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Should Central Banks issue digital currencies?

Consequences for the financial system, implications for monetary policy and concerns for privacy

Paul Gardin

Supervisor: Jean-Pierre Landau

Jury Members: Jean-Pierre Landau, Benoît Nguyen

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Economics and Public Policy

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Why read this research?

Many central banks and policymakers have discussed the possibility of central banks issuing new forms of money called "central bank digital currencies" (or CBDCs) while new actors and private initiatives have emerged to propose new means of payment. Many discussions centered on whether these initiatives could compete with traditional monies, such as cash and banknotes. Now, central banks wish to understand how they can respond. One possibility to innovate would be to issue digital money, called CBDC. These changes could have widespread consequences on the financial sector and the real economy, which is why CBDC has been widely discussed by both academics and central banks. That being said, these discussions remain theoretical for now, as central banks are yet to issue the first CBDC. This paper proposes to investigate those discussions and assesses the risks and opportunities of Central Bank Digital Currencies using evidence from the literature and from historical data on past financial crises.

The first contribution of this paper is to provide an overview of the debate, including other discussions relevant to the CBDC debate, such as whether or not cash should be removed or if an overhaul reform of the banking sector is necessary. It provides an accessible summary of the debate and all its main arguments as identified in the literature.

Compared to the literature, this paper presents new historical data and a methodology to answer some of the questions raised by CBDC. Using data on postal banking and state-backed saving institutions, we show that CBDC could pose important risks to the stability of the financial system. However, deposit insurance and the credibility of deposit protection schemes does appear to be able to partially mitigate those risks. Similarly, we evaluate the merits of several policies aimed at preventing banking disintermediation after CBDC is issued.

Furthermore, we show that privacy does appear to be a significant factor behind money demand. Therefore, central banks could face pressures to protect the privacy of users. Privacy is potentially a real constraint central banks would face when issuing CBDC as it is currently argued that removing cash and using traceable means of payment is beneficial.

We argue that the debates on the opportunities of CBDC for monetary policy underestimate factors beyond the existence of cash, which are behind the existence of the zero-lower bound. Political pressures and adverse economic effects could challenge central banks' ability to implement negative real interest rates beyond a certain level even in a cashless economy. Finally, this paper develops a preliminary political analysis of CBDC and shows that the political implications of CBDC are relevant for the debate.

This paper greatly benefited from advice, comments and suggestions by M. Jean-Pierre Landau, as well as valuable feedback from M. Benoît Nguyen.

Introduction

The different functions and natures of money

Understanding what CBDCs are first requires defining money and its main functions and characteristics. Traditionally, three functions of money are highlighted. First, money is a unit of account that facilitates exchanges by providing a single metric for pricing goods and services in a given jurisdiction: for instance, in the Eurozone, the price of any good or object is expressed in euros. Secondly, money acts as a store of value: as long as prices are relatively stable, a currency's real value remains stable. Finally, money is a means of payment and can be used to settle transactions.

That being said, money exists under different forms. Coins and banknotes today represent only a small part of money as individuals can also use a credit or debit card, a check, or a mobile phone to pay. Similarly, firms can place their money in deposits at a bank or buy government securities. Each of these forms of money has its advantages and drawbacks. For instance, cash is always available for payment even without access to the Internet, compared to mobile phone payment, but is quite cumbersome to settle large transactions. However, one key distinction is that cash, in the form of coins and banknotes, is issued by a central bank. Printing money has been established as a key responsibility of a central bank[1] (and, as such, of a public institution). These coins and banknotes are the central bank's liabilities. Given its public status and its prerogative to print currency, the central bank has no credit risk. This "public money"[2] is therefore very liquid and can be thought of as safe. By comparison, many widely used means of payment can be defined as private money. For instance, retail or wholesale bank deposits are widely used monies by both individuals and firms respectively. This form of money is private, being a liability of the bank. As a result, the value of this money is linked to the bank's ability to honor its liabilities. This key distinction between public and private money is the underlying mechanism behind a bank run: fears of a bank's insolvency lead to fears that it will not be able to honor its liabilities, in the form of the bank deposits it holds. Depositors wish to withdraw their private money and exchange them for public money (See section 5.1 for a more detailed discussion).

Cash has two other distinctive characteristics compared to other monies. First, cash is legal tender, and must therefore be accepted to settle any transaction in a given jurisdiction. Secondly, cash provides immediate settlement. Once cash has exchanged hands, so to speak, the transaction is said to be final and cannot be cancelled. By comparison, payment using a wire transfer from a bank account is not immediately settled. First, the bank must verify the identity of the account holder and the person who is bound to receive the payment and then settle the transaction with the latter's bank using its central bank reserves. Consequently, payments in cash suffer no delay compared to other means of payment such as wire transfers.

Furthermore, money can function with an account or through a token. It can be linked to an account and is therefore an asset of an identifiable individual or company. Only the latter can claim to use

[1] Historically, most central banks didn't have a monopoly on currency printing upon being established. See Figure 9 in section 5.2.

[2] In this paper, we define public money as a liability of the central bank or the government, very liquid and competing with cash or bank deposits as a means of payment.

it. Bank deposits or credit cards function in this way and as a result one of commercial banks' key functions is to ensure security through identification procedures and cyber-security measures so that only the owner of the account can access and use its money. Alternatively, money as a token can be used by anyone who possesses it without identification. Cash is the main example of such "token" forms of money as anyone holding a banknote can use it to settle a transaction. Cryptocurrencies have developed as another form of token money. Tokens do not require identification but verification: the authenticity of the token (to prevent against counterfeit cash for instance or double spending in the case of digital tokens) and not the identity of its holder determine whether the transaction can be settled[3]. Broadly speaking, token money thus offers anonymity at the expense of security from theft.[4]

Central Bank Digital Currencies, a new form of public money

Broadly speaking, CBDC would combine the public liability feature of cash with the digital nature of new means of payments. The Bank of International Settlements has proposed the following "money flower diagram" to sum up the possible forms that a CBDC can take (BIS, CPMI, 2018).

Similarly to cash, all three possible CBDCs would be issued by the central bank, and would thus constitute "public money". Contrary to cash, CBDCs would be digitally issued. The two remaining characteristics of money, the access and the choice between token money and account money, distinguishes three types of CBDCs, as the diagram shows:

- A widely accessible digital currency linked to an account that anyone could hold at the central bank. This would effectively be a public version of a bank deposit.
- A digital token widely accessible would function as the digital equivalent of cash. Tokens could be used to settle all transactions, including retail transactions.
- A digital token accessible to some institutions to settle wholesale transactions would be similar to granting access to Central Bank reserves to a wider array of institutions and economic agents to settle wholesale transactions[5].
- The remaining corner, CB reserves and settlement account in light grey describe an already existing form of money, only accessible to banks and selected financial institutions to settle transactions. It is a form of digital currency issued by a Central Bank, that is, a CBDC. Some authors argue that CBDC is simply generalization of those forms of money, made accessible to a broader public. For instance, The Bank for International Settlements defines a CBDC as "a digital form of central bank money that is different from balances in traditional reserve or settlement accounts".

[3] Cryptocurrencies function with an account called an electronic wallet defined by a public key and a private key. The private key is needed to access the wallet. In effect, this implies that whoever holds the private key can use the account and the tokens stored on it. As a result, the electronic wallet does not function as an account, following our definition, because assessing the identity of the person opening the wallet is not required to settle the transaction. Contrary to a regular bank deposit, for example, a person whose private key has been stolen cannot cancel the transaction. The wallet for cryptocurrencies is more akin to a safe than to an account as defined above.

[4] Stolen bitcoins or banknotes can still be tracked through a serial number to identify if they were stolen but those verifications are not required before completing a transaction.

[5] Depending on the jurisdictions, different financial institutions have access to central bank reserves and central bank money today, along with the underlying settlement system. Granted for the purpose of conducting monetary policy, this access to central bank money does not imply access to central bank lending facilities (BIS CPMI 2018).

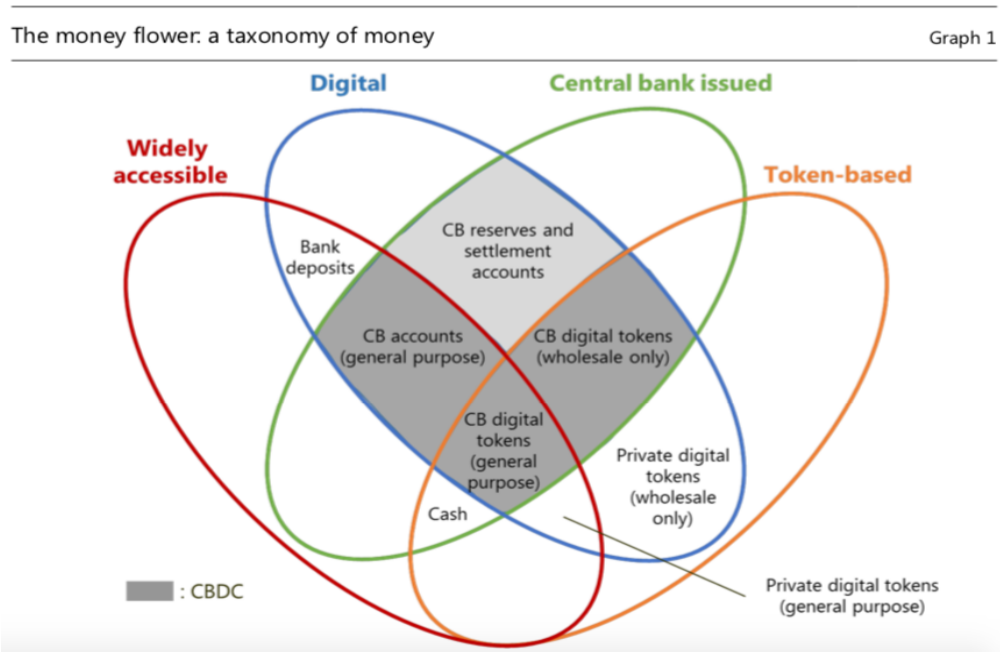


Figure 1: The money flower classifying the different types of monies

Source: BIS, CPMI, 2018
Note: each circle represents possible features money can have. Central Bank Digital Currencies are marked in dark grey in the center of the diagram.

The main differences between the three proposed CBDC is therefore the nature of the digital currency (account-based or as a token) and the extent of the access to this new form of money (selected financial institutions or companies on a wholesale market on the one hand, all agents for retail purposes on the other hand). All three are currently envisioned by central banks (as detailed in section 2). These proposals correspond to various policy choices and aim to solve different problems (see section 3). Finally, these proposals encompass different operating features and challenges.

Following this framework, CBDCs do not require using a specific technology such as a Distributed Ledger Technology (DLT) and they could be based on various technologies. Even though the rise of cryptocurrencies has put the spotlight on their underlying technology, DLT, the issuance of CBDC does not require using a DLT. On the contrary, as noted by the Bank for International Settlements (BIS, CPMI, 2018), technology to issue CBDC is mostly already developed.[6]

Therefore, as the president of the Bank of International Settlements explains, the main change CBDC would introduce is not technological but institutional: more people would have access to central bank liabilities or "public money" (Carstens, 2019a):

"The important part of the acronym CBDC is not the "D" for "digital". Nowadays, nearly everyone has access to digital payments. Whenever you or I pay using a bank debit card or use a banking app on our mobile phone, the payment is made digitally and often instantly. Instead, the important part of CBDC is the "CB" for "central bank". A

[6] That does not imply that technology has no impact on the characteristics of the issued CBDC. Scorer (2017) discusses extensively the various technologies that could be used to issue CBDC.

CBDC would allow ordinary people and businesses to make payments electronically using money issued by the central bank. Or they could deposit money directly in the central bank and use debit cards issued by the central bank itself."

	Existing central bank money		Central bank digital currencies		
	Cash	Reserves and settlement balances	General purpose token	accounts	Wholesale only token
24/7 availability	✓	×	✓	(✓)	(✓)
Anonymity vis-à-vis central bank	✓	×	(✓)	×	(✓)
Peer-to-peer transfer	✓	×	(✓)	×	(✓)
Interest-bearing	×	(✓)	(✓)	(✓)	(✓)
Limits or caps	×	×	(✓)	(✓)	(✓)

✓ = existing or likely feature, (✓) = possible feature, × = not typical or possible feature.

Figure 2: Characteristics of existing forms of central bank money and CBDCs

Source: BIS, CPMI, 2018

Other features of CBDC highlight other important choices, as indicated by figure 2. Compared to cash, the general purpose CBDCs could pay interest and deposits could be capped to avoid sudden outflows of deposits (the rationale is detailed in section 5). Finally, a token CBDC would necessarily provide users with anonymity whereas with an account-based currency, the central bank would have to choose whether or not to make payments private or not (this is addressed in section 7).

For the purposes of this paper, CBDC will mostly refer to retail CBDC, accessible to all, either through an account or as a token. Firstly, this setup seems to be the preferred option of central banks currently considering issuing CBDC (BIS, 2019). Secondly, this setup is standard in the literature to analyze the consequences of a CBDC (For instance, see Andolfatto, 2018; Berentsen and Schär, 2018; Meaning et al, 2018 and Mancini-Griffoli et al, 2018), although some of the literature specifically focuses on the introduction of a wholesale CBDC (Kumhof and Noone, 2018, Bech and Garratt, 2017 study both options).

The rest of the paper is organized as follows:

- Section 1 presents the main rationale behind issuing a CBDC, specifically changes on the payments market, the trend of financial inclusion as well as the impact of the financial crisis on financial regulation and monetary policy.
- Section 2 reviews the ongoing projects in central banks around the world and presents three current CBDC projects.
- Section 3 reviews the literature on CBDC.
- Section 4 presents the methodology of our analysis and the sources of the data collected.
- Section 5 focuses on the financial stability risks inherent with issuing CBDC using historical case studies.

- Section 6 discusses the implications of CBDC issuance for the structure of the financial system and financial intermediation and assesses the proposed policies to mitigate those risks in the literature.
- Section 7 assesses whether or not a CBDC could effectively circumvent the zero-lower bound of interest rates.
- Section 8 studies if and whether CBDC should provide privacy to its users.
- The annex reviews the available data on postal banking and further explains the data chosen for analysis in this paper.

Section 1: Why issue a CBDC?

As explained in the introduction, many of the underlying debates around Central Bank Digital Currencies are not new[7]. Recent technological developments such as the rise of cryptocurrencies and distributer ledger technology have sparked interest for CBDC. However, the concept of the central bank making available a public system of payment other than cash is not a fundamentally a new possibility due to technological progress[8]. The technology to issue electronic money is not new (for instance, the technology for account-based central bank money has been used as part of central banks' reserve and settlement system for interbank operations). As a result, it is important to understand why the debate on CBDC emerges today. The current discussions on CBDC encompass different situations and central banks facing different challenges. Understanding the problems CBDC would be asked to solve is relevant to explain both the framework CBDCs should adopt and how to assess if CBDC is the most efficient way to achieve its assigned policy goals. This section analyzes the main reasons why CBDCs have attracted such a level of attention.

1.1 Cash usage and disruptions in the payment industry

Many shifts in the payment industry have occurred in the recent years, stemming from public and private actors alike. Central banks have invested in an increase of the speed of payments. For example, the European Central Bank launched Target Instant Payment Settlement, or TIPS in November 2018 to respond to a growing demand for fast payments across the Eurozone. TIPS allows immediate transactions in euros to take place at any time through settlement in central bank money. Meanwhile, narrow bank initiatives and mobile payments have emerged and have become widely used: Apple Pay, Alipay and Wechat Pay in China, M-Pesa in Kenya and PayTM in India for instance. Finally, the use of the existing means of payment, mainly cash and card payment have recently shifted and is expected to continue shifting as shown in figures 3A, 3B and 4.

[7] In the case of the debates on narrow banking and Central Bank reserves for all, they specifically date back to the 1929 Great Depression and to Tobin (1985). This point is detailed in Section 1.3

[8] The debate on CBDC is however influenced by disruptions and recent technological changes.

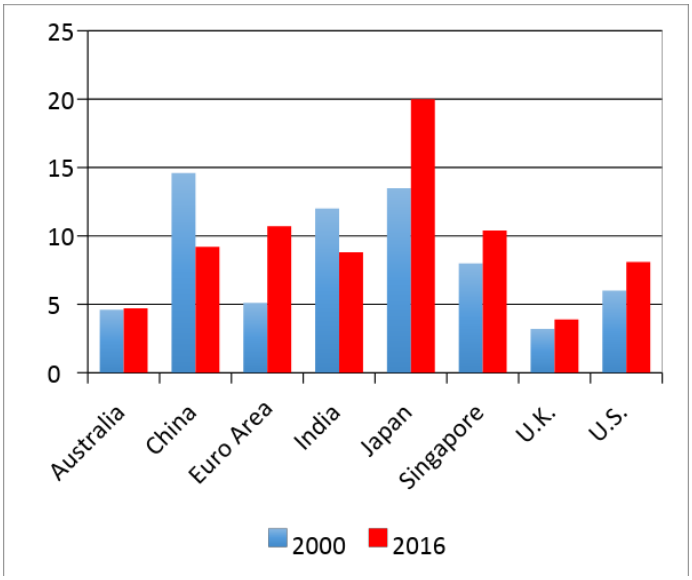


Figure 3A: Cash in circulation (% GDP)

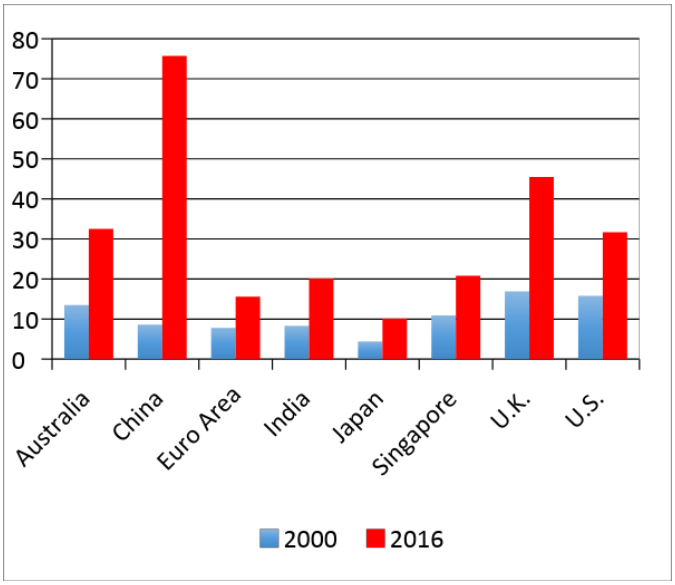


Figure 3B: Card payment (% of GDP)

Sources: Bech et al (2018).

Card payments have been used more and more since 2000 across countries even if overall, cash remains widely used as a means of payment. The rise of card payment in the 21st century is particularly dramatic in the case of China, where the value of these payments relative to the country's GDP has been multiplied by 7. This can be seen as the consequence of new payment services providers being launched, such as Alipay (2004) and Wechat Pay (2014), supplying accessible alternative means of payment to cash.

Cash use has increased in most advanced economies overall while it has decreased in both China and India. Globally, the demand for cash has increased even though card payments have become more widespread. For advanced economies, the persistence of cash can be attributed to the aftermath of the Global Financial crisis and the persistence of low interest rates, which reduce the cost of holding cash compared to having deposits at a bank (Bech et al, 2017; Berentsen and Schär, 2018).

These figures show that there is no generalized decline of cash but also that countries have very different levels of cash use: among advanced economies, cash remains widely used in Japan. In some countries like Sweden or Switzerland, cash is already scarcely used as a means of payment. In Sweden, the share of cash payment in retail transactions went from 40% in 2006 to 15% in 2016. However, prospective studies show that the use of cash is expected to further decline in many countries, partly for demographic reasons: younger generations are more willing to accept new electronic means of payment than older generations (Khiaonarong and Humphrey, 2019, see figure 4. They also review several methods to measure the use of cash as a means of payment). The authors use an alternative measure of cash use intended to measure the appeal of cash compared to similar forms of payment, such as credit card, mobile payment or e-money.[9] Most countries are

[9] Electronic money (e-money) is broadly defined as an electronic store of monetary value on a technical device that may be widely used for making payments to entities other than the e-money issuer. The device acts as a prepaid bearer

expected to see on average a 1,4% annual decrease in the use of cash as a means of payment. This similar trend will however have various implications depending on the country's current use of cash. Countries like Germany and the US will see a significant decline in the share of cash used in payments but given that cash is widely used today in those countries, the demand for cash would remain significant: it would remain a means of payment used in 20 to 50% of transactions, for the US and Germany, respectively. For countries like Norway, Japan and China, cash would be scarcely used as a means of payment by 2026, accounting for only 3 to 5% of transactions. Central banks could issue CBDC as a response of these trends for three main reasons.

