
Observations	527
Cross-sections	17

Notes: Real currency balances are nominal currency (and coins where relevant) outside banks divided by the Consumer Price Index. Real currency balances and real GDP are in logarithms while the interest rate is log (100 + interest rate). Estimation is by weighted fully modified panel least squares with a constant and a deterministic trend (results not shown). A Parzel kernel and Newey-West fixed bandwidth are used to estimate the cointegrating regression covariances. Std. err. is the standard error of coefficient estimates; p-value is the statistical significance level of coefficient estimates.

The Short Run

Demand for cash: Rate of change in real currency balances					
	Full sample	Full sample right tail	Full sample left tail	1980–2007	2008–2020
Variable	Coeff. estimate (std. err.) [p-value]	Coeff. estimate (std. err.) [p-value]	Coeff. estimate (std. err.) [p-value]	Coeff. estimate (std. err.) [p-value]	Coeff. estimate (std. err.) [p-value]
Constant	0.96 (0.19) [0.00]	0.85 (0.22) [0.00]	1.49 (0.20) [0.00]	1.12 (0.18) [0.00]	0.14 (0.70) [0.84]
Real GDP growth	0.67 (0.12) [0.00]	0.74 (0.14) [0.00]	0.72 (0.16) [0.00]	0.77 (0.13) [0.00]	1.46 (0.21) [0.03]
Interest rate	-0.14 (0.04) [0.00]	-0.12 (0.04) [0.01]	-0.27 (0.05) [0.00]	-0.18 (0.04) [0.00]	0.06 (0.15) [0.69]
Size of sovereign debt default	0.001 (0.0004) [0.07]	0.001 (0.0001) [0.00]	0.001 (0.0001) [0.00]	0.001 (0.0004) [0.01]	-1.28 (1.32) [0.33]
Contract intensity	-0.31 (0.06) [0.00]	-0.30 (0.09) [0.00]	-0.24 (0.09) [0.01]	-0.28 (0.08) [0.12]	-0.41 (0.13) [0.00]
EMEs	0.006 (0.009) [0.53]	0.02 (0.01) [0.03]	0.01 (0.01) [0.56]	0.02 (0.01) [0.12]	-0.01 (0.02) [0.48]
Error correction (-1)	-0.25 (0.03) [0.00]	-0.25 (0.04) [0.00]	-0.22	-0.25 (0.03) [0.00]	-0.32 (0.05) [0.00]
Period fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	476	297	297	297	179
Cross-sections	17	17	17	17	16
Adjusted R2	0.31	0.21	0.25	0.36	0.17
F-stat.	5.83 [0.00]	n/a	n/a	28.43 [0.00]	7.25 [0.00]

Notes: See long-run table for estimation method and coefficient estimate information. Size of sovereign debt default is sovereign debt defaulted as a percent of GDP. Contract intensity is $(M2\text{-}C)/M2$ where $M2$ is a broad monetary aggregate measure and C is currency in circulation. EME is a dummy variable taking on the value of one for the EMEs in the sample. The number of cross-sections and observations is shown in the long-run table. Period fixed effects are not shown, and test indicating that they are not redundant is shown above with degrees of freedom in parentheses and p-value in square brackets. Error correction is the residuals from the long-run table regression lagged one period. The right tail refers to the 75 percent and above quantile of real cash balances held; the left tail is the 0–25 percent quantile of real cash balance holders in the G20 economies considered.

GFC represents a large financial shock that may also have altered how cash demand responds to the variables assumed to affect it. Accordingly, the remaining columns in the bottom portion of Table 1 consider how the demand for cash at the high and low ends of the cash-holding spectrum are affected by its determinants. The final two columns examine the case where the sample is broken down into pre- and post-GFC periods (i.e., 1980–2007 and 2008–2020). The results suggest that income's impact on cash demand is not terribly sensitive to which portion of the distribution of cash holdings one considers, or if the pre-GFC period is considered in isolation. However, cash demand rises considerably less (the difference is statistically significant; test result not shown) in the post-GFC era relative to all the other cases considered. There is considerably more sensitivity in the short-run relationship between interest rates and cash demand. Those countries where cash holdings are higher than average are significantly less sensitive to an interest rate change than where cash holdings are relatively smaller in the spectrum considered. Moreover, while interest sensitivity is comparable at the higher end of the cash-holding distribution when looking at the full sample estimates (first column) and the pre-GFC era, interest sensitivity disappears, statistically speaking, post-GFC. The last result is not entirely surprising as this is also the era of ultra-low interest rates that began in AEs and spread throughout the world. Most of the other results remain largely unchanged, but it is noteworthy that contract intensity is considerably higher in the post-GFC era and almost as large as the impact of income on the demand for cash. At the risk of some oversimplification, the post-GFC era may have raised, at least across the G20 as a group, the relative importance of the institutional environment in dictating the demand for cash. Policy makers may wish to take this into account when thinking about how to introduce CBDC and the form it will take.[27]

The foregoing results clearly suggest a link between the demand for cash and the trust that societies place in the monetary authorities and, by implication, governments. After all, it bears repeating that, despite central bank independence, monetary authorities derive their power from government since they are an institution within, and not apart from, the political authorities. Hence, even if the public has confidence in the central bank, trust in government and governance considerations also loom large. This is especially true in the case of CBDC as we shall see in greater detail. However, for the time being, it is worth further underscoring the importance of the trust and governance by asking what the state of play is in the G20 around these two factors. Accordingly, Figure 3 considers how levels of overall trust in governments have changed since 2011 as measured by an annual survey since 2006 conducted by the Organisation for Economic Co-operation and Development (OECD).[28] Since not all G20 members are surveyed by the OECD, additional data from the World Bank (see Figure 4) is used to construct a proxy for trust. Consequently, some of the data must be treated with caution.[29]

Positive values for the bar chart indicate that a rising proportion of the population surveyed trusted governments over the 2011–2020 period. Crucially, the sample includes the first year of the COVID-19 pandemic but excludes the fallout from the GFC of 2008–2009.[30] Figure 3 reveals that levels of trust have risen in most countries surveyed, despite an eventful period both economically and politically. That said, there is considerable heterogeneity in performance across the G20. Equally important improvements in trust are not exclusively restricted to AEs or EMEs. Of course, changes in trust, while necessary, are not sufficient. It is also important for levels of trust to be high, especially when a change in the order of magnitude as CBDC rests on trust. That said, levels of trust are just as heterogeneous in 2011 and again in 2020 as suggested in Figure 3.[31]

Unfortunately, surveys such as the one reported in Figure 3 are not informative about the sources of trust, that is, the degree to which governance and accountability play a role. Figure 4 then offers a

27 Depending on the regulations and transactions costs, this result will also have implications for the public's ability to substitute digital currencies. This is an issue beyond the scope of this paper.