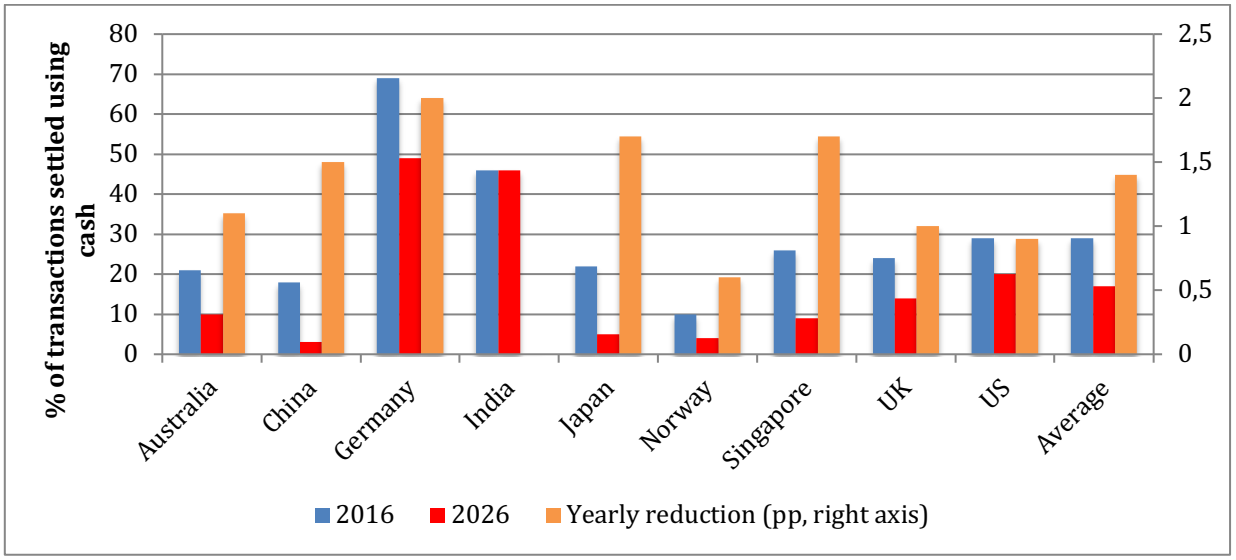


Figure 4: Estimated share of cash in payments.

Note: The variable is defined as the share of cash (withdrawn from ATMs or at the counter in banks) in all cash-like means of payment (including card payments and e-money). The variable can be interpreted as the share of cash in transactions settled by cash or its closest substitutes, where transactions are measured in volume, not in the number of transactions.
Note: the yearly reduction in India is estimated to be 0 percentage points.
Source: Khiaonarong and Humphrey, 2019

First, central banks could issue CBDC as a less costly official means of payment compared to cash. A study by the ECB (Hasan, De Renzis, Schmiedel, 2013) estimated the cost of operating cash as a means of payment to be 0,5 percent of GDP for the euro area. Central banks do not incur the majority of these costs (which would include the production of coins and banknotes). Instead, banks and other infrastructures incurred 40% of those costs (0,19% of GDP) while retailers incurred more than half of them (0,27% of GDP). In contrast, the social costs of operating credits cards were around 0,21% of GDP, less than half than those of cash, and were mainly incurred by banks. Similar results were found in other jurisdictions[10]. Alternatively, central banks and policymakers could aim to replace cash for another reason: so as to improve anti-money laundering, reduce tax evasion and prevent crime, as cash remains the main means of payment ensuring anonymity. Rogoff, (2016)

instrument, which does not necessarily involve bank accounts in transactions. As a result, institutions issuing e-money cannot provide loans (because e-money is fully backed by private money that is effectively stored as e-money).

[10] Kosse and others (2017) estimate the cost of different retail means of payment in Canada. The total social costs are estimated to be 0,78% of GDP. Cash is the most expensive means of payment overall, followed by debit cards and credits. According to their estimates, consumers bear a significant part of the costs of cash.

has argued against using cash given that the anonymity it guarantees fosters illegal activities and hinders monetary policy. Instead, he proposes to start phasing out large denomination bills. India implemented such an approach in November 2016 through the demonetization process, during which 500 and 1000 rupees denominations were removed from circulation.

Secondly, as mobile payments, cryptocurrencies and new forms of private money emerge, the share of "public money" (cash and central bank reserves, the latter being accessible to banks and selected financial institutions only), over which central banks have direct control, could decrease over time. In this context, CBDC could be used to achieve the objective of maintaining a public currency and a public means of payment. For instance, Villaverde and Sanches (2018) analyze a situation where only private forms of money[11] exist and show that while the system could ensure price stability, it could also face self-fulfilling inflationary pressures. More importantly, a purely private market for money would not lead to a socially efficient allocation of money. However, they argue that the coexistence of both public and private forms of money could be desirable to impose market discipline on governments. A similar argument can be made for the public provision of a means of payment specifically to ensure resilience in case the private means of payment fail, for instance due to a cyber-attack (BIS, CPMI, 2018, Khiaonarong and Humphrey, 2019, Sveriges Riksbnak, 2018).

CBDC could also address issues of competition in the payment industry and as a result reduce payment costs for consumers. Indeed, payment systems are likely subject to network effects, as a means of payment is exponentially more attractive when many users adopt it. As a result, operators of payment infrastructures face significant fixed costs with would disincentive competition (Carstens, 2019a). The dramatic rise of card payments in China can be seen as an example of these network effects. The two main competitors are Alipay and Wechat Pay. Both providers offer a payment service through a mobile phone app. Launched in 2004 and 2014 respectively, the two providers; market shares now reach 54% and 40% respectively, effectively making the market a duopoly[12]. It appears that CBDC could theoretically challenge this lack of competition: Bordo and Levine (2017) and Barrdear and Kumhof (2016) estimate that a CBDC could improve competition and provide substantial economic gains by lowering the costs of the overall payment system for consumers. This network effect also explains why many GAFA are considering issuing their own currencies, given their large network of users: Facebook's ongoing Libra project is to develop a cryptocurrency-based means of payment on its platform. The blockchain-based stablecoin would be based on a basket of national currencies and would be used across the network of participants (Libra Whitepaper, 2019). Given the platform's 2,38 billion users and the potential members of the network[13], this currency could quickly reach an economically significant valuation and use[14]. As highlighted by the G7's report on stablecoins, "GSC arrangements may achieve market dominance due to the strong network effects that initially spurred their adoption, the large fixed costs needed

[11] Villaverde and Sanches study cryptocurrencies as the main private form of money that would compete with central bank money. However, similar mechanisms apply to the rise of massive mobile payment systems and private e-money.

[12] according to iResearch Consulting Group.

[13] Which include Visa, Mastercard, Uber, Lyft, Ebay. Adding the users of these platforms and payment infrastructures leads to an even greater number of potential users of Libra.

[14] Figures on the number of users refers to the Monthly Active Users as of March 31st 2019 and are derived from the Q1 2019 report to investors, accessible online (https://s21.q4cdn.com/399680738/files/doc_news/Facebook-Reports-First-Quarter-2019-Results.pdf)

to establish operations at scale and the exponential benefits of access to data." (G7, 2019). CBDC has been presented by several policymakers as a possible response to Facebook's Libra project (see Ye and Desouza for a full review).

Even if no global stablecoin emerges and dominates the market, private digital currencies could also pose several risks. Brunnermeier, James and Landau (2019) study how the international monetary system would be affected by the competition between private digital currencies, each defining a Digital Currency Area (DCA). Smaller countries with high inflation could face risks of digital dollarization, as the digital currency would be an easily accessible alternative to the domestic currency. Alternatively, if several private digital networks emerge, the international monetary system could be more fragmented[15]. CBDC could be a response to both risks.

The consequences for the CBDC debate are threefold. First, even among advanced economies, the use of cash relative to other means of payment varies greatly from one country to another, suggesting that discussions on whether and how to implement CBDC are country-specific. This is also true in the medium term, as not all central banks will have to tackle the issue of a decline in cash. Finally, Central Banks could consider issuing digital money either to counter the rise of private forms of money or to regulate the payment industry and ensure competition. Many CBDC projects in advanced economies focus on the latter risks. For instance, the Banque de France's project to test a wholesale CBDC in 2020 specifically aims to tackle the rise of private initiatives such as Libra (Villeroy de Galhau, 2019). In this context, making the case for CBDC also requires assessing what the risks and benefits of CBDC are compared to alternative regulatory approaches.

1.2 Increasing Financial inclusion

Financial inclusion, defined as the access to financial services, such as deposit facilities, means of payment, insurance and credit has increased over the years. Achieving this objective is important as it takes part in reducing poverty (Carstens, 2019b). In 2011, only one in two adults (15 years old and older) had access to a bank account or a means of payment through a mobile phone. In 2017, around 70% of adults have access to at least one of these services (Carstens, 2019b). Figures 5A and 5B show different metrics of financial inclusion in various countries in 2017. In all advanced economies, around 99% of adults have an account at a financial institution. The figures are dramatically different for other countries, such as China or Uruguay, two countries that are considering issuing CBDC.

[15] One reason would be that each digital currency gives preferential access to some providers of goods and services. For instance, Uber and Lyft were initially part of the Libra project. If the costs of joining multiple networks are high for users, those platforms would dominate the market, wherever Libra is widely used.

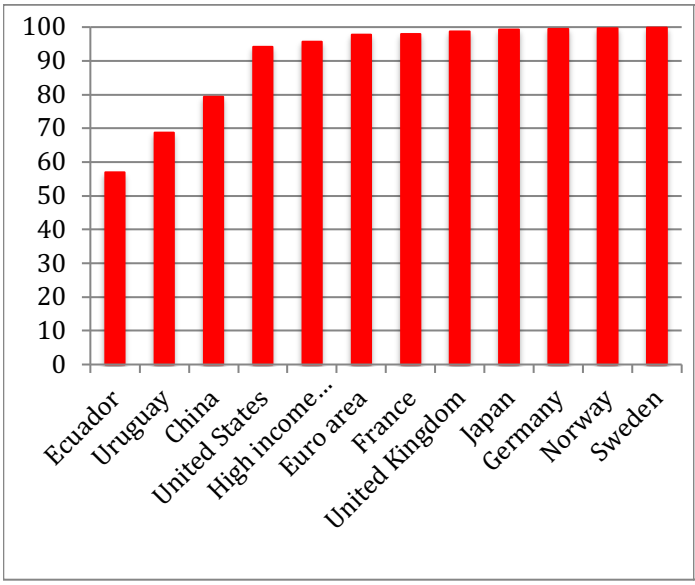


Figure 5A: Percentage of 25+ adults with an account at a financial institution

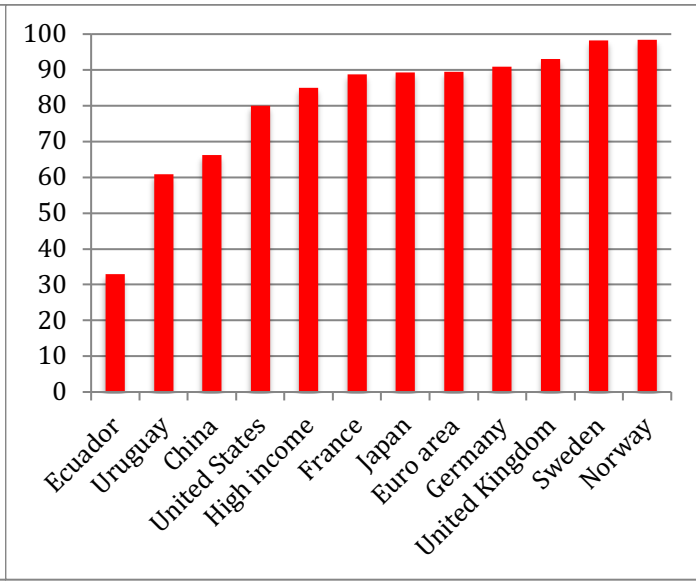


Figure 5B: Percentage of 25+ adults owning a debit card

Source: World Bank Global Financial Inclusion Database

When analyzing the causes of financial inclusion, surveys conducted by the World Bank show that both a lack of trust in financial institutions and high costs appear to be significant in explaining financial exclusion.

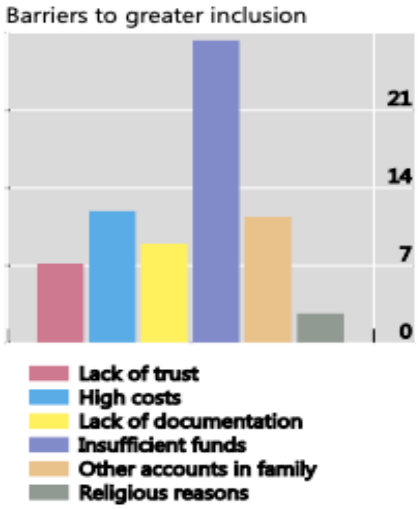


Figure 6: Barriers to financial inclusion in the world

Source: Carstens, 2019b. Data is from the World Bank Global Financial Inclusion Database

These issues could possibly be tackled by central banks issuing an alternative to cash. This form of public money could provide the necessary trust at a low or subsidized cost. Therefore, some central banks, such as in Uruguay, are considering issuing CBDC to foster financial inclusion (Bergara

and Ponce, 2018)[16]. Financial inclusion is therefore important for three main reasons. First, as highlighted by some of the literature, the strongest case for CBDC may be in developing countries, to improve financial inclusion (Mancini-Griffoli, 2018). Secondly, the existence of a gap in the provision of financial services and a widespread use of cash are key determinants to assess whether CBDC would pose a risk to financial stability (Andolfatto, 2018). Finally, although financial inclusion is very high in advanced economies, the rise of new digital payments could exclude parts of the population, such as older people or people with disabilities, leading to more financial exclusion. Therefore, a central bank may want to issue a CBDC to ensure that all the population has access to a means of payment to maintain a high level of financial inclusion once digital means of payment become widespread (see Sveriges Riksbank, 2018 for a more detailed discussion in the case of Sweden).

1.3 Financial regulation and monetary policy after the financial crisis

The financial crisis of 2007 has highlighted two issues relevant for the CBDC debate. First, many central banks had to significantly lower their interest rate and reached the zero-lower bound on interest rates or even ventured beyond it by introducing negative interest rates. Central banks also adopted unconventional monetary policies. Secondly, the crisis has sparked new debates on the need to regulate the financial system.

Following the financial crisis of 2007 – 2008, many central banks implemented unconventional monetary policies, as they had reached the zero-lower bound on their policy rates. As a consequence, central banks' balance sheets expanded. However, the global decline in interest rates largely preempts the crisis. Indeed, interest rates have decreased since the 1980s. This trend is largely expected to last, as several studies highlight that interest rates are expected to stay low in the near future, until 2030 to 2045 (for instance, see Gagnon et al, 2016, Carvahlo et al, 2016, Papetti, 2019). This persistence of low interest is partly identified as the consequence of demographic shifts in advanced economies, mainly aging. As a result, the zero-lower bound of interest rates is expected to constrain central banks in advanced economies in the medium term if they want to adopt expansionary monetary policy. One implication would be that central banks rely more and more on unconventional monetary policies. This context has renewed both the interest for alternative monetary policy instruments and for the possibility to set negative interest rates, thus circumventing the effective lower bound: central banks have already set negative interest rates but banks have not passed them on to depositors. Furthermore, as there are costs to storing and moving large quantities of cash, even with negative nominal interest rates, cash would not be preferred over other forms of money. The literature has thus defined the term "effective lower bound" as the negative value of interest rates below which cash-hoarding behavior appears (Di Fiore, Tristani, 2018). For the purpose of this paper, negative interest rates will refer to rates below this effective lower bound.

[16] This article was published as part of a chapter of the e-book *Do We Need Central Bank Digital Currency? Economics, Technology and Institutions,* published following a conference organized by SUERF - The European Money and Finance Forum in 2018 (SUERF, 2018).

Theoretically, issuing a certain type of CBDC could be a solution to both issues. First, if CBDC were issued as a replacement to cash, individuals would no longer be able to hoard cash to protect themselves against negative interest rates. Rogoff (2014, 2016) proposes to phase out cash specifically to allow for the central bank to set negative interest rates. Kimball and Agarwal (2015) propose a similar mechanism where the central bank could set a fee on cash deposits to disincentivize hoarding cash in times of crisis. Secondly, if a general purpose CBDC were interest bearing, then the central bank would have a new monetary policy tool, mainly setting the interest rate on CBDC deposits as a floor for the interest on bank deposits.

The financial crisis has also renewed debates on the adequacy of financial regulation and how to ensure the stability of the financial system. To tackle excessive risk-taking in the banking sector, several more radical ideas have been proposed, some of them resurfacing after having been first put forward following the Great Depression. Two of these proposals stand out in the context of the debates on CBDC (Ricks, Crawford, Menand, 2018 and Niepelt, 2018 discuss both proposals and how they relate to the debate on CBDCs).

First, some have proposed to put an end to fractional reserves banking to prevent banks from being able to create money as this maturity transformation process is seen as a source of instability: Under the current system, banks are only required to keep a part of the deposits they receive as reserve. Banks can offer loans using the rest of the deposits. As a result, banks are responsible for creating money: as short-term deposits are part of the money supply (M1), banks increase the money supply by loaning a part of deposit, which essentially creates new deposits. Each time the bank loans funds from deposits; it transfers a part of the deposits credited on an account to credit another account that receives the loan. However, the first account remains credited with the initial value of the deposits. For monetary policy, this effect, called the money multiplier (for a thorough discussion of the underlying mechanisms, see McLeay, Radia and Thomas, 2014), implies that money creation and the supply of loans are entangled. The idea to require bank to hold all deposits as reserves has first been put forward in the "Chicago Plan". Following the Great Depression of 1929, some economists such as Irving Fisher proposed to require banks to hold all the deposits they received as reserves, in a so called full-reserve banking system (Knight et al, 1933, Fisher, 1935). The Chicago Plan aimed to fully separate banks' lending activities from their deposit activities. Banks could collect deposits and hold central bank balance but would not hold riskier assets. As a result, their role would be reduced to operating a payment system. Instead, loans would be offered by private investment funds whose source of funding would be their equity and both private and public debt. The main rationale of this plan is to disentangle money creation from the credit supply so that both can be piloted from central bank's point of view using different instruments (see Ricks, Crawford and Menand, 2018 for a full discussion). Kumhof and Benes (2012) discuss how this plan could be implemented today and model its consequences. Following the financial crisis, concrete proposals have been put forward: for instance, in July 2018, the Swiss voted against a Vollgeld proposal, which planned to prohibit money creation by banks. In effect, banks would no longer have been able to rely on deposit funding to supply credit.

Under certain conditions, issuing a CBDC could achieve the objectives of the Chicago Plan but would have even greater consequences on the banking sector. The competition between CBDC and bank deposits could lead to a large withdrawal of bank deposits. If banks cannot compensate this outflow, for example by attracting new deposits through deposit rate increases, their lending could

decrease (this mechanism is discussed more extensively in sections 6.2 and 6.4). In other words, the Chicago Plan proposes to split banks into two institutions. Payment institutions, or narrow banks, would receive deposits but couldn't hold risky assets and or provide loans. Investment fund would hold various assets and provide loans. An account-based CBDC could drain all deposits from the banking sector. As a result, banks providing loans would rely entirely on wholesale funding, similarly to investment funds in the Chicago Plan. The central bank would assume the role of narrow banks, providing deposits and means of payment to depositors. The digital nature of the currency indeed implies that banks and their physical and local presence through a network of branches, that most central banks do not have, would no longer be needed to operate a payment system. In that sense, introducing a CBDC could be a more radical way to implement the Chicago Plan. This analysis relies on strong assumptions: CBDC would need to be strictly preferred to bank deposits regardless of the interest banks could offer on their deposits and the bundled services banks provide to their clients.