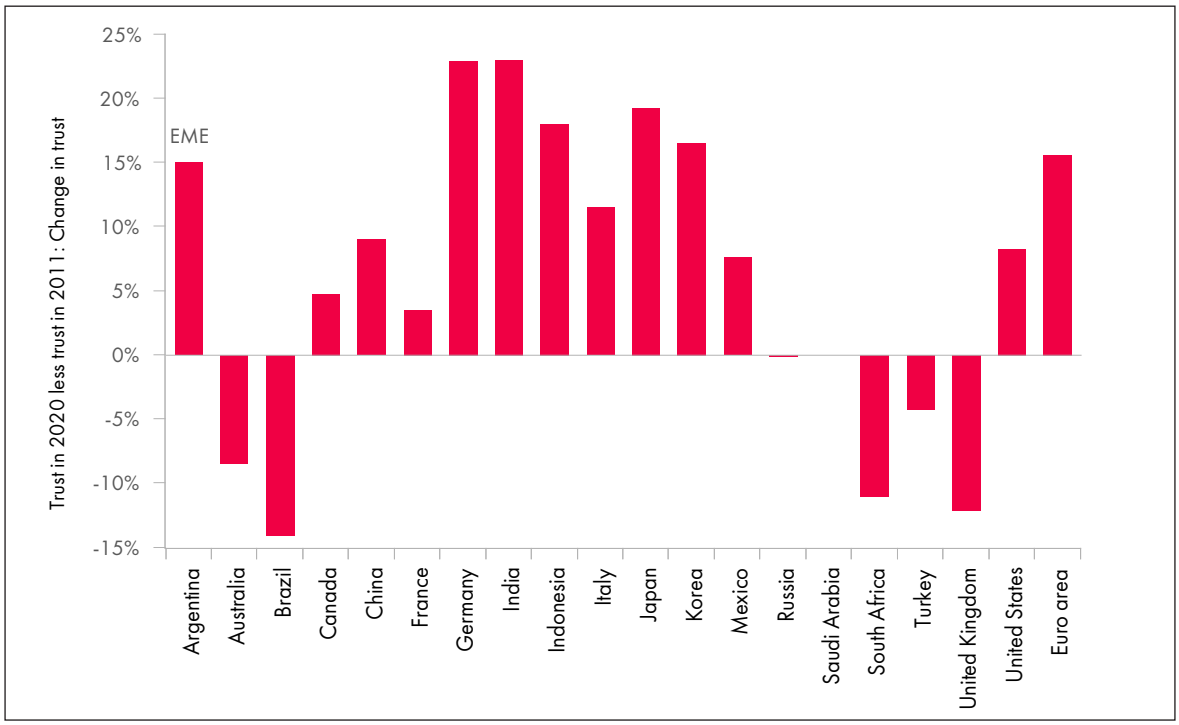
28 The OECD views integrity, fairness and openness of institutions as being reflected in the trust citizens display toward government. See www.oecd.org/gov/trust-in-government.htm for details.

29 The proxy is used for Argentina, China, India, Indonesia, South Africa and the euro area. There was no data for Saudi Arabia for 2011.

30 That is, if we assume that the impact of the GFC on trust in government dissipated by 2011.

31 For example, in 2011, levels of trust (i.e., percent of respondents that expressed trust in government) ranged from a low of 23 percent (Japan) to a high of 74 percent (Indonesia); in 2020, respondents in Brazil expressed the least amount of trust (36 percent), with Indonesia again ranked highest (92 percent).

Figure 3: Change in Trust in Government (2020 versus 2011)



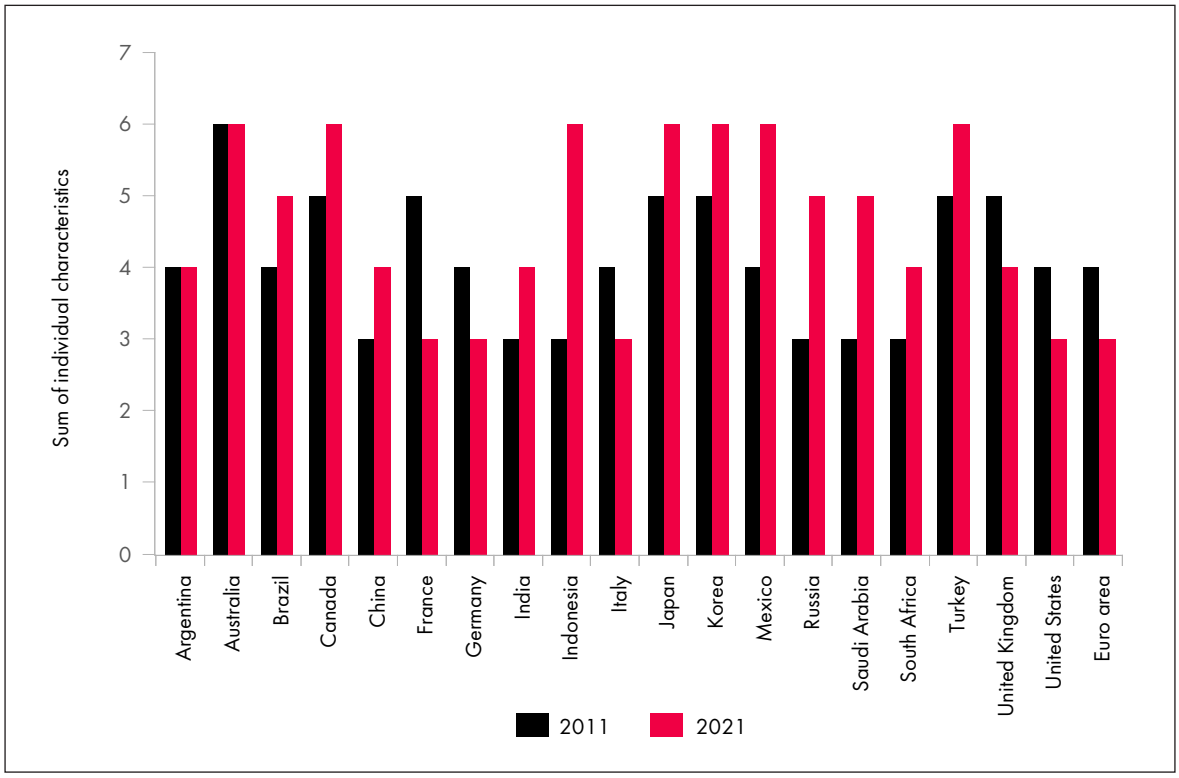
Source: Data is from the OECD Trust in Government survey in which respondents were asked whether they trust their governments (see www.oecd.org/gov/trust-in-government.htm for data and definitions).
Notes: Levels of trust in 2020 less levels in 2011. A positive number means a rise in trust in government (i.e., levels higher in 2020 than in 2011); negative values imply a loss of trust in government. In the case of Argentina, China, India, Indonesia, South Africa and the euro area, an index was constructed from the indicator described in Figure 4. The sum of the individual characteristics was converted to a value ranging from 0 to 100, and the change between 2020 and 2011 is seen as a proxy for the change in trust in government.