Another similar proposal is to allow anyone to hold central bank reserves. Tobin (1985, 1987) proposed that "the government should make available to the public a medium with the convenience of deposits and the safety of currency, essentially currency on deposit, transferable in any amount by check or other order." This service would be provided either by the Federal Reserve directly through a local network of offices or through the post office, or by mandating banks to offer a deposit fully backed by reserves. Tobin argued that there was a retail demand for safe and liquid money at the expense of interest revenue, especially among poor households. The private market for "near-money", such as money market mutual funds supplied safe and liquid assets imperfectly and was susceptible to runs. As a result, he argued the Fed should provide safe money to meet this demand. Ricks, Crawford and Menand (2018) make a similar proposal where the Fed would let anyone open a Fedaccount and deposit money at the central bank directly. Their proposal has several goals similar to Tobin's. First, Fedaccounts would allow the 5,8% of unbanked Americans (see figure 5A) to have access to basic financial services. Then, creating a public market for safe and liquid money would improve financial stability, as it would prevent any risks of runs on the private market for money[17]. A widely accessible CBDC issued on an account-based would effectively enact the "reserve for all" proposal.

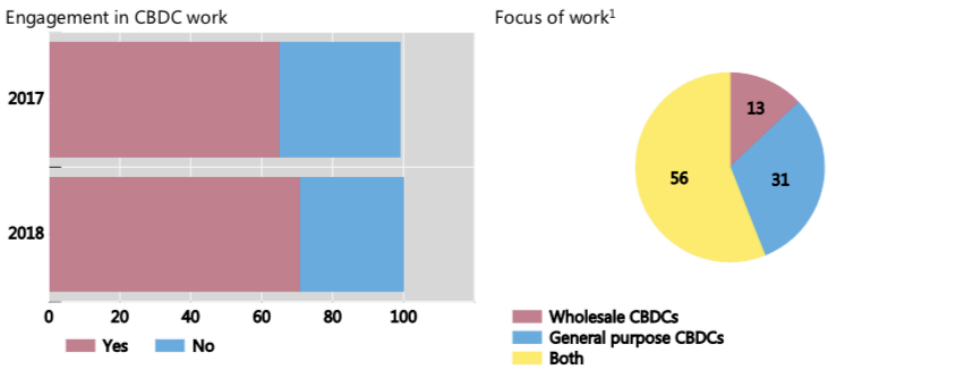
Section 2: Ongoing CBDC projects and central bank research

At this stage, most central banks are currently still investigating the implications of issuing their own digital currencies. A survey by the Bank for International Settlements (BIS, 2019) provides a snapshot of ongoing projects within central banks across the world. The following table presents the results from this survey.

[17] Though Tobin does not mention financial stability, the argument of addressing failures on the private market for money or near-money appears similar in both proposals. Ricks, Crawford and Menand highlight other goals not mentioned by Tobin, such as improving monetary policy transmission and payment efficiency.

Share of respondents

Graph 3

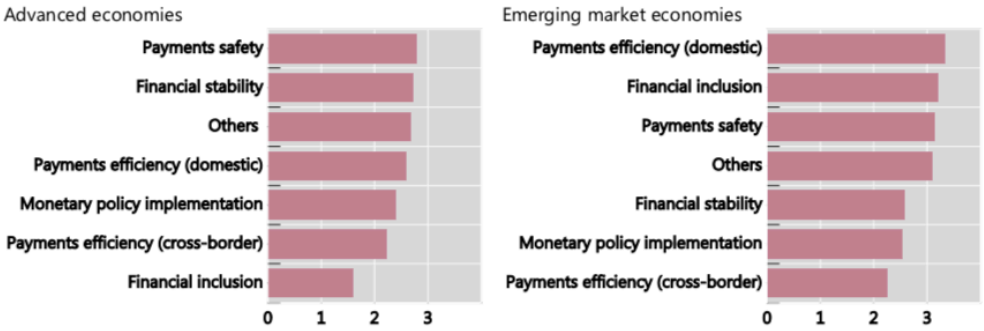


[1] Share of respondents conducting work on CBDCs, 2018 survey.

Motivations for issuing general-purpose CBDCs, ranked in order of importance

Score[1]

Graph 6

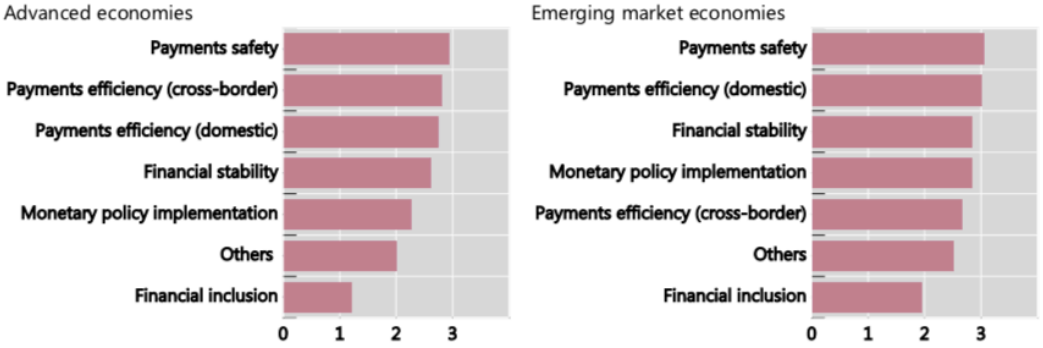


[1] The score is calculated as an average of the options: "Not so important" (1), "Somewhat important" (2), "Important" (3) and "Very important" (4).

Motivations for issuing wholesale CBDCs, ranked in order of importance

Score[1]

Graph 7



[1] The score is calculated as an average of the options: "Not so important" (1), "Somewhat important" (2), "Important" (3) and "Very important" (4).

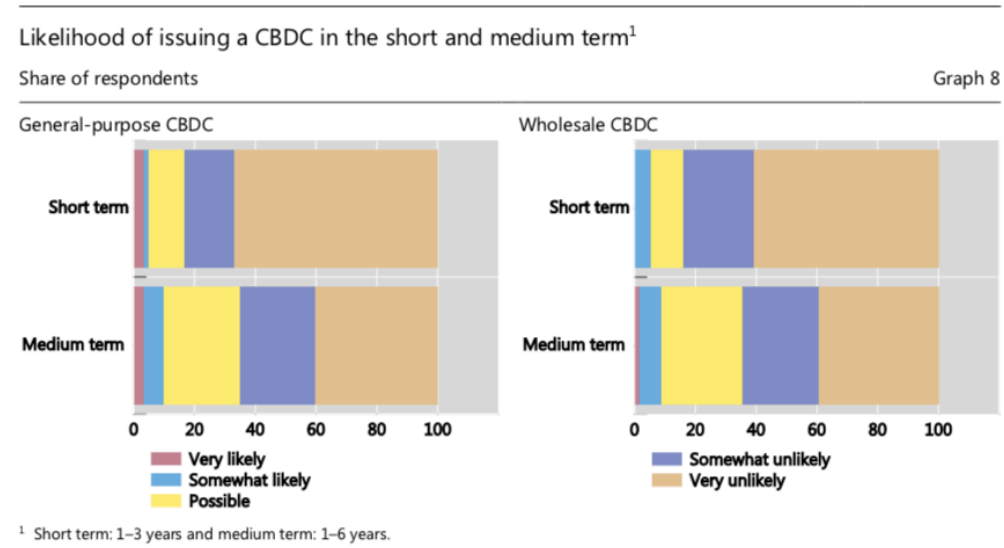


Figure 7: Survey of central banks' CBDC projects

Source: BIS (2019)
Note: 63 Central Banks were surveyed, including 41 in emerging economies and 22 in advanced economies. 70% of them responded working on CBDCs as of 2018. For graphs 6 and 7, Central banks were asked to rank the most importance aspects they were considering in their CBDC research. Therefore, the importance of financial stability does not imply central banks think CBDCs can improve financial stability but rather that they have focused their research on the Financial stability aspects of CBDC.

Overall, more than 40 central banks around the world are studying CBDCs. Only a minority of central banks is thinking of developping a wholesale CBDC. Most are either focusing on developing a widely accessible one or considering both options, as shown by graph 3. Graph 6 illustrates the rationale of central banks' research into widely accessible CBDCs. Consistent with the trends presented in section 1, a majority of CBDC projects study its impact on the payment system, especially its safety, which is presented as the first aspect studied in the research both in emerging and advanced economies. Advanced economies are particularly concerned by the financial stability impact of issuing a CBDC (second most cited response) while emerging economies particularly focus on the link between issuing CBDC and financial inclusion. The impact CBDC could have on monetary policy is not the main area of focus of central banks both in advanced economies and in emerging economies. The results are broadly similar for central banks studying wholesale CBDC except that those projects are often aimed at improving cross-border payment specifically, while financial inclusion is not a factor (not applicable) and financial stability is a greater concern for emerging economies. Finally, the last graph underlines that thus far, central banks' interest in CBDC remains mostly academic. For both the general purpose and the wholesale one, less than 20% of surveyed central banks are considering issuing a CBDC in the near future, although those figure increase when considering the long term.

These results are consistent with the analysis presented in section 1. Different aspects of CBDC are studied among advanced and emerging economies, suggesting that the theoretical case for CBDC is likely country-specific and depends on many factors. Specifically, in advanced economies, financial stability once CBDC is issued is a particular concern for central banks. Emerging

economies are actively studying whether a CBDC could improve financial inclusion. Finally, most central banks are not planning to issue a CBDC in the near future.

Some central banks have more advanced CBDC projects and are actively experimenting with CBDC. Three cases are detailed below:

- Uruguay: to tackle the rising cost of producing cash as well as to foster financial inclusion, the central bank of Uruguay intends to issue an e-peso as a partial substitute to cash, which would remain in use. E-pesos would be accessible to both individuals and businesses, stored and exchanged through in a digital wallet on a mobile phone. The wallet would be linked to users' phone number but e-pesos would function as tokens, exchangeable without identification. Transactions would be anonymous but traceable to the extent that the central bank tracks all transactions by account number but does not identify the accounts holders' unless asked to do so by judicial authorities. E-pesos stored on wallets do not pay interests. The central bank conducted a pilot of the e-peso in 2017 (see Bergara and Ponce, 2018[18] for more information).
- Canada and Singapore: the central banks of Canada and Singapore are developing a cross-border payment system based on Distributed Ledger Technology. Both central banks use a blockchain to exchange digital tokens with banks and financial institutions in exchange for cash. The blockchains are linked to central banks' settlement systems so that as digital tokens are credited or removed from banks' digital accounts, the similar amount of cash is removed from or credited to their account at the central bank. Both central banks reported having successfully settled a cross-border transaction in May 2019 (for more information on projects Urbin and Jasper, see BoC and MAS, 2018).
- Sweden: to tackle the declining use of cash, the Riksbank is considering issuing digital cash, e-krona, as a complement to cash. In a recent report (Sveriges Riksbank, 2018), the central bank presents several options. E-krona would be accessible to anyone in Sweden, similarly to cash and would not rely specifically on DLT. The Riksbank is considering both an account-based e-krona and a token e-krona. Traceable but anonymous transactions could be made. The final design and the specific features of the e-krona, including whether it would be interest-bearing are yet to be announced.

Section 3: Literature review

There has been a lot of interest in the literature for the implementation of a Central Bank Digital Currency, though the term CBDC refers to various setups. Overall, the literature appears divided on whether or not the opportunities of a CBDC would outweigh its risks.

Theoretical models find that CBDC could improve overall welfare: Kumhof and Barrdear (2016) run a Dynamic Stochastic General Equilibrium model of the United States following the introduction of a CBDC. This digital currency is interest-bearing and emitted against government

[18] This article was published as part of a chapter of the e-book *Do We Need Central Bank Digital Currency? Economics, Technology and Institutions,* published following a conference organized by SUERF - The European Money and Finance Forum in 2018 (SUERF, 2018).

debt. Overall, they highlight two main benefits of this setup. First, GDP would increase by 2,94% due to efficiency gains, including a reduction of monetary transaction costs, an increase in productivity, equivalent to a decrease in discretionary taxes, and an increase in banks' funding[19]. Secondly, the Central Bank would then have control of another monetary policy instrument, either through the quantity of CBDC or its price (the authors analyse the pros and cons of each approach). A key hypothesis in this model is that CBDC is emitted against government debt, which ensures that CBDC and bank deposits are not good substitutes of one another. Kumhof and Noone (2018) further discuss this setup, where households cannot directly buy CBDC and highlight several implementation principles. Andolfatto (2018) presents an overlapping generation model to estimate the impact of issuing a CBDC and finds similar results. Overall, he as an interest-bearing CBDC competes with bank deposits, it can improve financial inclusion without harming banks' funding or reducing financial intermediation. The main mechanism he highlights is that by controlling the interest rate on CBDC[20], central banks can force banks to increase their deposit rate to avoid a flight of deposits towards CBDC. In doing so, banks attract new clients who were previously excluded from the financial system and who were holding significant amounts of cash. One adverse consequence of CBDC in that framework is to increase the overall tax burden: as interest-bearing CBDC substitutes for cash, a larger part of money in circulation now pays interest.

Some authors argue that CBDC would be particularly beneficial to achieve some specific goals. Mancini-Grifoli *et al.* (2018) present a framework to analyze both the hypothetical demand and supply for CBDC and conclude that the main benefit of a CBDC would be to improve financial inclusion in emerging economies, by providing a digital payment system as an alternative to cash. Khiaonarong and Humphrey (2019) argue similarly that CBDC could only be beneficial in countries where cash usage is high. Bordo and Levin (2017) state that an account-based interest-bearing CBDC would provide a series of benefits: first, it would provide a more efficient and less costly means of payment compared to the systems currently in place. Secondly, it would improve monetary policy by removing cash and allowing central banks to set negative interest rates as well as ensure price stability more efficiently. Berentsen and Schär (2018) propose to introduce a CBDC to safeguard the independence of the central bank by allowing a wider access to central bank reserves. Specifically, following the 2007–2008 crisis, they argue that the interests paid by the central bank to the financial intermediaries capable of holding reserves function as government subsidy and could generate political backlash, eventually threatening the independence of the central bank. CBDC, by granting everyone access to the central bank's deposit facilities and its interest rate, would solve that problem.

Other authors emphasize either that the risks of CBDC are too great or that CBDC is not the best policy to achieve certain desirable outcomes. Cecchetti and Schoenholtz (2018) argue that central banks do not need to issue CBDC to promote financial inclusion and that private market solutions for means of payment are more efficient. On the contrary, they highlight two main risks of issuing

[19] The increase in deposits is explained by the higher economic activity stimulating demand and a low substitutability between CBDC and bank deposits.

[20] Interestingly, this result holds whether or not CBDC is effectively used. Andolfatto decribes two equilibria where the interest rate on CBDC is lower or above the interest rate on bonds. In the first case, even if CBDC is not adopted because banks match CBDC's rate on their deposit rate and maintain their funding, CBDC forces banks to increase their deposit rate. Andolfatto therefore describes a framework where CBDC can be used as a means to regulate the banking sector and its deposit rate.

a CBDC. First, banks could lose funding as deposits are exchanged for CBDC. Secondly, in times of stress for the financial sector, CBDC could facilitate a flight to safety and bank runs.

Many central banks have also studied the effects of a CBDC, reaching various conclusions. The e-peso project implemented by the central bank of Uruguay is mainly intended to provide a more efficient payment system and to promote financial inclusion by disincentivizing the use of cash (Bergara and Ponce, 2018)[21]. The rationale of the Sveriges Riksbank's e-krona project is that the central bank should still intervene on the payment market after cash is no longer in use, and research by the Riksbank estimates that these results can be achieved without significant disruptions on the banking sector (Juks, 2018, Sveriges Riksbank, 2018). The Central Bank of Norway reached a similar conclusion, estimating that issuing a CBDC may be necessary once cash is no longer in use, to ensure the continued existence of a public means of payment. However, the Central Bank's report does not conclude whether the risks of issuing a CBDC can be effectively managed (Norges Bank, 2018). Finally, the Danish Central Bank stated that it did not plan to issue CBDC, given the risks of banking disintermediation and the risks to financial stability. Another reason given is that such a system could lead to the central bank having to perform tasks better left to the private sector, such as retail banking, customer relations or providing loans (which are detailed in Section 6.1), while the need for CBDC is less clear (Danmarks Nationalbank, 2017). The Danmarks Nationalbank also argues that having the central bank operate a single digital payment system can be exceptionally dangerous given risks of cyber-attacks. Khiaonarong and Humphrey (2019) make a similar argument regarding CBDC's appeal to users. They state that in countries with some experience in digital payment, private market solutions are likely to be as efficient and that regulation would be more efficient than direct intervention on the market for payment systems.

Overall, there is no strong case for or against CBDC made in the literature. The risks and benefits of issuing a CBDC appear to be specific to some countries (for instance, Norway and Sweden have a very low level of cash usage compared to other advanced economies, as highlighted in section 1) and different policy goals are ascribed to CBDC depending on the proposals. Furthermore, the literature appears split on the specific impacts a CBDC would have on the financial sector and on monetary policy.

Regarding financial stability and financial intermediation[22], most of the literature acknowledges that a digital form of money with legal tender would compete with bank deposits, with potential adverse effects on banks' ability to fund credit through deposits both in normal times and during financial crisis. However, there is no consensus as to whether those risks can be mitigated through setting lower interest rates on CBDC, providing funding to banks in times of crisis or if banks rely more on wholesale markets for funding. Brunnermeier and Niepelt (2019) present a model where the introduction of a general purpose CBDC can improve the stability of the financial system, as the central bank effectively deposits money at banks to replace the lost deposits. They argue that such central banks could remain a source of funding for banks in terms of crisis and would be

[21] This article was published as part of a chapter of the e-book *Do We Need Central Bank Digital Currency? Economics, Technology and Institutions,* published following a conference organized by SUERF - The European Money and Finance Forum in 2018 (SUERF, 2018).

[22] Financial intermediation is a productive activity in which an institutional unit incurs liabilities on its own account for the purpose of acquiring financial assets by engaging in financial transactions on the market; the role of financial intermediaries is to channel funds from lenders to borrowers by intermediating between them (OECD Glossary of statistical terms).

optimally placed, as depositors, to identify bank runs and react accordingly. The majority of the literature, however, highlights that a widely accessible CBDC could destabilize the financial system by removing deposits as an available source of funding for banks. Kumhof and Noone (2018) strongly argue that a general purpose CBDC would be detrimental to the financial sector and present several conditions to ensure CBDC is not easily substitutable with bank deposits. Other studies emphasize one or several mechanisms to prevent financial stability risks from CBDC. Firstly, some argue that banks could replace the lost deposits with wholesale funding. In the case of e-krona, the Swedish central bank considers that the risks of a bank run already exist with cash and that CBDC would merely mirror those risks in a cashless financial system. The same instruments used by the central bank during the financial crisis could be used to provide funding to banks in case a sudden outflow of deposits reduces banks' funding. Juks (2018) provides a detailed analysis of the Swedish financial markets in the scenario where an interest-bearing e-krona is widely available to Swedes. He argues that the banking sector would react by replacing the lost funding in the form of deposits with wholesale funding, by issuing new bonds. Meaning et al. (2018), Pfister (2017), Nieplet and Brunnermeir (2019), and Mancini-Griffoli (2018) argue that banks could maintain their level of funding by being refinanced by the central bank, so that they needn't reduce their balance sheet and, as a result, the credit supply. Finally, a third proposal in the literature is that banks maintain their level of funding by increasing the deposit rate (Andolfatto, 2018, Mancini-Grifolli, 2018) or their lending rate.

Many studies discuss the implications of issuing a CBDC for monetary policy. Some of the literature considers that circumventing the zero-lower bound of monetary policy is an important objective or possibility offered by the issuance of a CBDC (for example, see Bordo and Levin, 2017; Meaning *et al.*, 2018). Some of the literature highlights that the existence of cash is not necessarily the only constraint on central banks' ability to implement negative interest rates. Cecchetti and Schoenholtz (2017) argue for instance that other factors such as the "money illusion"[23] (consumers actively thinking of their income in nominal terms and opposing a nominal decrease in their income due to interest rates) could generate a political backlash if interest rates are set below zero. Finally, most studies agree that central banks could still conduct monetary policy effectively after CBDC is introduced (see Sveriges Riksbank, 2018, and Juks, 2018, for a discussion on the Swedish example. Meaning *et al.* and Bordo and Levin highlight how monetary policy would be conducted if a general-purpose CBDC were issued).