snapshot of levels of governance and accountability as defined by characteristics identified within the financial sector. This strategy is adopted since acceptance and success of retail CBDC will be influenced by the confidence the public has in supervision, oversight and consumer protection in dealings with the financial sector. The good news is that institutional improvements are apparent in 12 of the G20 economies. Moreover, several countries are close to the maximum attainable score. The bad news is that a deterioration is seen in three of the arguably four systematically important economies, that is, the United Kingdom, the United States and the euro area. In the case of the United Kingdom, the source of the deterioration is due to a change in the number of agencies responsible for prudential supervision of banks; in the United States and the euro area, it is due to changes in the body responsible for macroprudential supervision. As a result, the appeal of narrow CBDCs issued by the world's two most important central banks may be negatively affected, although it is unclear whether the public is attentive enough to these developments.

An obvious criticism of the data shown in Figure 4 is that it is too narrowly focused on the financial sector and, especially, selected oversight and prudential elements. Therefore, Table 1 asks whether the volume of cashless payments over the 2012–2018 period (see also Figure 1) for which data is available, is driven, in part, by governance considerations more generally. Governance indicators from the Fraser Institute are used with controls for the group of economies in question and the fraction of the populations using the internet.[32] It is notable that the legal environment (Legal) and financial openness (Finopen) are highly significant and contribute to raising the

32 Since the sample is small, there are limitations on the number of controls one can include and, in addition, period fixed effects are added to absorb other controls that might be omitted.

Figure 4: Governance and Accountability of Government Agencies (2021 versus 2011)



Source: Annual data from the 2021 update of the 2019 database and the 2011 database from the World Bank's Bank Regulation and Supervision Survey (see www.worldbank.org/en/research/brief/BRSS).
Notes: The height of the bars is determined by scores on the following six questions: What body/agency supervises banks for prudential purposes? Has a banking supervisory agency mandate been written? Are financial system responsibilities included in the mandate? Is an integrated financial supervisory agency covering all significant financial institutions? Is a banking supervisor responsible for macroprudential supervision? What body is responsible for financial consumer protection laws/regulations? Each question receives a score of one or zero, except for one question where the score ranges from zero to two. The maximum score is seven; the minimum score is zero. See the appendix for the questions used in constructing the index. The higher the number, the more attributes a country has.

intensity with which the population resorts to cashless payments. The former highlights, once again, privacy and security concerns while the latter reflects the potential of cashless payments to transform cross-border payments.

It will be noted, of course, that there is no consensus in these areas about what constitutes best practice. There is likely an element whereby the same institutional environment will not suit all countries, especially ones as diverse as those in the G20. Indeed, cross-country diversity may be welcome, but since CBDCs are expected to potentially disrupt cross-border money flows, the roles of governance and accountability will be critical to its success.

CBDC and Central Bank Mission Creep

Both governance and accountability matters were instrumental in the transformation of the role and influence of central banks since the late 1980s as evidenced by the global rise in the autonomy and transparency of central banks. It seems that these features are similarly important in carrying out plans to roll out CBDC. However, unlike these earlier developments, which led to a narrowing of the mission of central banks to primarily maintain

a form of price stability,[33] the GFC led many governments, either informally or explicitly, to add to the burden of central banking by requiring them, either explicitly or implicitly (for example, see Lombardi and Siklos 2016) to add the mandate of financial stability. Accusations of central banks being overburdened are already commonplace (for example, see Orphanides 2013; Siklos 2017). CBDCs threaten to add to the burden of central banks unless there is clarity of the scope and limits of their authority since, as noted above, digital forms of money raise questions that are beyond the usual remit of monetary policy. Monetary authorities around the world appear keenly aware of the risks (for example, see Borio 2019), but they have left, or are hoping that governments will provide guidance and clarify their responsibilities.

At the global level, central banks are also confronted with a private sector keenly interested and involved in digital payments together. There is also an acknowledgement that public-private partnerships are likely crucial in delivering CBDC domestically and for cross-border transactions, and this further complicates the governance and accountability considerations with consequences for public trust. In some respects, the prospect of a central bank partially dependent on private sector behaviour is not new. The responsibility to maintain financial system stability has often led to the accusation that central banks face a moral hazard problem since it is not in their interest to let banks fail. Indeed, a mandate to prevent the occurrence of financial crises has arguably led some central banks (namely, the US Federal Reserve) to intervene beyond the conventional banking system to forestall contagion-type effects from the non-banking sector with links to the financial system. Not surprisingly, monitoring of so-called non-bank intermediation (i.e., shadow banks) has become important since the GFC, with institutions such as the FSB reporting on the financial stability threats from such institutions. Digital money has simply created a new type of shadow financial institution, namely, crypto banks (for example, see Lipton and Livni 2021), whose links with conventional banks are raising financial stability concerns among policy makers (for example, see Coeuré 2021). More generally, the asymmetry between a regulated banking sector threatened by the emergence of retail forms of CBDC and the insufficiently regulated and supervised non-bank financial sector is an additional source of alarm about the prospects of the maintenance of financial stability (Carstens 2021).