For each of the risks and opportunities highlighted above, the literature makes an extensive study of the different features a CBDC could have, such as an interest rate, caps on deposits or the convertibility with bank deposits. Most of the literature focuses on a general purpose CBDC, since a wholesale CBDC is viewed as a limited extension of the already existing banking reserves (see for example Meaning *et al.*, 2018, and Andolfatto, 2018), while a general-purpose CBDC is analyzed as a new alternative to bank deposits, with the subsequent consequences for financial markets. It is often assumed that CBDC would pay interest, either as a policy choice to improve the conduct of monetary policy (Meaning *et al.*, 2018, Bordo and Levin, 2017, Andolfatto, 2018) or as a necessity, to be attractive relative to private forms of money (see Khiaonarong and Humphrey, 2019, for a discussion on the possible need to set an interest rate on CBDC to attract

[23] See Shafir, Diamond and Tversky for evidence on money illusion.

depositors). While some authors analyze CBDC as an alternative to cash, the literature also analyzes the introduction of CBDC while cash is still being issued.

Finally, the issue of anonymity guaranteed by some CBDC frameworks is not widely discussed in the literature. Some authors assume that a CBDC issued by the central bank would replace cash (Bordo and Levin, 2017) so as to reap the supposed benefits of a cashless society - for instance, cash could no longer serve for tax evasion or money laundering purposes (Rogoff, 2014, 2016). In this case, the central bank would cease to provide an anonymous means of payment and unless economic agents use alternatives such as cryptocurrencies, users would no longer have the possibility to perform transactions anonymously. The majority of the literature does not make this assumption and analyzes the consequences of CBDC existing alongside cash. On the other hand, some authors argue that from the perspective of users, privacy is a desirable trait for a means of payment, and that this could influence the demand for CBDC relative to other means of payment. Kahn (2005) argues that the anonymity is one of the fundamental characteristics of money, compared to credit, which requires identifying both parties. In the context of CBDC, Kahn (2018) considers that a lack of privacy offered by CBDC could have a negative impact on the demand for CBDC and increase the demand for more private means of payment.

The CBDC literature has therefore identified several key research questions questions:

- Would CBDC generate instabilities in the financial system as it weakens banks' funding based on deposits, and can those risks be mitigated?
- Would CBDC improve the conduct of monetary policy?
- Is privacy a relevant factor of the demand for CBDC?

The next section details our methodology to answer these questions.

Section 4: Methodology

After having presented the general debate around CBDC in the literature, the aim of this paper is to assess empirically what the consequences of issuing a CBDC might be, and to provide answers to the three research questions that have been highlighted.

Thus far, only two pilots of a CBDC have been successfully conducted. Ecuador launched its own CBDC in 2015 before putting an end to the project, and Uruguay completed a six-month pilot project in 2017, as explained in Section 2. White (2018) analyses the Ecuadorian case and Bergara and Ponce (2018)[24] provide a first analysis of the pilot; however, a final evaluation has yet to be published. In this context, there is a lack of empirical data to assess the effects of a CBDC at this stage. Furthermore, following the discussion in Sections 1 and 2, even with the experience of successful pilots, learning from them and assessing the risks and opportunities of a CBDC may be difficult because the nature of the risks depends on the relative use of different means of payment

[24] This article was published as part of a chapter of the e-book *Do We Need Central Bank Digital Currency? Economics, Technology and Institutions,* published following a conference organized by SUERF - The European Money and Finance Forum in 2018 (SUERF, 2018).

and forms of money[25]. If the non-bank private sector holds little bank deposits and a significant amount of cash, then the introduction of CBDC is likely to substitute heavily for cash, having little impact on bank deposits (see Section 5). In countries where a significant portion of the population is financially excluded, having no access to a bank account and holding cash instead, substitution between bank deposits and CBDC could be low (or at least lower than if introduced in advanced economies). Conversely, CBDC could encourage many depositors to take part in the formal economy and the banking system by opening a bank account, as modeled by Andolfatto (2018). Because a lack of trust is one of the key factors behind financial exclusion, along with costs (Carstens, 2019b, see Section 2.2), we can assume that if in emerging countries people already hold a bank account, they have sufficient trust in the bank and are unlikely to massively switch to CBDC, especially if the central bank is less trusted than the private sector, as was the case in Ecuador (White, 2018). Furthermore, banks in emerging economies may have more room to provide higher returns on deposits given that inflation tends to be high on average in those countries, and that interest rates are more distant from the lower bound (De Lis, 2018)[26]. Overall, while pilots may provide useful data to understand how a CBDC can be implemented, they may not provide many insights into how CBDC could substitute for bank deposits and cash in a given country, especially when considering that banking crises are not frequent.[27]

Instead, we argue that historical data may help shed light on the consequences of issuing a general purpose CBDC. We present data on historical cases where postal savings and state-backed savings, public forms of money guaranteed by the government, were available to the public, including during banking crises. We analyze three banking crises to provide insights into the consequences of issuing a CBDC, both on financial stability and on financial intermediation. The annex details our choice of data and surveys the existing datasets available on postal savings and state-backed savings.

While nominal negative interest rates have been implemented in several countries, banks have not passed on negative rates to their depositors. As a result, assessing depositors' reactions to negative interest rates in an empirical way is outside the scope of this paper. Nonetheless, we present evidence from the literature to show that CBDC may not necessarily allow central banks to circumvent the zero lower bound if constraints other than cash, such as political ones, exist on central banks and their ability to set negative interest rates.

Finally, the existence of cash has always given users the option of having an anonymous means of payment. In this context, it is not possible to assess how agents would behave if no anonymous public means of payment existed. However, we rely on evidence from the literature to show that there are reasons to believe privacy is a relevant feature of the future demand for CBDC, and we draw the relevant conclusions for the debate on CBDC.

[25] Including whether "public-like" forms of money and safe and liquid savings are widely available.

[26] This article was published as part of a chapter of the e-book *Do We Need Central Bank Digital Currency? Economics, Technology and Institutions,* published following a conference organized by SUERF - The European Money and Finance Forum in 2018 (SUERF, 2018).

[27] For example, Reinhart and Rogoff (2014) analyze over 100 instances of systemic banking crises over the last three centuries. Throughout its history, Uruguay experienced three major banking crises, in 1890, 1931 and 2002. Sweden experienced four events of banking panic between 1907 and 1991.

Section 5: Financial stability after CBDC is introduced

5.1 The risks of bank runs

One of the key questions asked in the literature is assessing what the demand for a CBDC would be. While several features of a CBDC (for instance, see section 7 discussing the role of privacy) and their respective impact on the hypothetical demand are discussed, most of the literature highlights that the decisive feature behind CBDC demand, from users' perspective, would be the inherent safety of holding a central bank liability instead of a private form of money. Some of the literature underlines other features that could make CBDC attractive or unattractive. Mancini – Griffoli et al (2018) argue that bank deposits could still be attractive once CBDC is introduced because banks provide several services bundled with the provision of a bank account, such as savings, credit or insurance. Khiaonarong and Humphrey (2019) discuss whether there would be an important demand for CBDC. They argue that if private means of payment already exist, such as in a country where cash use is already low, then CBDC would likely not be attractive compared to private money because the private market for payments is supposed to be efficient. As a result, in this framework, central banks would have to pay interests on CBDC to foster demand. Following Andolfatto (2018) and Carstens (2019a), we assume that the only difference between CBDC and private money is the liquidity and safety guarantee inherent to public money. This allows us to interpret a preference for CBDC as a preference for liquidity and protection from credit risk, conditional on a difference in interest rates between CBDC and private bank deposits (in real terms). This difference in rates, referred to as the interest rate spread or the interest premium then represents the price of illiquidity, the interest revenue users are willing to forego to hold only public forms of money. We will relax that hypothesis in Section 7 when studying whether or not privacy is a relevant factor of the demand for CBDC.

Most of the literature agrees that CBDC could generate financial instability. The main mechanism is that the issuance of CBDC would grant wider access to central bank money, and therefore fully liquid money. As CBDC is introduced, users (which can be households, companies or financial institutions depending on CBDC's design) would now have the choice of holding private forms of money (such as bank deposits) or CBDC, which is inherently more liquid. To hold private forms of money, they would require a premium to compensate for the higher risk of illiquidity. As depositors withdraw their deposits, banks face the choice of either holding fewer deposits or having to offer higher rates on deposits to maintain their level of funding by attracting depositors. In a world without CBDC, this substitution mechanism between public and private money it at play between cash and bank deposits and has been recognized as the key mechanism of bank runs (Diamond and Dyvbig, 1983)[28]: fears of a bank failure lead all depositors to withdraw their money as the bank' assets and reserves do not match the value of all deposits held, in a fractional reserve banking system. This model emphasizes a self-fulfilling mechanism between bank runs and expectations of a bank run. Regardless of whether the bank is going to fail, the fear that others could withdraw their deposits pushes other depositors to do the same and convert their deposits into cash. However, cash storage itself can be costly, banknotes can be stolen or destroyed and

[28] A similar analysis can be made for wholesale markets of monetary instruments where cash corresponds to money market fund shares and bank deposits correspond to other riskier financial assets. A flight to safety event leads to an increased demand for safe assets such as government bonds and a lower demand for riskier assets. We develop this analysis further below.

transporting large amounts of cash is impractical. As a result, the introduction of CBDC could reinforce this mechanism as holding CBDC would be more convenient than holding large quantities of cash. CBDC would therefore likely facilitate flights to safety in case of a generalized banking crisis: if most banks are deemed unsafe, CBDC could facilitate flights to safety. If only a few banks face difficulties, CBDC would likely not have any impact as depositors turn to other more stable banks instead.

Figure 8 shows the consequences of the substitution between bank deposits and CBDC in the case where everyone has access to CBDC through an account held at the central bank. Before the introduction of CBDC, the non-bank private sector (including households) has access to several assets, mainly bonds, stocks (assumed to be the banks', but the results hold if the private sector also invests in other stocks), cash (notes) and bank deposits. Once CBDC is introduced, the non-bank private sector can also choose to add CBDC to its portfolio by reducing its amounts held in other monetary assets. In this framework, bonds are government securities, highly liquid and therefore can be substituted with other forms of money to some extent[29]. This substitution shrinks the bank's balance sheet and increases the central bank's balance sheet. The latter's balance sheet increases because it creates a new liability (CBDC) on top of its existing liability, cash. On the contrary, banks' balance sheets shrink as they hold fewer deposits. If CBDC replaces cash fully, the results would still hold but the Central Bank's balance sheet would increase less as some of the issued CBDC would replace cash in circulation. The results would stay similar for banks if CBDC replaced cash fully, unless most of the cash was converted into bank deposits and not CBDC. In Meaning et al's framework, this does not translate to less credit because banks reduce the amount of reserves they hold. However, banks could also maintain the level of reserves they hold, in which case they would reduce the credit supply (these disintermediation risks are explored in the next section).

[29] Money market fund shares are traditionally included in the broader M2 definition of the money supply.

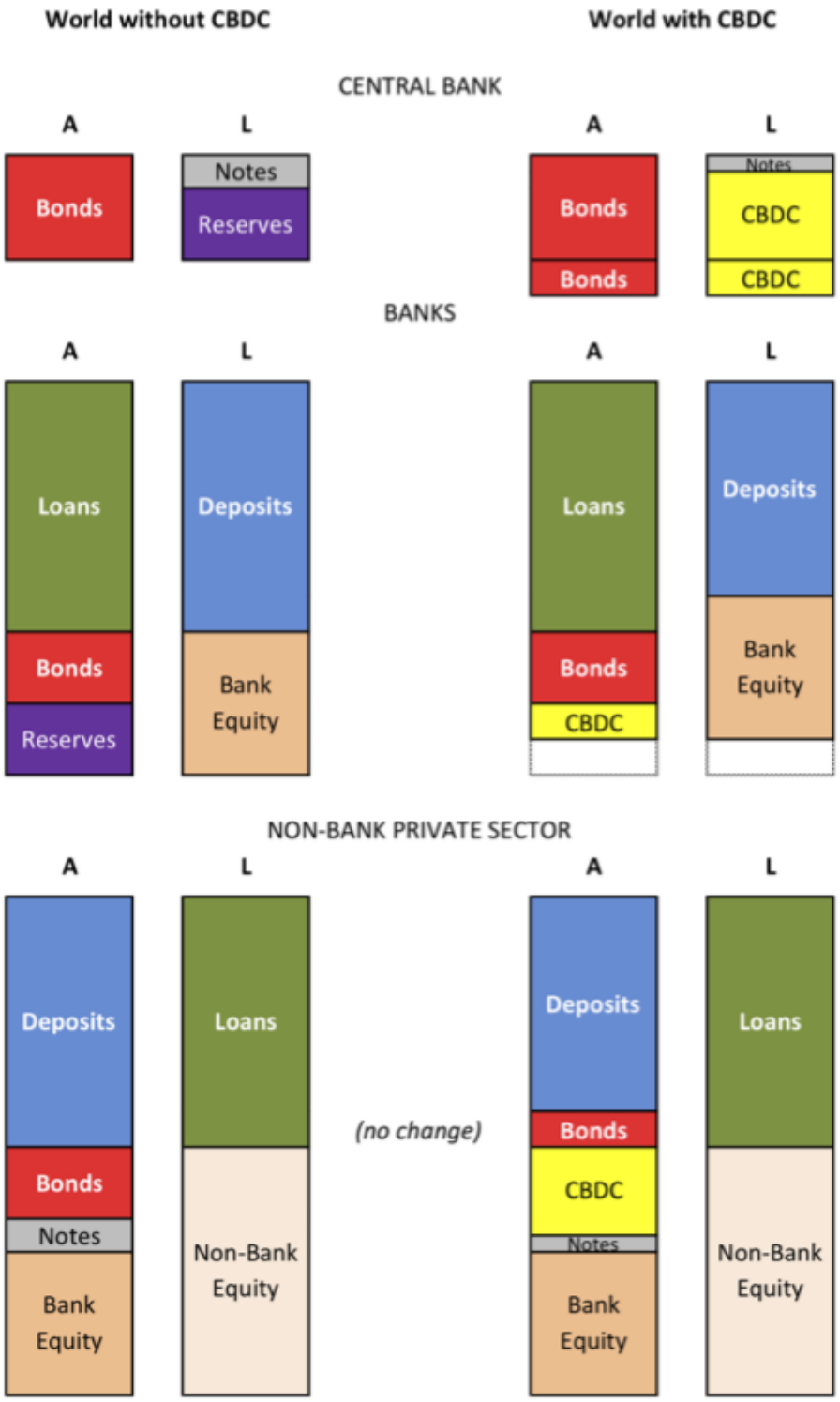


Figure 8: balance sheet implications of issuing a general purpose account-based CBDC

Source: Meaning et al (2018)

Note: In the authors' analysis, reserves disappear with CBDC because a general purpose account-based CBDC would be issued, offering different rates for banks and some financial institutions on one hand, for firms and households on the other. This setup is similar to the coexistence of central bank reserves and a general purpose account-based CBDC. Kumhof and Noone (2018) present a different model of CBDC that can co-exist with reserves and present the balance sheet implications.

In the case of a wholesale CBDC, only accessible to selected private market participants, a similar mechanism would be at play. During a financial crisis, investors would disinvest from riskier financial assets and the demand for CBDC would increase as part of a flight to safety. However, on those markets, safe assets already exist in the form of near-money instruments, which are very liquid, risk-free and have a low yield, such as money market funds, Treasury bills or certificates of deposit. As a result, after a CBDC is introduced, wholesale investors could reallocate their assets from these safe assets to CBDCs even in the absence of a financial crisis if CBDC is deemed more attractive. Compared to the retail case, it is less clear if such a competition between CBDC and near-money financial instruments (compared to bank deposits) is a risk or an opportunity due to rollover risks. Since the Global Financial Crisis, a global rising demand for safe assets (Caballero, Farhi, Gourinchas, 2017) has led to a decrease in the interest rates on the money market. While the decrease of the interest rates appears to be global (see Section 1.3), this higher demand for safe assets could incentivize investors to fund long-term assets with short-maturity liabilities. The underlying rollover risks could increase the financial stability risks: as the short debt matures and must be renewed, an unanticipated rise in interest rates could destabilize the financial system. In this context, some have proposed that central banks issue a safe asset to increase the overall supply of safe assets to reduce the rollover risks (Stein, 2012). The Bank of International Settlements' Committee on Market Infrastructures and Payments' report details those risks and the literature on this topic (BIS, CPMI, 2018).

As a result, the issuance of CBDC could have adverse consequences for the financial sector as CBDC substitutes for other assets on both the retail and the wholesale markets. These risks would be particularly important during a financial crisis and a subsequent bank run but such a substitution could also have adverse effects on the structure of the financial markets and financial intermediation. Beyond those theoretical considerations, assessing those risks is difficult.

5.2 Public money and financial stability

Historically, there have been many instances where both public and private means of payment and stores of value were in competition. For instance, most central banks did not always have a monopoly on banknote issuance, and private and public banknotes have coexisted for prolonged periods in many countries (Figure 9). Before central banks acquired a monopoly on issuing banknotes, most banks could either freely issue banknotes or had to back those banknotes with commodies or government securities in the case of the free banking era in the United States (see Söderberg, 2018 for a comparative analysis of banknote competition and early central banking in the US, UK and Sweden).

Using these historical cases help understand how competition between private currencies would work (see Villaverde and Sanches, 2018, for a more detailed discussion) but do not give insights into what would happen if similar forms of private and public money co-existed.

Country	Central bank founded	Decision on banknote monopoly
Austria	1816	1816
Norway	1816	1818
Denmark	1818	1818
United Kingdom	1694	1844
France	1800	1848
Belgium	1850	1850
Netherlands	1814	1863
Spain	1874	1874
Germany	1876	1876
Japan	1882	1883
Finland	1811	1886
Portugal	1846	1888
Sweden	1668	1897
United States	1913	1913 (banknotes backed by the state since 1863–1864)
Italy	1893	1926

Figure 9: Establishment of the central bank and introduction of a public monopoly on banknotes in selected countries

Source: Capie et al (1994)

However, in the United States, even though the newly established Federal Reserve acquired a monopoly to issue banknotes in 1913, private banknotes from national banks were not immediately removed and were slowly phased out. They were completely removed from circulation in 1935. From 1914 to 1935, the United States used two types of banknotes, some private and others public. Both types of banknotes were considered safe, because the national bank notes (private money) were guaranteed by the Federal Government and could be exchanged for Federal Reserve notes (public money), which were issued against government bonds. Furthermore, both types of banknotes were partially backed by gold, given that the US operated under the gold standard. The Federal Reserve notes were mainly issued to help the Federal Reserve act as a lender of last resort to stabilize the banking system after it had experienced seven bank runs in the second half of the 19th century (Gorton, 2012). Therefore, we can assume that when Federal Reserve notes were introduced, the public was sufficiently concerned with the safety and liquidity of the different banknotes. Overall, however, the phasing out of private cash was not the result of users' preference for a public currency because both forms of money were considered equally safe and were equally convenient to use in payments (Federal Reserve Notes could be used for all official payments, such

as customs and taxes), given that they had the same denominations (See Weber, 2015 for an extensive analysis of the 1914 – 1935 period in the United States and how it can inform the debate on CBDC[30]). Banks were able to use the Federal Reserve notes as reserves against deposits while their banknotes were still in circulation. Overall, one main lesson can be drawn from this period. Users can consider that private money is as safe and liquid as public money. Credible deposit insurance schemes covering all deposits, thus making private money equally safe, could then curtail risks of large bank deposits withdrawals.

Another development in the history of financial markets provides a better proxy for a Central Bank Digital Currency. Postal banking services and state-saving institutions were developed in the 19th and 20th century to provide financing for the government while incentivizing household to participate in the financial and banking system instead of hoarding cash. They provided two main services to depositors. First, they granted access to deposit facilities and savings accounts, usually invested in government bonds. In that sense, postal saving institutions operated as narrow banks, re-investing all their deposits in safe financial assets, using the earned interests to pay interest to depositors. Postal banking and state-saving institutions did not usually provide loans. Secondly, postal banking services usually provided access to means of payment such as short-term deposits and checks. They benefited from a direct or indirect government guarantee on the deposits they held, making them safe and liquid assets for the public. Compared to government securities and other safe assets, postal banking deposits and savings were highly liquid (deposits could usually be withdrawn on sight or with a very short notice) and more accessible[31].

The first postal bank, the UK Post Office Savings Bank, was established in 1861 in the United Kingdom. This model was replicated in many other countries, such as the United States, France, Germany or Japan. State-saving banks only provided a savings account, which could serve as a means of payment in some cases. One of the first system of state-savings banks was established in France as the *livret de caisse d'épargne nationale*, later renamed the *livret A*. Many postal banks and state-saving banks today are either no longer in operation (in the US, for example) or have become traditional banks following privatization (as is the case in France, Germany and Japan).

At first glance, these institutions appear very different from the proposed frameworks for CBDC but several features make them a good proxy for the latter (Andolfatto, 2018 makes a similar argument, focusing on the government guarantee of the accounts and on the similar objectives attributed to CBDC and postal banking). First, the public guarantee they benefit from is similar to the guarantee central banks offer on cash. The government, just like the central bank, can be assumed to face a smaller risk of default than any private institution. Furthermore, from a political economy perspective, in a case of default, a democratic government would arguably face more pressures to repay its liabilities towards voters, such as postal banking deposits and savings, rather than its debt held by foreign investors, such as a part of government bonds, which means that postal

[30] Weber uses the term e-money to describe a digital currency that the Fed could issue in ways that are very similar to how CBDC is discussed in the literature.

[31] This distinction is key: government debt and postal banking have the same level of credit risks because the government guarantees postal banking. The risk that the postal bank defaults is the risk that the government defaults. While we argue below that postal banking could benefit from a higher level of security under some conditions, the key difference between government securities and postal banking is the ease of access, specifically for retail markets. This ease of access and use as a means of payment explains why postal banking can be a good proxy for a widely accessible retail CBDC.

banking could even be perceived as safer than government debt under some assumptions[32]. Furthermore, a parallel can be drawn between the introduction of postal banking and CBDC from a technological perspective. The ease of access to CBDC implies that a flight for safety would be easier in case of a banking panic. Similarly, post offices were chosen to provide financial services because they were accessible to most of the population, far more so than banks. This facilitated flight-to-safety behaviors, as depositors could withdraw their money held at banks and deposit it at the local post office where it would benefit from a full guarantee. Their introduction also led to a debate that mirrors the one on CBDC in several ways. The introduction of postal banking was often the result of several attempts and faced some opposition, notably from banking lobbies. The first proposal to establish a savings bank in the UK dates back to 1807 but the proposals were defeated due to lobbying from the banking sector until 1861.[33] In the French case, Antiste, Oger and Salanon (2007) study the introduction of the *Chèque Compte Postal (CCP)* in 1918, which allowed any French resident to open a bank account at the post office and use postal checks as a means of payment. The system was managed by the *Ministère des Postes, des Téléphones et des Télégraphes*, a government administration. Opponents of the policy argued that providing financial services was not the main function of the government. Competition between banks and the post office would also be unfair given the guarantee offered to deposits at the post office by the government. In the United States, opposition to the establishment of the US Postal Savings Systems highlighted that such a system would likely remove deposits from banks at the local level and use those deposits to fund the government, reducing local credit instead. Additionally, the government's involvement in providing financial services was also challenged on constitutional grounds (Sprick Schuster, Jaremski and Ruth Perlman, 2019). The first argument is similar to arguing that a central bank is ill suited to provide retail banking services. The second and third arguments show that postal banking was believed to facilitate the withdrawal of bank deposits both during and outside episodes of banking panics, with adverse consequences on banks and their ability to provide credit, in a similar way that CBDC could reduce banks' balance sheets and credit supply.

Overall, postal banking was a form of public money, widely accessible at the time compared to alternative technologies and account-based. Studying the response of postal banking to three financial crises and the impact on the banking sector can therefore shed some light on the CBDC debate, specifically because many of the policies proposed to curtail some of CBDC's risks, such as capping deposits or introducing lower interest rates than bank deposits have been put in place in the case of postal banking to address similar risks. In the next section, we analyze three cases where postal banking and bank deposits coexisted in times of banking panics and show what insights can be drawn to estimate CBDC's likely effects, as well as the impact of specific policies introduced to mitigate risks, such as deposit insurance, lower interest rates than bank deposits, as well as capping deposits.

[32] A similar argument can be made for dictatorships. The two main pressures for dictators, as identified by Svolik (2012), are to avoid the threats of revolution while insulating themselves from being overthrown by other members of the rent-seeking elite. If a large part of the population holds postal savings, the government would still be incentivized to guarantee the deposits in case of default.

[33] National Savings and Investments, the current name of the UK post office savings bank, presents the organization's history https://nsandi-corporate.com/about-nsi/our-heritage-timeline#foundation_1807

5.3 Postal banking during financial crises

5.3.1 The United States Postal Savings during the Great Depression

From 1911 to 1968, the United States Government operated a postal bank. Based on the United Kingdom Post Office Bank's framework, the United States Postal Savings granted the possibility for every resident to open an account and deposit money at the local Post office, up to 500$ in 1911, the cap being later increased to $1000 in 1916 and further increased to $2500 in 1918 (See Sprick Schuster, Jaremski and Ruth Perlman, 2019, Davidson and Ramirez, 2016 and O'Hara and Easley 1979 for details on the system, its history and its links with bank local presence, state-wide deposit insurance and its impact on credit during the Great Depression, respectively). Depositors could freely convert their deposits into bonds, offering higher interest rates, or the balance on their account was otherwise used to buy government bonds, in which case depositors benefited from lower interest rates but higher liquidity. To address concerns raised by opponents that such a design would deprive local banks of the necessary funding to finance the local economy, the US Post Office had to offer to re-deposit a part of postal savings to banks in exchange for receiving interests.

Between 1911 and 1930, half a million Americans deposited between 50 and 500 million at the US Postal Savings: there was significant variation in both deposits and withdrawal, the sum of which totaled more than 130% of the system's balance. Furthermore, less than 2% of deposits were exchanged for bonds. These two facts would suggest that postal savings was primarily used as a very liquid store of value or means of payment, instead of an investment product.

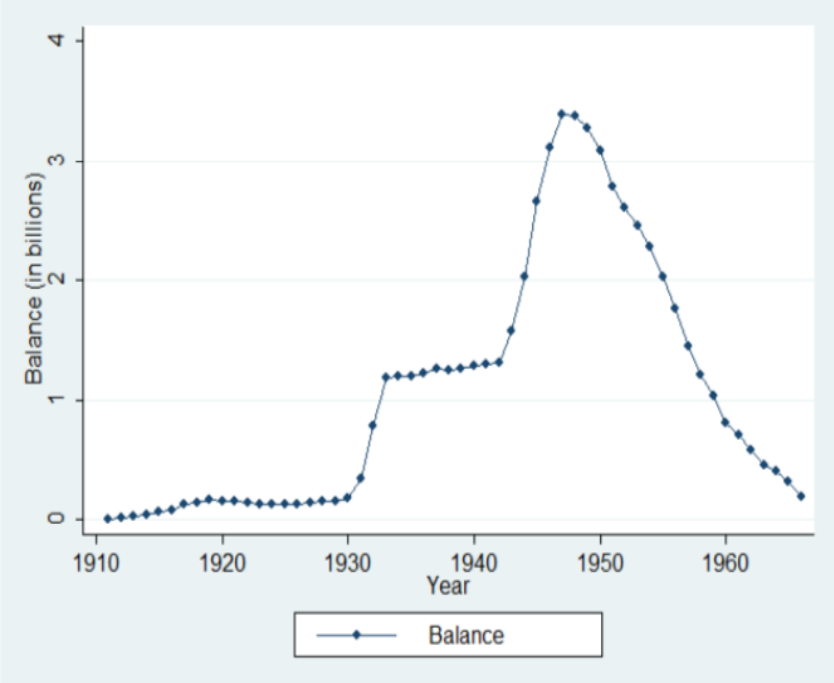


Figure 10: Balance of the US Postal Savings

Source: Sprick Schuster, Jaremski and Ruth Perlman (2019)

Then, from 1929 to the end of the Second World War, US postal savings increased dramatically, with a growth rate over the period of 700%, from 175 millions before the Great Depression to 1,2

billion dollars by 1940. The US postal savings saw its balance continuously increase throughout the Second World War. After 1950, however, the balance starts to decrease, as the system loses in popularity until it was disbanded in 1968 due to a small number of depositors. The literature explains this overall evolution of US postal savings by the increasing access to the traditional banking system, the rise of federal deposit insurance, and changes in interest rates. During the Great Depression, the exponential increase in the US postal savings system' balance highlights how the system was used as part of a flight for safety. Davidson and Ramirez (2016) also show that during the Great Depression, high deposits in postal savings were correlated with more money in circulation and lower bank deposits. They conclude that both cash and postal savings were vehicles for a flight-to-safety from banks. These analyses have various implications for the debate on Central bank Digital Currencies, which we develop below.

Firstly, there is evidence that the US Postal Savings fostered financial inclusion by providing basic financial services to rural areas where banks were less present, especially in the early years of the system. From 1911 to 1919, the distance to a bank was a significant factor in explaining if the system was popular among depositors. The installation of a national bank in a one-kilometer radius reduced the amount of postal banking deposits, on average, by 33% (Sprick Schuster, Jaremski and Ruth Perlman, 2019). Similar but smaller effects are found for smaller banks (state banks) and varying distances. As a result, a public form of money can be introduced successfully to improve access to financial services. As banks arrive in underbanked regions, depositors switched to the private form of money (bank deposits) that became available. Furthermore, it appears that postal savings mainly served as a store of value and a safe asset. When sufficiently safe alternatives existed, such as national banks (arguably more regulated and less risky for depositors than smaller state banks), postal savings were withdrawn. This historical example shows that the creation of public money like CBDC could improve financial inclusion in developing and emerging countries without reducing banks' funding significantly.

By 1934, the federal deposit insurance scheme (FDIC) was introduced in the US, following the Great Depression. However, by 1929, several states such as Mississippi, North and South Dakota had already introduced a form of deposit guarantee at the state level. In some states, deposit insurance schemes were also discontinued (for instance, Washington in 1921 and Nebraska in 1930). Sprick Schuster, Jaremski and Ruth Perlman (2019) use this discontinuity to compare states with and without deposit insurance, as well as the same states before and after the scheme is introduced or discontinued. Davidson and Ramirez (2016) compare postal banking deposits at the border between states with a deposit insurance scheme and states without deposit insurance. Overall, the presence of a deposit insurance scheme decreased postal banking deposits by 16,5%. After deposit insurance is discontinued, postal savings grew 50% faster and 100% faster if the deposit insurance scheme functioned on a compulsory basis. In both cases, the introduction of deposit insurance appears to have limited the amount of money Americans saved at the Post Office. Finally, after the Federal Deposit Insurance (FDIC) was introduced in 1934, regional variance in postal deposits dropped dramatically, confirming these results. The first implication is to confirm that postal banking was mainly attractive, at that time, because they provided liquid and safe deposits. Davidson and Ramirez as well as Sprick Schuster, Jaremski and Ruth Perlman argue that postal banking functioned like complimentary deposit insurance at that time in states where deposit insurance had already been introduced. Americans used the Post Office to safeguard up to $2500 of deposits outside of the deposit insurance scheme. Empirically, more bank failures locally were

associated with higher deposits on postal savings[34]. However, as soon as the private sector is able to provide a safe and liquid product (when credible deposit guarantee is introduced), the demand for postal banking diminishes. As a result, public and private forms of money can coexist without public money necessarily substituting for private money, if there is a credible deposit guarantee or insurance.

The fixed interest rate of 2% paid by the Post Office was low in 1911 compared to interest rates offered by banks on deposits, which were around 3,5%. However, by 1940, the interest rate offered on postal savings was equal or higher than that of bank deposits or even municipal bonds. By contrast, the fixed 2% interest rate of postal savings was inferior to other interest rates on bank deposits and bonds by 1945, which explains why postal savings were not popular after the Second World War (Sprick Schuster, Jaremski and Ruth Perlman, 2019). However, one of the consequences of the fixed interest rates was that in the 1930s, re-deposits of postal savings was low, reaching 5% by 1939 because banks had to pay high interest rates to the Post Office.

Overall, the relative appeal of postal savings compared to bank deposits appeared driven by the interest rate outside of the financial crisis period of 1929 – 1930s, and by its safety once the crisis hit and as some banks failed. In the case of CBDC, this could imply that the risks of bank runs would be heightened, but that outside periods of financial stress, CBDC would not heavily substitute for bank deposits and threaten current banks' business models.

5.3.2 The *caisses d'épargne* during the 1931 banking crisis in France

In France, safe saving institutions, called *Caisses d'épargne*, were introduced in the early 19th century and the first *Caisse d'épargne* was created in 1818. They offered a financial product called the *livret de caisse d'épargne*, nowadays called a *livret A*, a liquid sight deposit that was guaranteed by the savings bank and which paid a relatively small interest rate. The funds were invested in bonds and available rapidly: by law, depositors could withdraw funds with no more than a notice of eight days. However, in practice, payment was faster, even immediate (Coupry, 1935). In 1837, funds collected by these saving institutions became centrally managed by the *Caisse des Dépôts et Consignations,* placed under the control of Parliament, this institution was tasked with providing short-term financing to the government by buying public debt. The *Caisse des Dépôts et Consignations* did so using the deposits gathered by the *caisses d'épargne*. In exchange, the government guaranteed the deposits held in *caisses d'épargne.* Finally, in 1882, the government started providing its own *livret de caisse d'épargne* through the creation of a *Caisse d'épargne nationale* whose savings products were distributed through the network of post offices.

As a result, starting in 1837, these savings banks effectively gave depositors access to a public form of money paying an interest rate set by the government. Figure 11 plots the interest rates of *caisses d'épargne*'s savings accounts against the policy rate of Banque de France, the long-term interest rate and the rate on money markets. Overall, the interest rate offered by *caisses d'épargne* was lower than the long-term interest rate and the policy rate. However, around 1930, both of those

[34] While these results are consistent with depositor behaviors at that time, we cannot rule out that higher deposits at the Post Office would reduce the available funding of banks, causing more banks to fail.

rates decrease sharply while the interest rate on *caisses d'épargne*'s savings accounts only slightly decreased. This means that around 1930, the interest rate spread or risk premium on these savings was not particularly large. Finally, deposits in *Caisses d'épargne* were capped, but the cap was increased during March 1931, due to an inflow of deposits, to 20,000 francs for individuals (from 12 000 initially) and from 50,000 to 100,000 for corporations (Baubeau, Monnet, Riva and Ungaro, 2018).

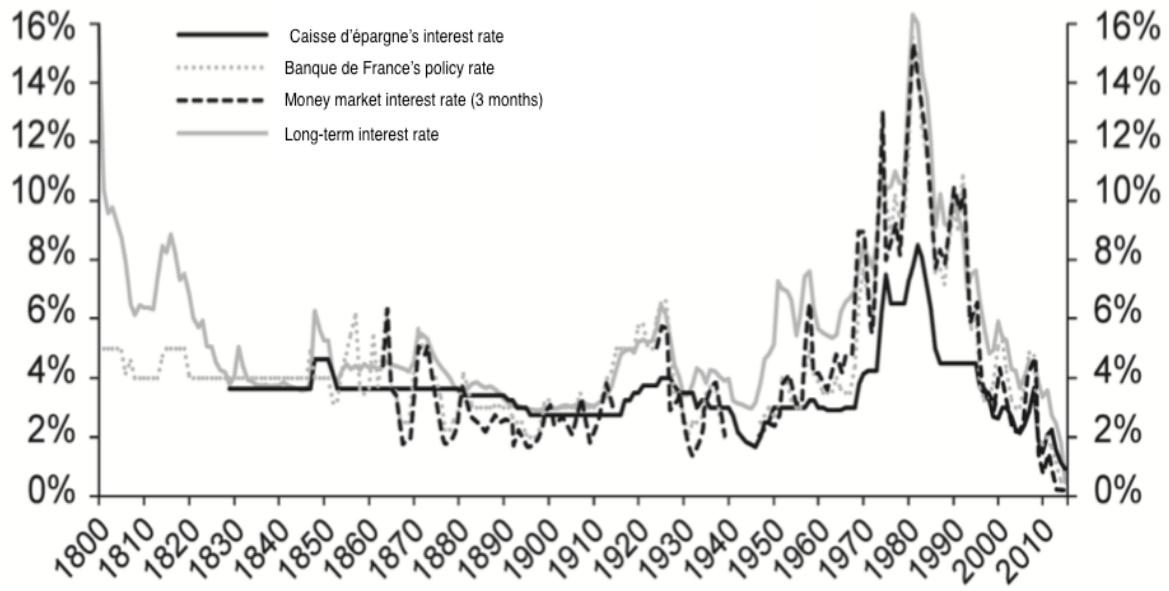


Figure 11: Interest rates in France between 1800 and 2010

Source: Monnet and Levy-Garboua (2017)

For this case study, we focus on the French banking crisis of 1930 – 1931. Starting in October 1930, the French banking sector experienced two waves of panic, the first ending in early 1931 and the second occurring throughout the second half of 1931. Baubeau, Monnet, Riva and Ungaro (2018) provide a detailed analysis of the crisis and use a new dataset to show that an important flight-to-safety was fueled by *caisses d'épargne* and the safe state-guaranteed savings they provided. They show that the crisis led to many bank failures among small and medium-sized banks, while the larger banks were not particularly affected. As figure 12 shows, the panic of 1930 – 1931 caused a sharp drop, around 40% of banks deposits, for all banks except the larger banks that didn't experience a run.