Trust is especially important to central banks, so the prospect that retail CBDC can dilute accountability is a risk. This prospect stems from the necessity of the monetary authority to trust the private sector to assist in ensuring the usage and acceptance of CBDC. Central banks may be blamed, fairly or not, for failures of the kind that often plague internet service providers if these threaten the availability or reliability of retail CBDC or the completion of transactions in real time. Another institutional risk stems from central banks having to work cooperatively with other government agencies to guarantee that the public's rights, privacy and security in their financial dealings are protected. An additional risk originates from the potential for CBDC to serve not only as an additional instrument of monetary policy but also one that is viewed as a fiscal instrument. Indeed, it is but a short step from the potential for retail CBDC's deployment, for example, as an instrument to transfer income to certain segments of the population to asking central banks to contribute more formally to reducing income inequality by taking on additional responsibilities in the digital realm. Income inequality is not the only type of economic imbalance. If current inflationary pressures prove persistent, then CBDC could also be viewed as a device to index against losses of purchasing power.[34] The so-called digital divide, both within countries as well as across countries, is also relevant if digital forms of money eventually completely, or almost, replace traditional means of payments. Some suggestive evidence is provided below.

The blurring of fiscal and monetary policies that began with the GFC, in the form of the collection

33 As former Bank of England governor Mervyn King once said, even central banks that are mandated to achieve an inflation target are not "inflation nutters" (King 1996). Stated differently, central bankers will point out that there is no conflict between inflation control and being concerned with real economic developments as in central banks (for example, the United States) with a dual mandate (i.e., inflation control while maintaining maximum employment). Of course, this has not prevented some academics from arguing that a focus on inflation can be detrimental to ensuring that real economic growth achieves potential (for example, see Stiglitz 2008).

34 This possibility brings to mind the debate in the 1970s over indexing against inflationary losses. See, for example, Nelson (2018). Figure A8 in the appendix plots inflation for several AE G20 members. Unless one thinks that the period of the 1970s and early 1980s is unique, inflation is persistent whether it is low or higher than the 1–3 percent inflation range adopted by many banks, formally or implicitly.

of monetary policies referred to as UMPs, may be exacerbated in a world where CBDCs also circulate. Indeed, Sweden's central bank, the Riksbank, has acknowledged that retail CBDC's introduction is also a political decision because its presence "is one that will affect the whole of society and,...the decision on whether to introduce an e-krona in Sweden is a political one."[35] Best practice calls for monetary and fiscal policies to jointly operate in a coherent manner, but there is discomfort with UMPs in some quarters and their continued deployment,[36] first as a result of the GFC and, more recently, with the onset of the pandemic. This suggests that the existing "contract" between central banks and government needs to be reconsidered, or at least clarified. Indeed, the number of contracting parties concerned needs to be broadened to include other government agencies that will play a role in ensuring not only financial stability but also the other elements relevant for the introduction of CBDC (i.e., security, privacy) where central banks are not especially equipped to be accountable for, or able to carry out providing, the additional elements required to successfully launch CBDC. Stated differently, legislation that defines the responsibilities and accountability of individual institutions impacted by the introduction of CBDC may not be enough. A new understanding of the relationship and functions of the various entities accountable to government is required.[37]

To the above threats and risks, one needs to add those that are technological or climate change related. The former need to be considered because digital transactions require a stable and reliable infrastructure; the latter because of the broader economic risks from weather-related changes and the surge in electricity demand, particularly if, at a technical level, CBDCs eventually have some of the features of bitcoin or cryptocurrencies more generally. It should be stressed that most central banks are not planning to rely on using the verification systems associated with bitcoin; they would rely instead on a centralized system commonly used to currently settle some digital transactions.[38] Jon Huang, Claire O'Neill and Hiroko Tabuchi (2021), for example, show that bitcoin electricity usage exceeds the consumption demand experienced in entire economies in the advanced world. Other researchers have raised similar concerns, among others, including worries over mission creep (for example, see Hansen 2022; Engle 2021). These developments also come at a time when central banks have entered the debate about "green" economic and financial initiatives, leading some to suggest that monetary authorities risk being further overburdened to the extent that new forms of interventions in financial markets are created and expectations are raised that monetary policy should aim to assist in mitigating climate risks versus encouraging the financing of environmentally friendly processes. Unfortunately, whereas central banks have understandably begun to explore the economic and financial costs of climate change, there is little evidence that political authorities who, ideally, share responsibility for defining the mandate of central banks,[39] have acknowledged a link between climate change and attainment of monetary policy objectives. Instead, the case has typically been made by central banks themselves such as when the ECB revised its monetary policy strategy in 2021 (for example, see Schnabel 2021). The respective responsibilities of the political authorities are ordinarily not spelled out.

Beyond the potential impact of technological and climate-related issues is the added complication that the distribution of technological and climate-related incidents is highly unevenly distributed

35 See www.riksbank.se/en-gb/payments–cash/e-krona/. Political motives are especially important since resistance in Sweden to digital money originates with the older members of the population who have expressed concerns over this development. Nevertheless, it is likely that the pandemic has lessened overall resistance to frictionless modes of payment. Together with the younger generation's embrace of the digital economy, this movement will create political pressure to introduce some form of CBDC.

36 See Lombardi, Siklos and St. Amand (2018). Fabo et al. (2021) have suggested that central bank researchers are more likely to find evidence favourable to UMPs than independent researchers.

37 Whether this requires legislation, or a memorandum of understanding, will be country dependent.

38 An illustration is the Swedish Riksbank's e-krona pilot project (see www.riksbank.se/en-gb/payments–cash/e-krona/technical-solution-for-the-e-krona-pilot/). Also, see Shah et al. (2020) on the variety of verification systems that are contemplated and the comparative advantage of a centralized system. A reviewer points out that energy consumption associated with bitcoin stems from the process of mining to introduce new ones into circulation. Although this is less frequently mentioned, sustainability issues may also play a role in the selection of a verification system.

39 In other words, the presumption is that society is better off if the mandate and accountability of the central bank is a joint responsibility of the government and the monetary authority.

across the G20.[40] Since the associated risks to the financial system are likely substantively different across the G20 and, by implication, the potential burden on institutions including central banks, it is not only the overburdening of central banks that is in question but also the prospect that the weight of responsibilities on the monetary authorities will be unevenly distributed among the G20 membership.