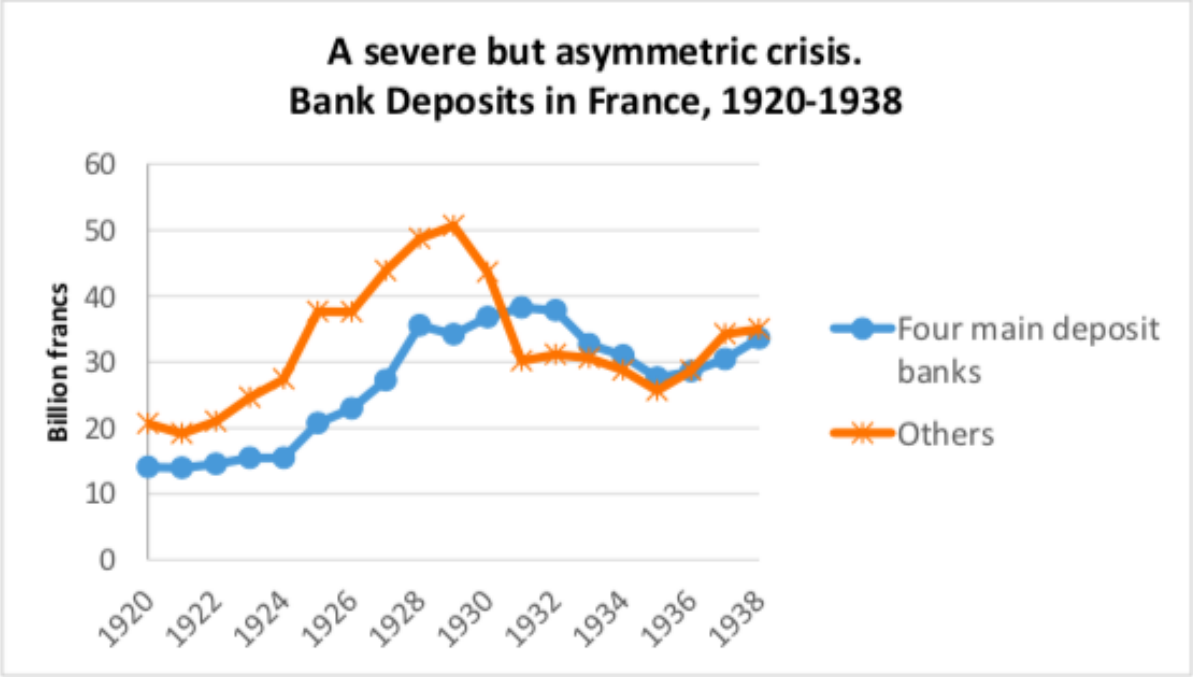


Figure 12: concentration of bank run risks among small and medium large firms during the crisis

Source: Baubeau, Monnet, Riva and Ungaro (2018)

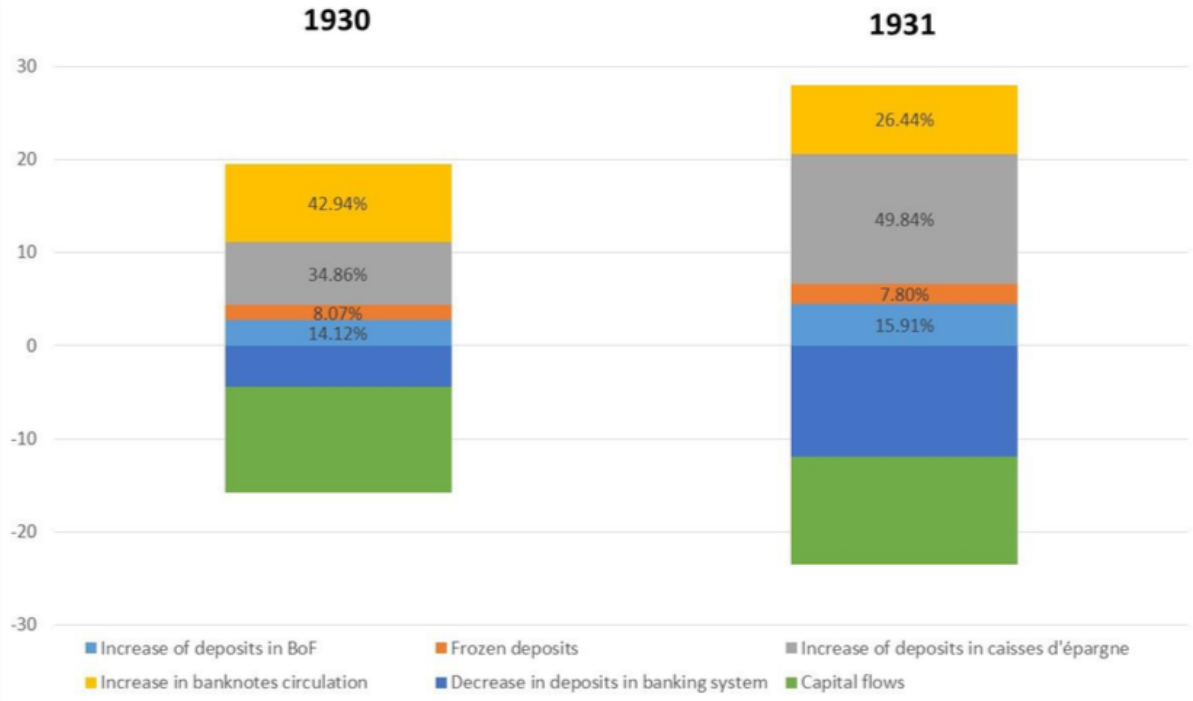


Figure 13: Flight to safety and deposit withdrawal during the crisis

Source: Baubeau, Monnet, Riva and Ungaro (2018)

Baubeau, Monnet, Riva and Ungaro (2018) use detailed data from banks' archive to show where the withdrawn bank deposits went (Figure 13, in dark blue). During that period, France experienced

a net positive flow of foreign capitals (in green), which, on top of the bank deposits, was allocated to other forms of money. First, we can see that cash (in yellow) played a significant role in the bank run the first year, as the increase in cash represented 43% of decrease in bank deposits and the imported capital. During the second year, only 26% of these funds were allocated to cash. The savings in *Caisses d'épargne nationale* (in Grey) increased sharply and were doubled over the period, absorbing 35% of the deposits fleeing the banks and capitals from abroad the first year, and 50% the second year. The third factor in this flight-to-safety episode was the individual accounts held at the Banque de France by corporations and banks (light blue). During the crisis, 15% of the fleeing money ended up at the Banque de France's deposit facilities (see Baubeau, 2018 for an historical analysis of the Banque de France's balance sheet). The remaining funds from withdrawn deposits remained frozen due to bank failures (8% of the overall funds).

This analysis has several implications for the CBDC debate. First, as in the American case, we see that public monies other than cash facilitate flights to safety, in accordance with predictions from the balance sheet analysis conducted in section 5.1. In this situation, both the central bank's individual deposit account and the *livrets de caisse d'épargne* share the public nature of a CBDC. The Banque de France's deposit facilities were public forms of money used by the Central Bank to buy gold reserves. However, in terms of accessibility, those deposit facilities would model a wholesale CBDC while the *livrets de caisse d'épargne*, being distributed through a very large network of local saving banks and institutions would arguably resemble a general-purpose CBDC. All in all, both examples would suggest that a widely accessible account-based form of public money would greatly facilitate a flight to safety, could destabilize the financial system: empirically, they fueled flight to safety behaviors more than cash. However, we can't infer definitive conclusions on the nature and likelihood of financial stability risks due to the introduction of a CBDC from this experience. In particular, the low interest rate spread between safe savings and other interest rates as well as the absence of a deposit insurance scheme could have heightened the flight to safety, so that this historical example could represent an extreme case compared to today. However, this example does provide insights into the risks of financial disintermediation when public forms of money are widely available (further discussed in Section 6).

Since then, the *caisses d'épargne* have been privatized in France. However, the *livret de caisse d'épargne nationale,* now called *livret A*, remains an attractive saving product in France, with 245 billion euros deposited as of January 2019 according to data from Banque de France. Deposits on this account are tax-free and still benefit from a state-guarantee outside of the deposit insurance scheme, which covers regular bank deposits. Deposits on the *livret A* no longer directly finance the government. Instead, they are partly used to fund specific policies such as providing social housing and supporting small and medium-sized firms. During the Financial crisis of 2008, deposits on the *livret A* increased but concomitantly, a banking reform in early 2009 widened its distribution.[35] It is therefore hard to disentangle the effect of this policy from a possible flight to safety. As a result, for the purpose of our analysis, the use of state-backed savings in France during the 2007 – 2008 financial crisis is not a good proxy to assess the effect a CBDC could have on the financial system. However, later on in 2013, the deposit cap of the *livret A* was raised to accommodate the rising demand for liquid deposits, similarly to how the cap was raised in 1931 as more depositors were

[35] The policy was announced before 2009, so anticipations of the rise in the deposit cap could have fueled deposits during the crisis. We cannot interpret a sudden rise in deposits on Livret A as a consequence of a flight to safety.

looking for safe savings. This would tend to imply that when governments or central banks provide a safe asset to the public, using caps on deposits in part to tackle risks of bank runs might not prove effective if policy-makers face political pressures to accommodate the rising demand for safe savings (see Madec, 2013, for a discussion of the risks and benefits of the *livret A* in this context).

5.3.3 The National Savings & Investment Bank in the UK in 2008

Created in 1861, the Post Office Savings Bank functioned both as a savings bank and a deposit bank. Both deposits and savings were used to finance the government through the purchase of bonds. Initially, a cap was introduced to limit deposits at £30 a year, with an overall cap on accounts at £120. Interest rates on deposits were low to avoid unfair competition with traditional banks. By 1908, 50% of Britons held an account at the Post Office Savings Bank, and deposits totaled 781 million pounds. By 1969 and 1971, the Post Office Savings Bank became the National Savings Department and then the National Savings & Investment Bank, placed under the authority of the Treasury. To this day, the National Savings & Investment Bank remains a government agency and takes part in financing the British government. The agency receives financing objectives from the government, which it meets by selling various savings products. Aside from traditional savings instrument that pay regular interests, some products function as a lottery (Premium Bonds), where savers are eligible to win a prize by buying bonds. Interest rates are lower than saving products from private banks and all savings products are capped at various levels: for instance, premium bonds are capped at 50 000 pounds. Investment accounts are capped at 1 million pounds and Directsaver, a saving product entirely digitally managed through a mobile phone is capped at 2 million pounds. All deposits and savings are guaranteed by the UK Treasury and advertised as such on NS&I's website. As a comparison, deposit insurance in the UK only covers 85 000 pounds per bank account since 2017[36].

To analyze how the NS&I could have facilitated flight to safety behaviors during a financial crisis, we study how deposits evolved in 2007 – 2009. During the 2007 – 2008 Financial Crisis, the UK's banking sector experienced significant stress as early as September 2007 when Northern Rock, a UK bank, faced financial difficulties and was eventually nationalized in 2008. At the end of 2008, Bradford and Bingley Building Society was nationalized and the British government acquired parts of Royal Bank of Scotland Group's capital. To study bank run behaviors, we therefore want to see if bank deposits were withdrawn from the beginning of 2007 until the end of 2008 amidst fears of banks failing, leading to bank runs. While results cannot be interpreted causally, a large rise of savings flowing into NS&I at that time while bank deposits fall would suggest that our proxy for a CBDC could facilitate a flight to safety. To test that hypothesis, we collected data on the National Savings & Investment Bank from its annual reports, available from 2004 to 2017.[37] Using the product investment tables, we are able to construct a dataset tracking both the total amounts invested and the net flow of savings into NS&I. We use data from the Bank of England on the

[36] From the Financial Services Compensation Scheme's website: https://www.fscs.org.uk/what-we-cover/banks-building-societies/

[37] All reports are available here https://nsandi-corporate.com/performance/historic-annual-reports

amounts of cash and bank deposits[38] held by British households at that time. The following figures show our results.

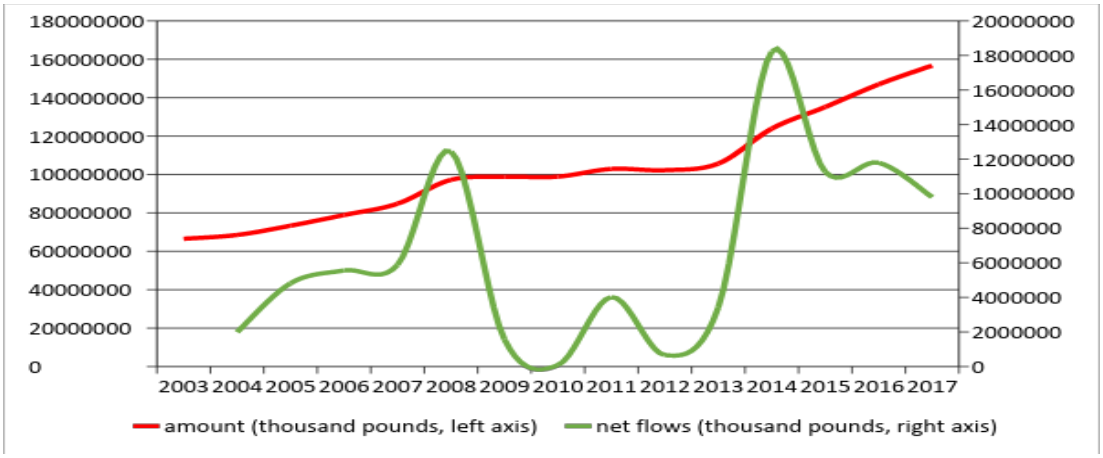


Figure 14: Change in the amount of savings invested in NS&I

Source: NS&I annual reports, author's calculations
Note: NS&I's annual reports provide annual data starting in March. In NS&I's reports, changes reported in 2009 occurred between March 2008 and March 2009, mostly in 2008. To allow for a comparison, we use the values for the year as those for the previous year. The flows from March 2008 to March 2009 are reported as the flows for the year 2008 in the graph.

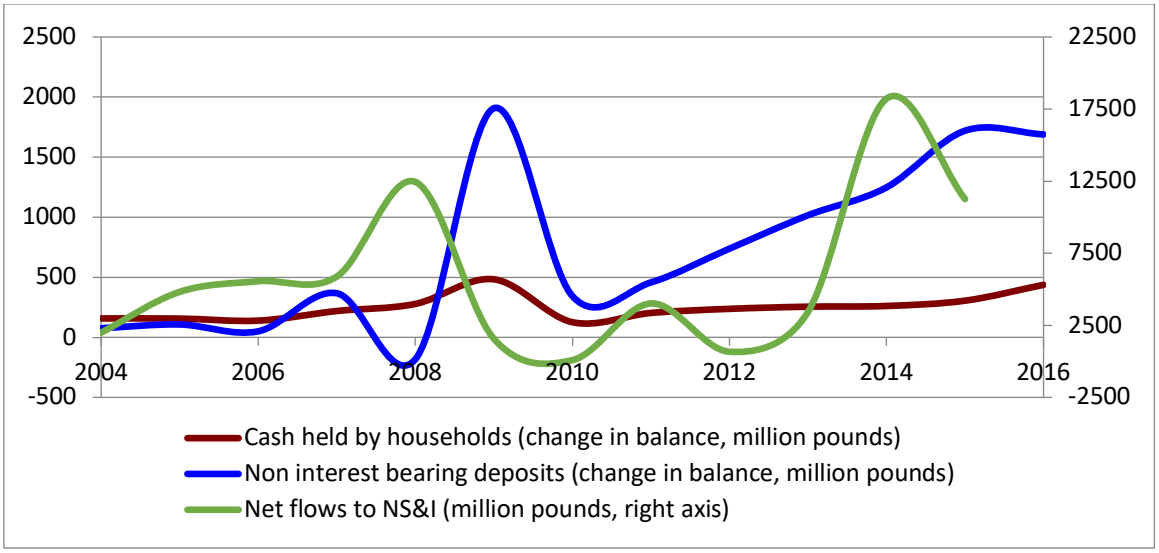


Figure 15: Evolution of NS&I savings compared to other monetary aggregates.

Source: Bank of England, NS&I annual reports, author's calculations. Data from the Bank of England is seasonally adjusted.
Note: Data for cash includes banknotes and coins held by households. Data for cash and deposits reflects the average value of the monthly balance change during the year. NS&I reports annual data starting on March 31st. To allow for a comparison, we use the values for the year as those for the previous year. The flows from March 2008 to March 2009 are reported as the flows for the year 2008.

[38] We use data on non-interest-bearing deposits for two reasons. First, the Bank of England reports data on other forms of deposits (sight deposits and time deposits) from 2008 onwards. Using this data does not permit us to show the trend prior to 2008. Secondly, all investment products offered by NS&I pay interests. Thus, the variation of non-interest-bearing deposits cannot be influenced by the variations of savings deposited at NS&I.

Since 2004, the amounts invested in the National Savings & Investment Bank have steadily increased. However, we cannot interpret this trend as a rise for the demand of NS&I safe savings products. As the bank is tasked with providing specific amounts of funding to the government each year, its aim is not to gather as much funding as possible. The government provides NS&I with a target of funding and an interval. To achieve this target, NS&I effectively pilots how much the public invests through its interest rates and marketing. Its 2007-2008 and 2008-2009 annual reports explain how NS&I has reduced its marketing strategy to avoid attracting savings, having met its financing targets early in the year due to the important inflows. For that reason, we believe that the net inflows of savings better reflect the demand for safe money than the total amounts invested. The net inflows of saving first spiked in 2008 – 2009 (between March 2008 and March 2009) with 12 billion pounds of savings, when the financial crisis had developed. A second peak occurred in 2014 – 2015, as NS&I offered a new financial product targeting savers aged 65 years old and older. The product raised 2,3 billion in three days and for the whole year, NS&I overshot its financing target by 5 billion. Therefore, the second peak in inflows can be explained by a policy decision, while the first one cannot. These results suggest that NS&I benefited from an important flight to safety during the crisis.

In Figure 15, we compare the evolution of the flows of savings into NS&I with the evolution of cash and bank deposits held by British households at the same time. During the financial crisis, households did not withdraw deposits in the form of cash in any significant way. When looking at monthly values, we do find an increase in cash at the start of the financial crisis but over the one-year horizon, this effect is negligible and balanced by periods of lower cash use. However, banking deposits that do not pay interests fell in 2008 while savings into NS&I increased. These results are consistent with the theoretical risks of financial stability highlighted in section 5.1 and the results of the two other case studies. However, our results must be interpreted cautiously as the correlation we have presented could be explained in several different ways and we do not control for factors that could explain both variations. That being said, the case of the National Savings & Investment Bank does show that the mechanism of capping deposits into liquid and safe savings is not sufficient to prevent an inflow during a financial crisis. The capping mechanism does not appear flexible enough to prevent a sudden inflow, as is the case during a banking crisis. For two years, the NS&I overreached its financing objectives, partly because the government was reluctant to reduce savings by cancelling the offer of new savings products. NS&I therefore focused on reducing the marketing of its products to reduce the inflows. As a result, NS&I effectively raised its caps on deposits[39]. This example could also show that a Central Bank could face political pressures not to limit the supply of safe assets in the form of CBDC during a banking crisis to meet depositors' demand. Finally, the importance of inflows in this case could also be explained by the relatively low protection offered on deposits at the time in the United Kingdom.

Overall, the historical examples analyzed provide several key insights relevant for the CBDC debate:

[39] As described above, NS&I faces two forms of deposit caps. One applies to individual product accounts and is formal and legally binding. The other, less formal, is the consequence of the government giving NS&I a financing target. This effectively means that NS&I has an informal cap on the amounts of total deposits it can hold. NS&I did not comply with this second cap mechanism during the financial crisis because of the government's decision not to drastically try to reduce NS&I's savings. This translates into NS&I overall caps on savings being effectively raised.

- Public forms of money, such as state-guaranteed savings or central bank money have coexisted with private forms of money such as bank deposits. In normal times, depositors do not necessarily allocate most of their portfolio to public, safer and more liquid forms of money. Introducing a CBDC would not necessarily lead to a significant drop in banks' funding through deposits, especially if a credible deposit guarantee scheme and a negative interest rate spread are put in place.
- However, during a financial crisis, the evidence suggests that public forms of money other than cash facilitate bank runs and flight-to-safety episodes. Policies aiming to mitigate those risks had mixed results.
- In particular, the French and UK examples show that capping deposits may not be an efficient tool to limit incoming flows of deposits during a financial crisis because caps appear to be pro-cyclical and increase to meet higher demand during flight-to-safety episodes. Interestingly, policymakers may face political pressures to not reduce the supply of safe money in times of stress on the banking sector and could fail to commit to do so. These examples also show that to promote financial stability, central banks would need to adjust both the cap and the interest rates on CBDC rapidly: The US example highlighted how the inability of the interest rate paid on postal savings deposits to adapt was directly linked to a credit crunch in the 1930s. However, in doing so, they could directly face political pressures as depositors demand access to safe savings and as their income is directly affected, in nominal terms, by the central bank's interest rate decisions. The pursuit of such a policy to foster financial stability could weaken the political independence of central banks.
- While this analysis does not provide definitive empirical proof, we do believe that a more comprehensive study of postal banking across countries could help answer many questions relevant to the CBDC debate[40]. For instance, cross-country studies could estimate what was the negative interest rate spread between postal banking deposits and private banks' deposits and how much of a spread was required for depositors to choose holding deposits in private banks. Estimating this opportunity cost of safety, that is to say how much would depositors ask in terms of higher interest rates to accept holding private money instead of public money is relevant for the CBDC debate, particularly in the current context of low interest rates: if the interest rate spread asked by depositors is too high, then central banks may have to introduce negative interest rates on CBDC to avoid a run on the banks or use other tools to disincentivize holding CBDC.
- However, these historical examples also show that introducing a CBDC could have important adverse effects on the banking sector by seriously reducing its funding, particularly in times of crisis. Those risks and their implications are detailed in the next Section.

[40] The lack of data for other countries with a long tradition of postal banking, such as Germany, the UK and Japan prevents us from presenting a more thorough analysis of postal banking.

Section 6: Financial intermediation after CBDC is introduced

Outside of any stress on the financial sector, the introduction of CBDC could reduce deposits and bank's funding in a similar mechanism to the one describes in Section 5. As depositors have a preference for holding public money, banks lose deposit funding as a result, and would have to react by either attracting new funding, for example by reducing their profits and increasing their deposit rate, or reduce their balance sheet by providing fewer loans to the real economy. In the literature, these risks raise two main questions. Firstly, what would be the impact of banks reducing their balance sheets? Secondly, could they be mitigated by specific policies or banks' reactions? Three main mechanisms have been proposed to address those risks. Central banks could respond to mitigate those risks by providing more funding to banks. Private banks could replace the lost deposit funding with other funds. Alternatively, banks could seek to maintain their level of deposit funding by increasing their deposit rate.

6.1 Central Banks' policy responses

The effects a CBDC would have on financial intermediation clearly depend on the response of the central bank. To curtail the risks of financial disintermediation, a mechanism proposed in the CBDC literature is to allow for central banks to loan the excess funds received as bank deposits are withdrawn for CBDC back to the banking sector. As analyzed in section 6.2, similar mechanisms have been put in place historically following the introduction of postal savings. The failure of these mechanisms, however, does not indicate that they would prove inefficient today.

Alternatively, the central bank could directly provide loans and act as the financial intermediary between savers (users of CBDC) and borrowers. However, there is a large consensus in the literature (see Ceccheti and al, 2017 for a full discussion) underlining why central banks would not perform this task well, given that they have no experience in credit allocation and customer relations. Furthermore, such a proposal appears inconstant with most of central banks' mandate. However, following the introduction of a CBDC, central banks could be forced to do so. First, Ricks, Crawford and Menand highlight that in the framework where CBDC is issued against government debt (see Ricks, Crawford and Menand, Kumhof and Noone for a discussion on the need to establish such a framework), the government may not issue sufficient debt to accommodate the digital money supply and the subsequent large balance sheet of central banks. Instead, central banks would have to invest in other assets, such as private debt. In that context, it is unclear if central banks could issue CBDC against private debt in a non-distortionary way, prompting similar debates as to those regarding the neutrality of quantitative easing regarding the targeted economic sectors or the environmental impact (see Matikainen 2017 for a discussion). Mancini-Griffoli (2018) raise similar concerns regarding the central bank's ability to re-deposit funds at banks without creating distortions, such as favoring large banks over small banks. While the central bank could theoretically reallocate the deposit outflow towards the banking sector, relying on this mechanism to prevent disintermediation can be problematic as these reallocations choices wouldn't necessarily be perfectly neutral.

6.2 Bank deposits and lending

We now analyze the consequences of CBDC introduction in the absence of any response by central banks. Theoretically, an outflow of deposits would imply that banks reduce their supply of credit, unless they can find alternative sources of funding.[41] That has historically been the case.

During the Great Depression in the United States, the US postal savings reduced banks' deposits (Section 5.3.1, Annex): O'Hara and Easley (1979) estimate that a flight to safety towards postal savings led to a decrease of bank deposits by 17% and local mutual savings by 28% (Savings & Loans, or S&L, offered savings accounts and mortgages to households). Banks and local mutual savings responded by offering fewer loans. Using data on mortgages, O'Hara and Easley show that between 1928 and 1933, as postal savings deposits increased by $1 billion, deposits in S&L decreased by 23% ($1,4 billion). They document that the number of loans issued by S&Ls (non-bank financial intermediaries) decreased by 400% over the same period. The authors focus on S&L as they argue that these institutions were more severely hit by the deposit outflow than banks. Overall, they conclude that both banks and non-bank financial intermediaries reduced the supply of credit following a large deposit outflow towards postal savings. Comparing states where postal savings were largely re-deposited with states where postal savings were not re-deposited, they argue that the second group of sates was more severely hit by the recession due to the credit crunch. This mechanism is, according to them, one of the explanations of the severity of the recession. However, the authors point to two main policy failures to explain why postal savings had a negative impact on the credit supply. At their inception, postal savings had specifically aimed to avoid disintermediation risks through two mechanisms. Firstly, postal savings would pay a 2% interest, lower than the 3,5% interest rate offered by banks in 1910. Secondly, the Post Office would have to re-deposit most of its funds to banks, which would pay the post office 2,25% interest on those deposits. However, a law set the interest rate on postal savings. As a result, Congress had to approve any change in the interest rate. This safeguard mainly failed, as by 1939, less than 5% of postal savings were re-deposited at banks. During the Great Depression, O'Hara and Easley show that not only were re-deposits very low, they were also concentrated in states with larger and more resilient banks, which increased the number of bank failures in other states. This concentration of re-deposits can be explained by the 2,25% interest rate banks had to pay on re-deposits. By 1929, this interest rate was comparable to other interest rates, and re-deposits became costly for banks, which often refused to take them on. Because of the inability to change the interest rate on postal savings without going through the legislative process, postal savings led to financial disintermediation. A second factor appears to be that the initial framework addressed the risks that postal savings could lead to bank deposits withdrawals, but not other forms of deposits held by households at other financial institutions. This focus on banks is also partly responsible for the credit crunch of 1929.

Baubeau, Monnet, Riva and Ungaro (2018) find similar results for the 1931 crisis in France. They show that the flight to safety towards state-backed savings and central bank deposits led to a severe credit crunch (Figure 16). From 1920 to 1929, over 60% of all deposits (both at banks and in state-savings banks) in France were transferred to firms in the form of loans (in blue and orange). By 1931, however, less than a third of deposits were transformed into loans by banks. This large

[41] This possible effect does not contradict the money multiplier effect (see McLeay, Radia and Thomas, 2014 for a discussion) which highlights that deposits are created when banks emit loans. Indeed, banks can reduce the credit supply as a response of a decrease in deposits to maintain the structure of their balance sheet.

disintermediation is explained by the flight to safety towards state-backed savings (*caisses d'épargne*) and central bank deposits, and, consequently, the decrease in deposit funding for banks. Furthermore, the public sector (included in the grey curve), which received these new funds, did not increase its credit supply by providing more loans to firms. The *caisses d'épargnes* used the new deposits to buy more government debt and the Banque de France increased its gold reserves after receiving more deposits. Baubeau, Monnet, Riva and Ungaro (2018) identify this as the key policy failure explaining the lasting recession.

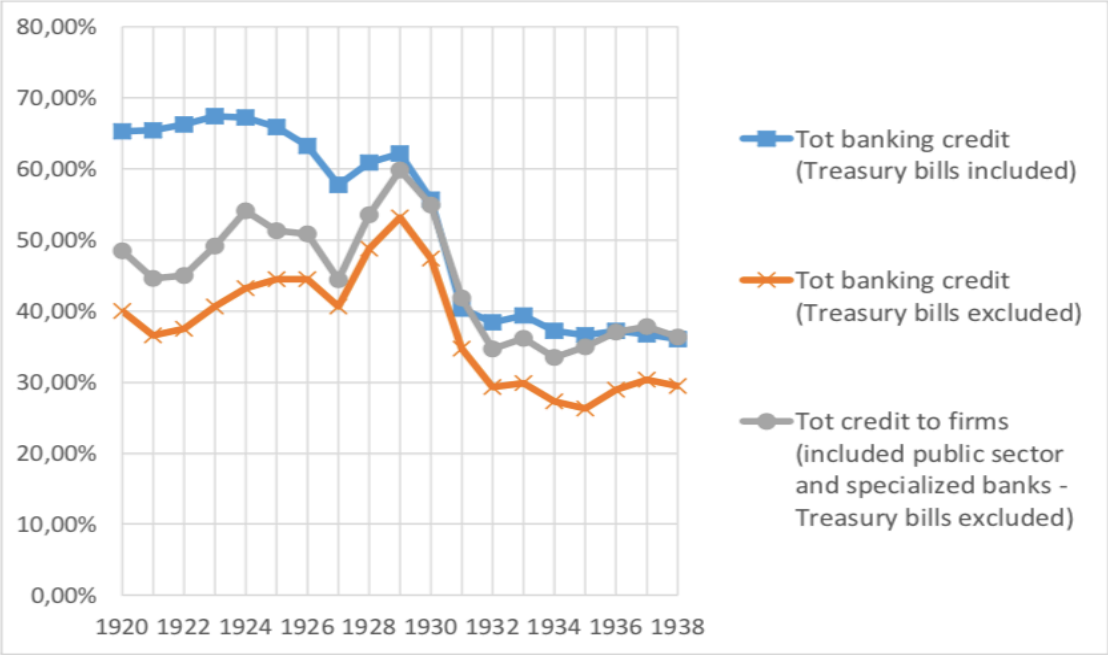


Figure 16: Credit to firms as a percentage of total deposits in France

Source: Baubeau, Monnet, Riva and Ungaro (2018)
Note: Treasury bills refer to direct loans to the Treasury offered by banks.

In both historical examples, the introduction of public account-based money was associated with an overall decrease in the credit supply in times of crisis as bank deposit decreased. However, both also point to several policy failures, which caused this decrease. In the US case, the risks of disintermediation were properly identified but the inability to quickly adjust interest rates without going through the legislative process and the fact that the re-deposits only targeted banks, and not other financial institutions supplying credit. In the French case, no specific policies to curtail those risks were implemented as the central bank didn't facilitate credit following the flight to safety and the state-savings were only invested in government debt.

In both cases, the disintermediation shock was linked to policy failures. However, it is unlikely that similarly flawed policies would be implemented today. Indeed, central banks issuing CBDC would likely have control over the interest rate on CBDC deposits. Furthermore, if their balance sheet expanded as a result of an outflow of bank deposits into CBDC, central banks could likely react by providing more funds to banks to lend. To assess the risks of disintermediation today, we therefore survey the literature.

Empirically, the link between bank deposits and lending is unclear. During the 2008 financial crisis, US banks with more stable deposit funding, which were less affected by runs and flights to safety were able to extend more loans and banks which were not able to substitute the lost deposit funding by wholesale funding reduced their supply of credit even more (Acharya and Mora, 2011). As the demand for loans increased during the financial crisis, the decrease of credit appears to be the consequence of banks' having less stable funding. Outside of any financial crisis, there is also evidence that US banks respond to decreases in deposit funding by decreasing lending: following changes in the FED's policy rate, banks change the interest rate on deposits. However, this change is not one-to-one because deposit rates are sticky. When the policy rate increases, banks partly increase interest rates offered on deposits. When the policy rate decreases, however, banks tend to decrease the interest rate on deposit in a similar magnitude to the policy rate's change (Drechsler et al, 2017). Depending on local competitive pressures[42], banks can offer different spreads (defined as the difference between the policy rate and the deposit rate). However, on the money market, rates follow more closely the changes of the policy rate. As a result, as the Fed's policy rate increases, depositors should substitute bank deposits for monetary instruments such as money market mutual funds. Drechsler et al (2017) use differences in competition on local banking markets in the US to show that banks respond to Fed's rate increases by only partly increasing deposit rates. As a result, they face deposit outflows towards the money market. On less competitive markets, banks suffer more important deposit outflows, which is correlated with a lower credit supply.[43] These results would suggest that a decrease in banks' deposit funding would decrease the overall credit supply in the economy.

However, proponents of CBDC often highlight that bank deposits' rates are sticky. Ricks, Crawford and Menand (2018) and Andolfatto (2018) show that the stickiness of deposit rates implies that banks effectively capture a subsidy on bank deposits, which they do not transit to the economy by decreasing the cost of credit. Driscoll and Judson (2013) estimate that when interest rates rise, sticky deposit rates cost depositors up to $100 billion per year. The benefits of sticky deposit rates for banks are therefore significant. Compared to deposit rates, bank-lending rates follow the policy rates more closely. As a result, proponents of CBDC argue that this discrepancy shows that bank lending is disconnected from their deposit funding. Consequently, following the introduction of a CBDC, banks could supply a similar level of credit even if they faced a deposit outflow but they would lose this indirect subsidy.

Overall, we cannot draw general conclusions on the impact a CBDC would have on lending through a deposit outflow. While a decrease in banks' deposit funding tends to be correlated with a decrease in the credit supply (both in previous crises and during the 2008 crisis), this result can be explained in two different ways: banks could use deposits to fund credit, in which case a decrease in deposits decreases banks' ability to supply credit. Alternatively, banks could mainly use deposits to capture a subsidy and increase their profits. In that case, after a CBDC is introduced, the consequences on intermediation would depend on banks' response and whether they choose to cut into those profits.

[42] These results assume that the market for bank deposits is mainly local, as depositors require the physical presence of a bank to benefit from all the services bundled with holding a deposit account at the bank, such as access to credit, means of payment, etc. However, following the mass introduction of fintechs and digital bank models, this assumption could no longer hold.

[43] Dreschler and co-authors find that this mechanism accounts fully for the transmission of monetary policy in the US.

The rest of our analysis therefore focuses on assessing the viability of the contingency measures proposed in the CBDC literature to curtail disintermediation risks.

6.3 Alternatives to deposit funding

Using wholesale funding to compensate for a deposit outflow following the introduction of a CBDC could mitigate the risks of disintermediation (Juks, 2018). However, to avoid adverse effects, this mitigation supposes that banks can have access to wholesale funding with similar characteristics (such as liquidity, volatility and maturity) and at a similar cost than retail deposits. The available evidence casts doubt on whether these assumptions would hold in practice.

As part of investigations into the feasibility of the e-krona project, Juks (2018) provides a detailed analysis of the likely reaction of the Swedish banking sector following the introduction of the CBDC. Assuming that deposit outflows would be compensated by the issuance of new market funding such as long-term debt, Swedish banks would likely face higher funding costs. Indeed, from banks' perspective, retail deposits are a cheap source of funding. Historically, the cost of retail deposits, that is to say the interest paid by banks on deposits, has been below the repo rate. As a contrary, the cost of market funding has often been above the repo rate (although following the introduction of negative nominal rates, the opposite has occurred). Using average historical values, Juks estimates that "for every 100 billion of deposits that are converted into e-krona, banks' funding costs would increase between 0 to 2 basis points depending on the level of the repo rate at the time of the outflow". While the specific costs of switching to wholesale funding are likely to vary across jurisdictions, banks' funding costs would likely increase as deposits tend to be cheaper than wholesale funding.

Furthermore, even if banks managed to reach their initial level of funding prior to the deposit outflow, the credit supply could still be affected because retail deposits are the only source of funding whose supply is not fully interest-sensitive (Dreschler et al, 2018). Indeed, as a consequence of deposits' stickiness, deposits give banks access to a stable funding that is partly risk-free. In other words, even if interest rates increase, banks can pass on only part of that increase to the deposit rate they offer. Dreschler et al (2018) show that this characteristic is unique to bank deposits, as other sources of funding for banks, such as wholesale funding are highly sensitive to changes in the policy rate. In other words, Dreschler et al highlight that deposits are a stable source of funding for banks not only because the demand for deposits is stable but also because changes in the interest rates have a smaller impact on the cost of funding for banks. As a result, they argue that holding deposits is key for banks to provide long-term loans. Else, if banks replaced deposits with wholesale funding, they would also need to hedge against risks that interest rates may rise, through interest rate swaps or increased reserves. As a result, banks would face higher costs of funding.

6.4 Maintaining deposit funding through increases in the deposit rate

An increase of the deposit rate to attract new depositors is viewed in the literature as one of the main mechanisms by which banks could maintain their level of deposit funding. For instance, Andolfatto (2018) presents a model where as long as CBDC pays a lower interest than deposits, banks can adjust their deposit rate to maintain funding and even increase it by attracting new depositors. Mancini Griffoli et al (2018) make a similar argument but argue that the impact of CBDC on intermediation would also depend on banks' ability to increase interests on loans to limit the increase of rates on deposits.

The available empirical results point to a low interest rate - elasticity of deposits so that banks would suffer significant funding costs to compensate for outflows in deposits. One study for the UK found that banks would need to increase their deposit rates significantly to retain retail deposits in case of an outflow (Chiu and Hill, 2018). Using data on UK banks between 2004 and 2013, they show that deposit rates are highly inelastic, the elasticity being between 0,1 and 0,5, meaning that a 1% increase in the interest rate offered to depositors only increases deposits by 0,5% at best, and 0,3% on average. They also compute how much banks facing a deposit outflow would need to increase interest rates to stabilize their deposit funding.[44] They report that to obtain a 1 billion increase in retail deposit, a British Bank had to increase its deposit rates by five basis points at the twelve-month horizon, 10 at the six-month horizon and 20 at the three-months horizon. For a bank holding 50 billion pounds in deposits, the cost of stopping a £500 million outflow of deposits (1% of the total deposits) over twelve months is therefore £0,25 billion in interests paid to depositors. As discussed by the authors, this estimate at the bank level is likely to underestimate the cost banks would face in case of a larger banking crisis. Indeed, in their study, a single bank facing a deposit outflow can raise its interest rates to attract deposits from other banks. In case of a larger banking crisis, more banks would need to maintain their level of retail deposit funding and would likely have to increase their deposit rate further. A similar study conducted in New Zealand (Armstrong and Mulligan, 2017) found that banks need to increase their deposit rate by 100 basis point (equal to one percentage point) to increase retail deposits by 1%. As a result, preventing a deposit outflow is costly for banks, especially when those outflows are sudden (in the UK, the cost to put an end to the deposit outflow in three months was four times greater than the cost to do so at the twelve months horizon). These results must be interpreted with a great deal of caution: the results could be heavily influenced by the impact of the Financial Crisis where depositors were specifically concerned by the safety of their deposits and depositors could be more sensitive to differences in interest rates in the future[45]. Additionally, the rise of FinTechs could increase competition in the banking sector by allowing depositors to compare interest rates on deposits offered by different banks more easily. On the contrary, these results do not account for the premium in interest rates that depositors would demand from banks. However, these studies do show that raising deposit rates to curtail an outflow of deposits is not straightforward. Banks may not be able to increase their deposit rates to keep their level of deposits constant following the introduction of a CBDC.

[44] The authors use a structural model to identify shocks to bank deposits. Then, they empirically compute the required average increase in deposit rate (RAIDR) as the observed ratio of change in deposits and change in interest for a given period after the shock has occured.

[45] Alternatively, in the context of lasting low interest rates, depositors could have become more sensitive to differences in interest rates.

An interest rate spread, as argued by some of the CBDC literature (see for instance Andolfatto, 2018; Mancini-Griffoli et al, 2018; Meaning et al, 2018; Juks et al, 2018) may not be an efficient tool to avoid disintermediation and allow banks to maintain their level of deposit funding in the context of low interest rates.

Neither the literature nor the historical case studies allow to precisely assess the risks of disintermediation should a CBDC be introduced. In the absence of any response by central banks (which is unlikely), banks' profits or the credit supply could be affected. If central banks re-deposited funds at banks, the risks of disintermediation could be curtailed. However, such a policy could have important political consequences, including for central banks' independence.

Section 7: CBDC and privacy

The economic literature has often highlighted two main characteristics of money: its liquidity and its rate of return. As a result, privacy and money have mostly been analyzed through the lens of the adverse consequences of anonymity, such as tax evasion and money laundering (Rogoff, 2014, 2016). Rogoff (2014) estimates that "a large percentage of currency in most countries, generally well over 50%, is used precisely to hide transactions" and explains the prevalence of cash use among criminals by two key properties of cash: anonymity and convenience. He points out that for criminals, the main alternative anonymous means of payment are commodities (such as diamonds), foreign currencies and small debt transfers. The latter often take the form of inflated costs in otherwise lawful transactions. Such a system, widely used as part of money laundering, guarantees secrecy instead of anonymity: both parties to the transaction are aware that costs are being inflated, However, third parties see the legal transaction and are unaware that the illegal transaction has occurred. These alternative means of payment are not convenient to use. As a result, phasing out cash would hamper the funding of criminal activities (Rogoff, 2014, 2016). For proponents of a cashless society (See Rogoff, 2014, 2016; Bordo et Levin, 2017; Berentsen and Schär, 2018), the demand for privacy in money and means of payment is thus mostly linked to the need to fund illegal activities and central banks should not actively supply a private means of payment to prevent tax evasion or money laundering.

However, this view can be challenged on two main grounds: just as cash has adverse social costs (tax evasion and money laundering), substitutes for cash also have social costs. Then, the demand for privacy could also stem from legitimate concerns so that law-abiding citizens may still demand to have anonymous means of payment at their disposal.