Ultimately, the foregoing risks depend on the precise responsibilities of central banks. Just as there need not be a unique model of regulation and supervision of the financial sector, there are alternative institutional arrangements that determine the scope of the tasks for which central banks will be accountable. Nevertheless, mission creep is potentially exacerbated by the prospect of CBDC. However, unlike the mission to maintain price and financial stability, arguably justified by historical experience, the connection between CBDC and a host of other issues mentioned previously that lie outside the usual purview of central banks, create the possibility of central bank overreach with the risk of an irreconcilable tension between good economic governance and democratic accountability.

The Shape of Things to Come

The prospect of a CBDC raises questions that are diverse enough to ask whether existing forms of governance are adequate to meet the upcoming challenges. Of course, no single governance framework is right for all countries or at all times. That said, current governance frameworks generally operate on the following principles. Monetary authorities are ordinarily statutorily responsible for the maintenance of price stability or are required to meet a dual objective, which adds seeking to achieve full employment or exchange rate stability (for example, see Mahadeva and Sterne 2000). There are, of course, some differences in the manner in which statutory objectives are defined precisely and revised over time. However, the dominant strategy involves the government and the central bank jointly reaching an agreement about the specifics that may or may not involve a regularly scheduled assessment and revision of existing mandates. Precisely how these objectives are arrived at will also, of course, vary across countries and over time. Nevertheless, all of the existing arrangements have in common that the central bank ultimately answers to government.

Matters became more complicated since financial stability concerns came to the forefront in the aftermath of the GFC. Although a core function of all central banks is the lender of last resort function, which provides a lifeline for certain financial institutions in the event of a liquidity or confidence crisis, financial stability as such was, and continues to be, ill-defined as are other aspects of the rules of engagement when it comes to interventions in the financial system (for example, see Lombardi and Siklos 2016; Gadanecz and Jayaram 2008). Prior to the GFC, the focus was on the behaviour of individual institutions and the need to protect the financial system more generally because the public might confuse an isolated financial problem with one that is systemic in nature (i.e., the bank run problem). The lender of last resort function is meant to prevent wider spillover effects from a problem at the individual institutional level. However, the GFC has resulted in a large expansion of central bank interventions in financial markets, and it has given the impression that the lender of last resort function is replaced with a "whatever it takes" strategy to shield the financial system from large shocks that not only threaten its smooth functioning but also economy-wide performance, including inflation.[41] More than a few observers have argued that some elements of UMP are *ultra vires*. Indeed, court cases continue to challenge many of these interventions (for example, as in the case of the ECB; see Siklos 2020 and references therein). In other instances (for example, the United States), these kinds of concerns have threatened the role and policy delivery of central banks.[42]

40 Data relegated to the appendix shows the number of cyberattacks in G20 countries between 2006 and 2020. There is, perhaps unsurprisingly, a wide gulf between the United States (156) and eight other countries with fewer than 10 recorded cyberattacks (Argentina, Brazil, Indonesia, Italy, Mexico, Russia, South Africa and Turkey). Another source that records "technological" disasters stemming largely from transport and industrial disasters also sees a large gap between countries such as China (951), India (753) and the United States (232) over the 1980–2020 period.

41 Perhaps the most famous example of the "whatever it takes" formula to deal with a financial crisis is former ECB president Mario Draghi's promise to save the euro from collapse and his conviction that "believe me, it will be enough" (Draghi 2012).

42 This has, so far, taken the form of bills proposed in Congress that have yet to be passed such as H.R.24 — Federal Reserve Transparency Act of 2021 and H.R.6741 — Federal Reserve Reform Act of 2018.

In any case, most arrangements post-GFC rely on one of two models. In one case, the burden of the central bank is increased by the addition of the requirement to maintain financial stability together with the traditional monetary policy objectives. The concept of financial stability is usually left imprecisely defined, and it is usually up to the central bank to determine whether financial instability exists when it sees it and then to act to mitigate its impact.[43] The other model has the central bank sharing responsibilities with another institution, which is often responsible for the *micro*prudential elements that might threaten financial stability while coordinating with the monetary authority that retains some powers in the *macro*prudential sphere. It is not unheard of for some of the macroprudential instruments, in particular, to be the responsibility of governments.[44] Hence, one can imagine this kind of governance to be akin to a pyramid with government at the top of the pyramid and the central bank and the financial stability authority (FSA) forming the base of the pyramid. It is expected that the institutions at the base of the pyramid either coordinate or, at the very least, cooperate closely to ensure that financial stability conditions are met. This arrangement recognizes that while monetary policy and financial stability objectives are complementary, they are best jointly achieved through a separation of the accountability to meet the twin objectives. To repeat, country-specific considerations will dictate the extent to which the institutions at the base of the pyramid are equal partners.[45]

Elsewhere, the governance structure resembles more a tower with the government at the top, followed by the FSA and then the central bank. The FSA is expected to coordinate with the central bank, with the latter ultimately responsible for delivering both monetary policy conditional on the maintenance of financial stability. In this scenario, the central bank is effectively first among equals since, in effect, it sits as the foundation of institutions responsible in the financial sphere.

Despite the differences in governance arrangements described above, both models generally have one thing in common, namely, that monetary and fiscal policy are separate while best practice is supposed to ensure that they operate in tandem. The horizon over which monetary and fiscal objectives are expected to be met can, of course, play a role in how well monetary and fiscal policies interact with each other. The usual narrative has the political authority discounting the future at a rate higher than the central bank. However, as politicians in most parts of the world came to accept price stability as the *sine qua non* of monetary policy, and the choice of monetary policy regime is supposed to be a joint responsibility,[46] the only convincing differences in discount rates that are left are the relatively longer terms of office of central bankers.

The introduction of CBDC complicates matters in at least two ways. First, to the extent that CBDC is a device that is tantamount to creating the possibility of introducing "helicopter" money (the notion that the central bank can just print money and drop it on the public as if by helicopter), the blending of fiscal and monetary policies threatens to become more explicit than the public is used to. Even if CBDC is used as a monetary policy instrument that is able to largely replace conventional notes and coins, then, via negative interest rates, it may serve as an alternative device to deliver UMP. There are plenty of central banks that have resisted using negative interest rates in the aftermath of the GFC (notably, the United Kingdom and the United States), while the evidence that interest rates below the zero threshold can be effective in boosting lending, and economic activity more generally, is mixed to negative (for example, see Brandão-Marques et al. 2021).

43 As with monetary policy, a forward-looking view of the maintenance of financial system stability ideally requires the central bank to act pre-emptively. Indeed, central banks often touted this approach as critical for delivering sound monetary policy (for example, see Siklos 2017). The philosophy appears to have changed with the most important central banks willing to let inflation rise above target before significantly tightening monetary policy. In the case of financial stability, there has similarly been a debate between the so-called Greenspan view of the world, which prefers to pick up the pieces after a financial crisis, assuming the central bank focuses on stability in inflation and economic activity, versus the pre-emptive approach to dealing with impending financial instability. See, for example, Bernanke and Gertler (1999) versus the more proactive attitude in Borio and Lowe (2002) and Cecchetti et al. (2000).

44 Canada is one example where the Department of Finance retains the levers over important macroprudential concerns in the housing market.

45 Thus, for example, prior to the GFC, in the United Kingdom, the Bank of England and the FSA, as it was then called, could be thought of as equal partners. Following the financial crisis, the authority over monetary and financial stability policies was merged with separate but equal policy committees but under the authority entirely of the Bank of England.

46 One might say that the more cynical view of politicians had them exploiting the Phillips curve trade-off since their objective function differed from the ones central bankers have in mind. This idea is reflected in the time inconsistency made famous by Finn E. Kydland and Edward C. Prescott (1977). Alternatively, the ideal central banker would be more conservative than the politicians (or the public) to ensure against excessive inflation and economic activity (Rogoff 1985).

Negative rates must also contend with an environment where central banks will have to deal with private sector forms of money in the form of stablecoins and cryptocurrencies more generally. Whether the burden is shared or not with governments or other institutions, the resulting mission of central banks will become more complex. Regardless of the outcome, the "contract" between the government and central banks will require rewriting. In principle, the challenges can be overcome by focusing on two elements of central bank legislation, namely, limitations of lending to the government and the financial independence of the monetary authority that were considered central components in the early years when central bank independence was believed to be the standard of best practice in governance matters (for example, see Cukierman 1992).

Arguably, areas where legislative fixes are much less straightforward, yet critical to the success of CBDC, are the digital divide among G20 countries and gaps in the confidence of the public concerning technological developments and in institutions more generally. Figures 5 and 6 help make the point. Figure 5 displays a metric that seeks to quantify the digital divide among the G20 countries since 2014. Figure 6 relies on a worldwide survey that measures the wider public's attitude about technology and their confidence in institutions more generally. Unfortunately, the survey does not specifically ask about trust in central banks.[47]

The data in Figure 5 is arranged in such a fashion that the higher the bar, the less digitally evolved an economy is. Because cross-border transactions are believed to be an essential ingredient of future CBDC success, the digital divide is sufficiently large to give the AEs in the G20 a large advantage a priori in facilitating the global deployment of CBDC. Some might argue that legal tender legislation, which is presently inadequate (for example, see Siklos 2021), might be used to shield countries that are digitally less sophisticated than the rest. Even if this is the case, the digital divide is likely to be a source of tensions in the G20. At the very least, multilateral institutions will be required to play an important role. Hence, international cooperation, at a time when this is in short supply, is essential but will be tested as CBDCs are introduced. This will also have implications for sovereignty. Perhaps a global framework of sorts, that is, one that mirrors the Basel standards, is the solution. Nevertheless, a regulatory standard is unlikely to be enough since closing the digital gap will also require infrastructure expenditures that are the exclusive purview of fiscal policy. Therefore, whereas G20 political leaders recognize that cooperation plays a "key role…to make use of the growth opportunities of digitalisation" (G20 Research Group 2021), competitive pressures will also lead each member to advance their own position in the race.

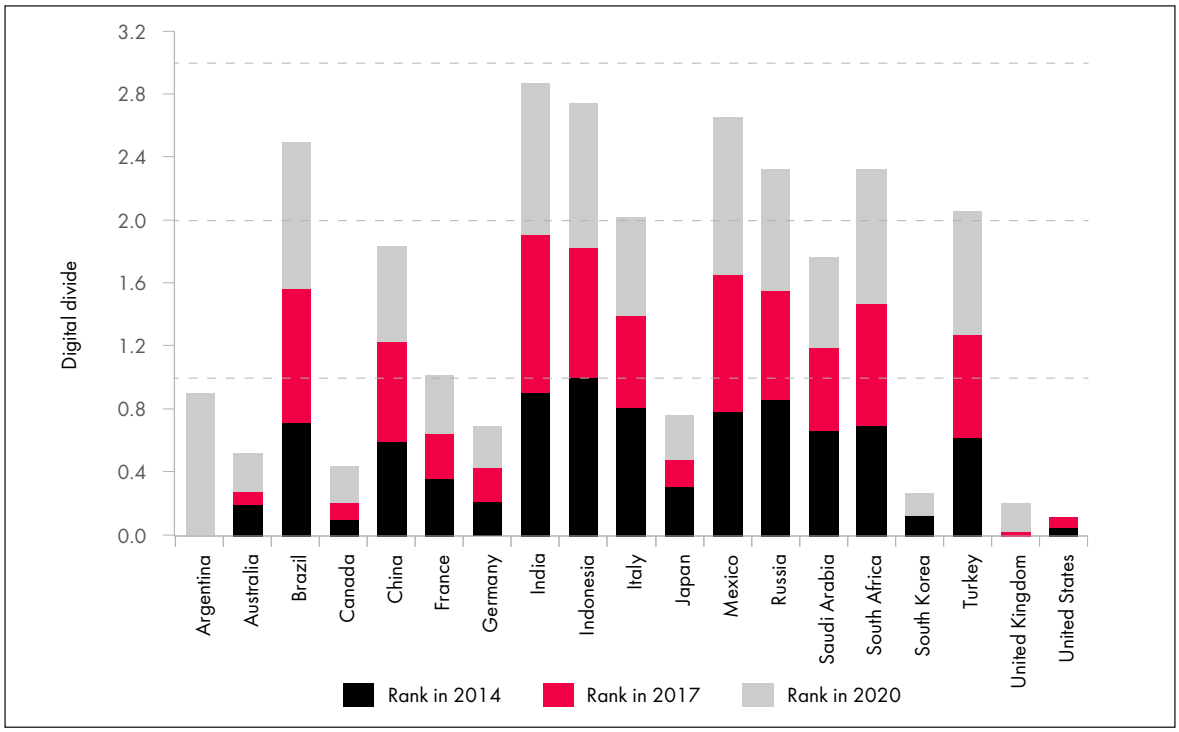
Figure 6 explores the public's perceptions of technology and government institutions as measures by the latest World Values Survey.[48] Four dimensions are considered so that we can obtain a broad perspective on the role of technology, especially since this is at the heart, of course, of CBDC. The good news is that, for the countries where the data is available, the future of technology is viewed in a largely favourable manner, although China stands out in this regard from the other countries surveyed. A gap and a challenge begin to emerge when we consider that respondents in China and Indonesia largely view the monitoring of digital content favourably. In contrast, elsewhere in the G20, a substantial majority of the public does not view digital monitoring in a favourable light. While central banks have generally recognized the potential difficulties in ensuring the acceptability of CBDC and the work that needs to be done, governments have been largely silent.

Since the acceptability and usage of currency, digital or otherwise, rest with the public's trust in government, it seems sensible for them to shoulder much of the burden with other institutions, not the central bank, left as guarantors of the security and privacy of CBDC. The challenges should not be underestimated. Indeed, as shown in the bottom-left bar chart in Figure 6, the majority of respondents do not have confidence in banks, major companies and government in most G20 countries. China, Indonesia and, to a lesser extent, Turkey are exceptions. It is especially interesting that EMEs are more likely to evince trust in the institutions considered, and this may be explained, at least in part, by the improvement in macroeconomic and

47 The closest survey that exists, which polls the public's trust in a central bank, is the Eurobarometer survey (see https://europa.eu/eurobarometer/screen/home). The survey includes a question asking whether the public trusts the ECB. The evidence to date (for example, see Bergbauer et al. 2020) suggests a gradual but persistent reduction in trust since the GFC, with a far from complete recovery beginning at the end of 2017 when overall economic prospects began to brighten.

48 See www.worldvaluessurvey.org/wvs.jsp.

Figure 5: Digital Divide in the G20



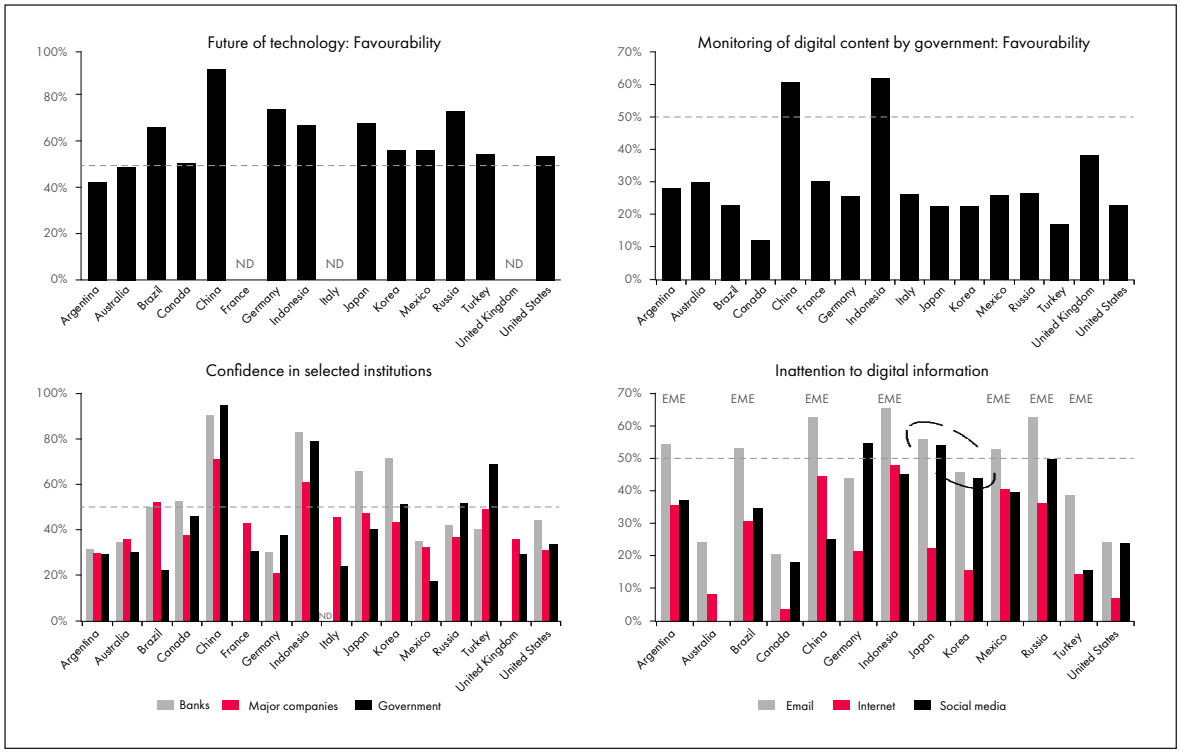
Source: Chakravorti et al. (2020).

Notes: The G20 consists of 19 sovereign countries whose names are listed on the horizontal axis. Using the authors' digital evolution indicator generated for a large number of countries (50 in 2014; 60 in 2017; and 90 in 2020), countries were ranked from least (highest rank) to most (lowest rank) evolved or advanced in 2014, 2017 and 2020. For some countries (Argentina), no data was available for 2014 and 2017. To ensure comparability, the relative rankings were normalized using $(X\text{-}Min(X))/(Max(X)\text{-}Min(X))$, where X is the original ranking, and *Min* and *Max* are the lowest (i.e., one) and highest (i.e., depending on the number of countries surveyed) ranks. The higher the bars, the less digitally evolved an economy is. The appendix provides a graphical representation of how digital evolution is evaluated. Also, see the main text for additional details. The horizontal dashed lines are drawn for values of one, two and three. Normalized rankings range from zero to one in any given year but add up to a maximum of three over the three years the survey was conducted.

financial performance of many EMEs (for example, see Bordo and Siklos 2021). In contrast, considerably less trust is in evidence in AEs and, in particular, in economies where CBDCs are likely to play a global role (i.e., UK, US and euro-area economies).

Another challenge emerges from a gap that is apparent between central banks and financial markets that are devoting more and more attention to digital forms of money while the public appears largely inattentive to digital information. There are vast differences shown here: the countries where confidence in institutions is relatively high are also the most inattentive to information delivered in this form. The challenge, then, in AEs is for governments and central banks to overcome lack of trust in institutions while in several EMEs, the challenge will be to educate the public to explain the promise of CBDC and prevent a loss of confidence in the institutions that will rely the most on digital transactions technologies. These considerations go well beyond the contract between the central bank, regulatory institutions and governments. Writing a new contract with a governance structure that suits the country in question is a necessary condition in a world with CBDC, but it is not sufficient.

Figure 6: Confidence Gaps and Digital Challenges across the G20



Source: World Values Survey (see www.worldvaluessurvey.org/WVSDocumentationWV7.jsp).
Notes: The upper-left figure shows the percent of those surveyed in the countries listed on the horizontal axis who view favourably future technological developments. The upper-right figure shows the favourability response to digital monitoring by government. The lower-left figure shows the percent of respondents who have confidence in the select institutions shown in the legend below the figure. The lower-right figure shows the percent of respondents who are inattentive to (i.e., do not pay attention to or ignore) forms of digital information shown in the legend below the figure. EME identifies emerging market economies in the sample of G20 countries. The horizontal dashed line is drawn at 50 percent.

Conclusions and Policy Recommendations

CBDC as a digital alternative to notes and coins ought to simply represent the latest in the evolution of money over the past few centuries (for example, see Bordo 2021). Behind the simplicity, however, lies a series of complications that extend far beyond the traditional role and mandate of central banks. Indeed, the imminent introduction of CBDC is a touchstone for much bigger societal questions, including privacy, security of financial transactions and the sphere of influence of governments, not to mention how fiscal and monetary policies will work together. While policy makers are aware of the broader issues, it appears that CBDC will be introduced well before many of the governance-related questions, in particular, have been addressed. These developments risk repeating the well-known phenomenon whereby regulation and supervision are lagging indicators of financial innovations.

After a review of the drivers of cash demand, the paper considers whether CBDC increases the potential for further overburdening central banks. The straightforward answer is in the affirmative. Next, the main governance models where central banks play a role are summarized, the implications once CBDC are introduced are considered and potential solutions are suggested. For example, since CBDC has the prospect of transforming cross-border transactions, it is argued that the same forces that led to the creation of the FSB could be marshalled to ensure that cross-border retail CBDC does not threaten monetary policy

or financial stability objectives globally. Indeed, one of the principles for the introduction of CBDC outlined by the Group of Seven (G7 Research Group 2021) is the mitigation of any cross-country spillovers while striving for the global interoperability of systems and arrangements.

Domestically, policy makers must guard against giving even more power, deliberately or by default, to central banks that still grapple with how to simultaneously maintain price and financial stability. Unfortunately, as this paper makes clear, the introduction of retail CBDC is likely to place even more responsibilities on the central bank. How monetary authorities will define transparency and accountability in a world with CBDC that generates the production and potential dissemination of even more private financial information has yet to be addressed.

Finally, the neat division between fiscal and monetary policy can be blurred by the introduction of CBDC, which can be used as a new device to transfer financial resources to the public. In principle, this challenge can be overcome by ensuring clarity and limits to the fiscal authorities' ability to tap monetary policy to deal with, say, ongoing inequality. Stated in different terms, the usual contract between central bankers in place since the late 1980s, which narrowly defined the mandate of central banks in return for greater accountability, transparency and autonomy, needs revisiting. The author has argued that, while revised statutory arrangements should be country specific, all governance arrangements must have adequate and credible checks and balances. Otherwise, the success and impact of CBDC will be threatened.

The usual argument is that the G20 is simply too diverse a group for any optimism in cooperative behaviour to address large problems. That said, the group has been able to deliver some successes, such as its response in the face of the GFC and, more recently, the COVID-19 pandemic, although the outcomes have not been unalloyed successes. The good news is that, in the area of digitization, the traditional differences between AEs and EMEs no longer appear to hold. Moreover, institutions such as the FSB are providing an understanding of existing regulatory and supervisory gaps (FSB 2020), although a so-called road map currently looks more like a wish list. Nevertheless, a significant digital gap exists. Finally, the potential implications arising from the introduction of CBDC do not appear on the radar of the public, which is preoccupied with pandemic- and climate-related problems. Central banks, in particular, but governments, more generally, need to educate the public more aggressively for the changes to come. Otherwise, the spread of CBDC risks becoming the next economic shock.

Given the various challenges facing policy makers, how should the road ahead be designed? The potential for disintermediation, combined with the rise of decentralized finance (DeFi, as it is often referred to), means that traditional financial intermediaries are faced with potential competition on two fronts. The first area for competition is the potential for central banks to deliver a form of digital money that earns interest. Since central bank money is considered a safe asset, this poses risks to the conventional banking system. The growth of DeFi, on the other hand, offers an opportunity for non-financial firms to mimic some of the services offered by the traditional financial intermediaries without many of the regulations and supervision they must adhere to. These forces suggest that monetary authorities should, at first, consider introducing only the narrow form of CBDC. Matters are less clear concerning whether CBDC should be account-based or tokens. While the latter offers greater privacy, the former does have some advantages, for example, in mitigating corruption and possibly enhancing the role of intermediaries who are entrusted with supporting the CBDC system. Second, since even narrow CBDC has the potential to impact the economy beyond simply looking at the central bank's balance sheet (for example, efficiency of payments systems, energy usage and climate), there is a need to revisit the current governance of central banks. Mission creep is a reality and CBDC may well add to the problem. While there will not be a unique formula applicable to all countries, central banks are better off defending their reputation, ensuring transparency and accountability, if their mandate is narrow and they are expected to collaborate with other institutions within government. At the international level, interoperability is desirable, but this need not imply that a single system or one institution is required. The foregoing does not exhaust the challenges that need to be met, but they are, arguably, some of the most important policy makers will have to grapple with.[49]

49 Interested readers should consult Robert Fay et al. (2021) for a broad overview of additional challenges and questions surrounding the digitalization of money.

Author's Note

Due to space constraints, a separate appendix is available online with additional results. Insightful comments from two anonymous reviewers are gratefully acknowledged.

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67 Erb Street West
Waterloo, ON, Canada N2L 6C2
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