In a world without cash, several anonymous alternative means of payment could be used. Criminals could resort to transferring short-term debt and inflating costs in transactions. As they would face a higher demand for this cash substitute, they would increase its supply by increasing the number of small businesses used to launder money. McAndrews (2017) reviews the consequences of phasing out cash for the funding of criminal activities and argues that in many cases, corruption and extortion of small businesses would increase because of the mechanism highlighted above.

This hypothetical scenario highlights the fact that phasing out cash could have adverse social consequences, which must be weighed against the ascribed benefits of removing cash[46].

While it is clear that criminals demand a private means of payment, there could also be a legitimate demand for privacy in payment. Kahn, McAndrews, Roberds (2005) model an economy using different types of payment. They show that consumers would demand cash partly as an anonymous means of payment. In particular, they explore cases where consumers do not want to reveal their identity to the suppliers of goods and services. For instance, consumers may want to remain anonymous so as not to signal their wealth or protect their reputation. Specifically, in the digital age, consumers may also demand privacy to avoid being tracked by ads as a result of their purchase. Finally, there is also a demand for privacy relative to the issuer of the means of payment if, for example, central banks and governments are not fully trusted (see Kahn, 2018, for a review of the factors of the legitimate demand for privacy). Theoretically, there is a legitimate demand for privacy. Some empirical results confirm the theory. Borgonovo et al (2019) conduct several experiments where participants allocate funds to different forms of money depending on three characteristics: the liquidity risk, the return on money and the anonymity of the means of payment. They do find a general preference for privacy. However, the stable value of the means of payment (expected return) and liquidity are more significant determinants of the demand for money. Finally, their results also show that the demand for privacy is higher among risk-prone individuals (Figure 17). They conclude that if CBDC offered no anonymity, the use of alternatives such as cryptocurrencies would increase.

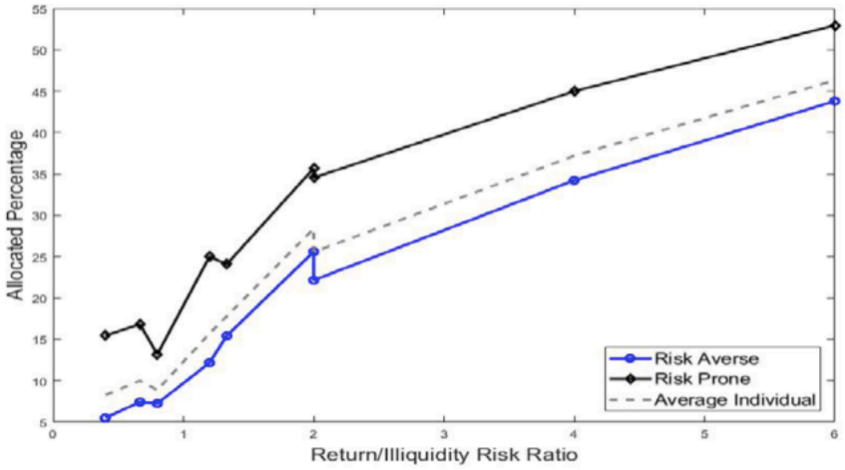


Figure 17: The demand for anonymous money depending on the risk profile of individuals

Source: Borgonovo et al, 2019

Notes: from their experimental designs, the authors estimate a demand for a means of payment that is anonymous and offers different returns compared to its risks of liquidity (horizontal axis). The vertical axis shows how much of a given portfolio is allocated to this means of payment compared to one that offers no return but is fully liquid and private and one that is not private but fully liquid and offers no return. The slope shows that as the means of payment offers significantly larger returns while the risks of illiquidity slightly increase (ratio on the horizontal axis increases), the demand increases.

In a world without cash, this legitimate demand for privacy could be met by private or public means of payment. Berentsen and Schär (2018) argue that cryptocurrencies and other private means of

[46] Cash also serves as a means to foster financial inclusion and the cost of removing cash for the unbanked and financially excluded should also be taken into account.

payment can meet that demand so central banks should not offer private means of payment. Kahn (2018) makes the argument that public institutions would not be trusted enough with issuing a private means of payment in the digital age[47]. However, the use of private means of payment should be large enough to provide privacy for legitimate use. While cryptocurrencies can be used to fund illegal activities, the same cannot be said for legitimate users. For example, a consumer with a pre-existing medical condition may want to purchase her medication in an anonymous way to avoid facing negative consequences from her insurance or his employer. She could do so using cryptocurrencies only if the supplier of the medication accepts to use cryptocurrencies as a means of payment. From the supplier's perspective, however, doing so may be costly (it requires technical expertise, cybersecurity measures to protect the digital wallet, etc.) and he would have no incentive to meet this demand for privacy. Due to network effects, a private means of payment would need to be widely used to be legitimate anonymous money. However, as the network of the means of payment grows, the operator of the means of payment has increasingly valuable data[48]. In doing so, he has more incentives to use that data for analytical purposes or to sell that data to interested parties. In other words, from the demand-side, a consumer wishing to remain anonymous requires a widely used means of payment. From the supply-side, a provider has less and less incentives to provide anonymity as its network of users grow. In this context, it is unclear if consumers would trust the central bank and the government more than such large payment service providers.

These findings and the evidence presented do not sufficiently distinguish between the various degrees of privacy, specifically the difference between anonymity and privacy. For example, the General Data Protection Regulation in the European Union[49] guarantees privacy by regulating how data can be used and processed by both public and private actors. The regulation provides several legal bases to collect data, such as consent or a legal constraint[50] and grants specific rights to European citizens, such as the right not to be subject to automated data processing (Art. 22) or the right to have access to all their collected personal data (Art. 15). This framework does not guarantee anonymity, as personal data is still collected. However, it provides transparency (which includes both knowledge of all the data that is collected and why the data is collected) to citizens on how their data is used and for which purposes. Through judicial checks and balances, citizens can then control that the data processing is lawful. Another key principal of the regulation is data minimization. Data can only be collected for specific purpose and only the necessary data must be collected. This prevents companies and governmental organizations from collecting as much data as possible on users before deciding how to use it.

In the context of a CBDC, it is unclear if the demand for privacy identified above refers to a demand for anonymity or a demand for a more limited privacy. More specifically, users could accept to use CBDC accounts where the central bank can trace all transactions if legal and institutional checks and balances prevent the government (for example for tax purposes) to access and process the data: this framework of traceability is used in Uruguay as the central bank can track all transactions in e-peso by the account number but can only identify the account holder by instructions from the judiciary. Alternatively, if the demand for privacy is mainly a demand for anonymity, users would

[47] He argues that it is hard to believe that the government could provide anonymity and not use the data on transactions to track individuals when governments continue using communications data for this specific purpose.
[48] This argument would typically apply to GAFA offering means of payment.
[49] Regulation (EU) 2016/679
[50] For instance, banks are required by law to collect personal data such as name and address to open a bank account.

not trust the central bank to collect data on transactions regardless of the institutional safeguards or data protection laws in place. A similar argument relates to the difference between anonymity and pseudo-anonymity and the risks of re-identification. Anonymity refers to the guarantee that the identity of parties of a transaction remains secret. Pseudo-anonymity only guarantees that the identity of parties is not directly revealed. However, using available information, one could "re-identify" both parties. For example, assume a central bank issues a CBDC on an account basis. The central bank guarantees pseudo-anonymity through traceability: users must disclose their identity upon opening an account but the central bank's database only tracts transactions by their account number. The central bank does not tie the account number to the name of its holder. As a result, the central bank guarantees pseudo-anonymity, as users' behavior is not directly tracked by the central bank. However, assuming the central bank also collects other data on users, such as age or income, for instance to perform statistical and macroeconomic analysis, then it does not guarantee anonymity. Cross-referencing all the data could identify the account holder. Meiklejohn et al (2013) use re-identification techniques to show that bitcoin transactions are traceable and its users can be re-identified. Using only public data recorded on the bitcoin's public distributed ledger, they manage to map the bitcoin flows and provide a methodology for identifying regular users. As a result of re-identification techniques, they argue that bitcoin would not efficiently provide anonymity when engaging in illegal activities. Therefore, the demand for privacy and the demand for different types of CBDC would also depend on users' perception and understanding of re-identification risks. Knowledgeable users could be wary of pseudo-anonymous CBDC while others could be satisfied with its degree of anonymity. As a result, more studies on the specific nature of the demand for privacy are needed to conclude how the design of CBDC and the privacy it can offer would impact the demand for CBDC

Finally, on the supply-side, some studies have argued that central banks could be constrained to provide a non-anonymous form of money to effectively fight money laundering. (For example, see Berentsen and Schär, 2018). However, central banks already provide cash as an anonymous means of payment and could do the same in a digital way if policymakers decided to do so. This argument appears to underline that the decision or not to provide an anonymous means of payment is a political decision to be made by legislators more than it highlights a constraint on central banks. Furthermore, in some cases, an anonymous CBDC could comply with AML regulations. For instance, the Sveriges Riksbank's legal analysis concluded that a token-based e-krona would comply with those objectives if the cap on transactions were small enough (Sveriges Riksbank, 2018). Otherwise, e-krona would be traceable but not anonymous.

Section 8: CBDC and the zero-lower bound

A CBDC could impact monetary policy in two ways. First, the use of CBDC instead of cash could remove the zero lower bound constraint on central banks. Furthermore, by setting interests on CBDC, central banks could improve the pass-through of monetary policy. This section focuses on the first argument: there is no strong consensus regarding the current pass-through of monetary policy (BIS, CPMI, 2018) and, as a result, the ability of CBDC to improve the transmission of monetary policy is unclear. A more precise case-by-case analysis on specific jurisdictions is outside the scope of this paper (see Meaning et al, 2018, for an extensive discussion on how CBDC could

improve the conduct of monetary policy by improving the pass-through and the efficiency of quantitative easing in the UK case).

The existence of cash has often been highlighted as the main reason behind the existence of a zero-lower bound[51]: facing negative interest rates, households rebalance their portfolio by withdrawing their deposits held at banks where they would have to pay the negative interest rates in exchange for cash, which does not pay interest, whether positive or negative. An account-based CBDC replacing cash would circumvent this constraint, as people would either hold an account at the central bank and pay the negative interest rate imposed by the central bank or hold deposits at a commercial bank which would offer similar or higher rates. To this day, negative interest rates have been introduced in many jurisdictions (US, Euro area, Japan, Sweden, Denmark, Switzerland) but banks have not passed on those negative rates to depositors. As a result, it is difficult to assess how depositors would react to negative interest rates. Anecdotal evidence in the form of surveys suggests that depositors would partly react by hoarding cash: Cliffe (2016) presents the results of a survey conducted in several jurisdictions investigating how depositors say they would react if negative rates were introduced. Between 70 and 90% of depositors state that they would withdraw money from their account. Among them, 10% would spend more, between 30 and 60% would switch to other investment products and between 30 and 60% would hoard cash, depending on the countries. This anecdotal evidence is not conclusive. However, it shows that there could be a political channel by which central banks are constrained and cannot directly set negative interest rates. In this survey, the central bank can be considered as responsible for pushing banks to implement negative rates on savings and checking account. However, savers could still hoard cash as a safe asset. If the central bank implemented a negative interest rate on CBDC, assuming cash was phased out, it would be held directly responsible for a "tax" on depositors whose only alternative to avoid negative rates would be to invest in riskier products such as stocks. Compared to the situation described in the survey, the central bank would then be even more politically exposed when setting negative interest rates. This suggests that, if there were political pressures to accommodate the demand for safe savings, the central bank would be more exposed if CBDC were introduced. Historical case studies in section 5 suggest that such pressures exist: in times of crisis, governments often accommodating depositors' demand for safe savings. In the Eurozone, the recent experience gives credence to the existence of such political pressures. For example, in 2016, the ECB's low interest rates' policy was criticized by Germany's Finance Minister, who held that their negative effects were partly responsible for the rise of the AfD in Germany. Mario Draghi responded in the following way: "Criticisms of a certain type could be viewed ... as endangering the independence of the ECB"[52]. In his statement, the president of the ECB therefore identifies negative responses from politicians regarding low interest rate policies as a possible pressure, which undermines the principle of central bank independence. Arguably, pressures would be higher if the central bank implemented negative interest rates for depositors. McAndrews (2015) and Ceccheti et al (2017) defined public acceptance as one of the constraints that central banks face regarding their ability to implement negative rate. While not providing definitive proof, this analysis does highlight that such a constraint should be investigated. In other words, cash is not the

[51] Rogoff (2014), Agarwal and Kimball (2015) and Bordo and Levin (2017) discuss either the removal or cash or the introduction of fees on withdrawals as ways to circumvent the zero-lower bound of interest rates.
[52] As quoted by Reuters in April 2016.

only constraint behind the existence of a zero-lower bound. Among other constraints, such as legal and operational difficulties (see McAndrews, 2015, for a full review of the constraints behind the existence of the zero-lower bound), the political constraint should be seriously investigated.

Furthermore, negative interest rates could have detrimental effects. For instance, cheaper loans (and, in the case of negative interest rates, subsidized loans as borrowers pay back less than what they borrowed) could remove financial pressures on firms. One possible outcome is the rise of zombie firms. For example, Banerjee and Hoffman (2018) study the prevalence of zombie firms, defined as "firms that are unable to cover debt servicing costs from current profits over an extended period". They argue that low interest rates are a significant factor behind the rise of these firms and provide evidence that zombie firms decrease investment and productivity. These possible effects would arguably be more important if interest rates were negative and CBDC would offer no mitigating mechanisms.

For the CBDC debate, three main conclusions can be drawn from this analysis. Firstly, cash is but one of the constraints central banks face when setting negative interest rates. As such, removing cash by replacing it with CBDC does not remove the other constraints. For CBDC to effectively circumvent the zero-lower bound on interest rates, the other constraints must be addressed. In particular, central banks could face a political constraint in this matter. By directly setting negative rates on deposits, central banks' independence could be threatened if public acceptance of the policy is low. Finally, it is unclear if negative interest rates would improve monetary policy. Implementing a CBDC specifically to allow for negative interest rates, as proposed by some of the literature must first address these consequences of negative interest rates.

Conclusion

As established in this paper, CBDC is not a properly defined term, as different policies, from central banks issuing a digital currency to settle wholesale cross-border payments to replacing cash with a digital currency are studied under the term *Central Bank Digital Currency*. A common denominator, however, is that CBDC would broaden the access to public money. Using this perspective, the consequences of issuing a CBDC were studied in this paper.

The evidence presented first cautions in favor of conducting a precise investigation of both the goals and potential risks of issuing a CBDC. This caution is warranted for two main reasons. Firstly, many goals are ascribed to CBDCs, from improving monetary policy to regulating the market for payments. However, different setups for CBDC could be necessary to address each objective. Secondly, the impact of a CBDC highly depends on country-specific characteristics such as the use of cash compared to other means of payment, competition in the banking sector and values and beliefs on privacy, for example.

This paper has provided a novel approach to assess the impact of CBDCs. By looking at historical examples where public money, for instance in the form of postal savings, was widely available, key questions in the CBDC debate can be investigated: how low should interest on CBDC be compared to bank deposits for users to keep their cash in the bank? Is deposit insurance sufficient

to prevent runs towards central bank money during financial crises? Using that approach, preliminary results have been presented in this paper, Overall, they confirm that an account-based form of public money has usually facilitated bank runs. It is less clear if in normal times, they had adverse effects on the financial sector and the real economy, as some identifiable mistakes by policymakers are also to blame regardless of the existence of these forms of money. A more thorough study of postal banking could provide further insights and central banks could consider adding the study of postal banks and state-backed savings in their CBDC research agenda.

However, both the historical evidence of past financial crises and the reviewed literature underline that the risks of issuing a CBDC must not be underestimated. More specifically, the ability of various policies, such as lower interest rates, caps on deposits or banks increasing their deposit rate to avoid deposit outflows and disintermediation, is not well established and warrants further investigation.

Similarly, both the theoretical and empirical evidence available today point to a clear "demand for privacy" which could impact how CBDC is introduced and the level of anonymity it guarantees.

The discussions on monetary policy highlight that the identified benefits of removing cash and issuing a CBDC instead are not as clear-cut and depend on several factors, including users' susceptibility to the "money illusion" and their ability to lobby the central bank against such policies.

Whether looking at the consequences on the financial system, on monetary policy or on privacy, it is clear that CBDC could significantly expand the role of central banks, to different degrees depending on the specifics of the issued digital currency. In some cases, as in privacy or if CBDC accounts were interest bearing, central banks would directly impact the lives of users and citizens, arguably more directly than they currently do. While such a shift could arguably provide social gains, such as a more efficient payment system, it also makes central banks more exposed politically. This paper casts doubts on the claims that CBDC could improve the transparency and acceptability of monetary policy and has shown that the political economy of CBDC must be studied and should be included in the debates on the feasibility and merits of CBDCs. Particular attention should be devoted to whether CBDC could undermine central banks' independence.

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Annex: data on postal banking and state-backed savings

Our choice to analyze three instances of financial crisis where postal banking systems existed is based on the available data at this time. Some datasets on postal banking exist, although they usually group together several financial products and programs.

United States

The National Bureau of Economic Research[53] has compiled a dataset on postal savings and mutual savings in the United States throughout the 20th century (until 1968 for data on postal savings, when the United States Postal Savings system was discontinued). However, data on postal savings is aggregated with data on mutual savings. These institutions did not benefit from a government guarantee on deposits. Furthermore, postal savings represented a small portion of the aggregate: in the 1930s, there were roughly 11 billion invested in postal and mutual savings, while postal savings represented only 1,2 billion dollars. As a result, this data is not a good measure of the effects of public money. We prefer to use on the data presented in Sprick Schuster, Jaremski and Ruth Perlman (2019).

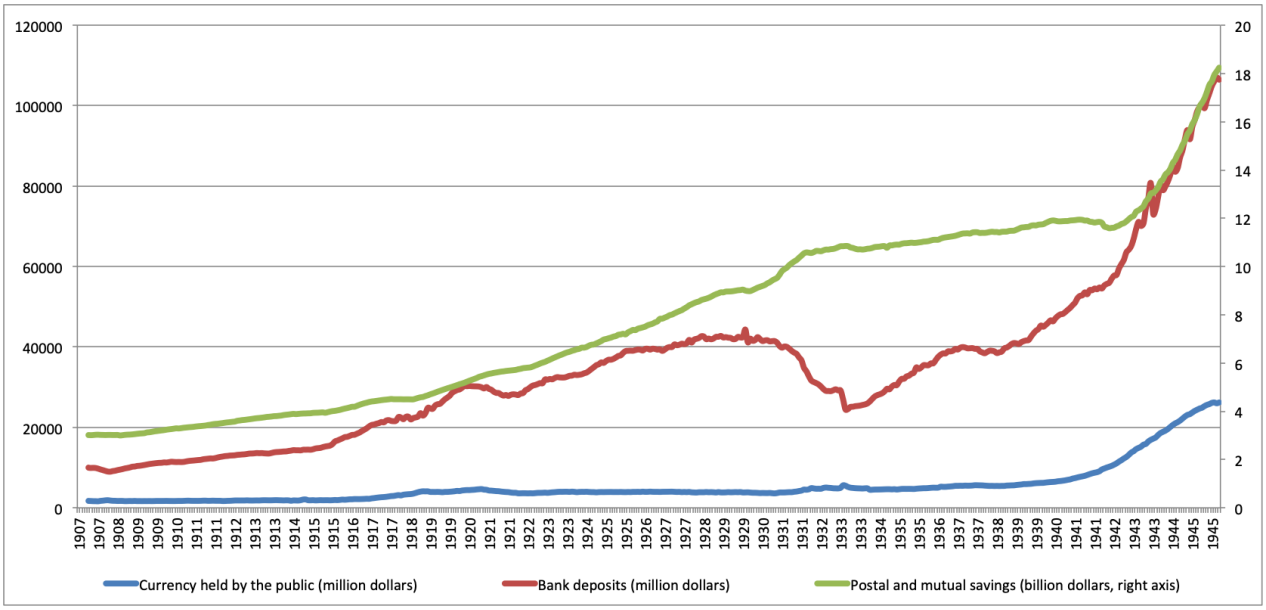

Figure 18: Amounts of postal savings, cash and deposits in the US, 1907 – 1945

Source: NBER

France

Two main data sources exist for France. First, the post office's archives provide data on products sold by the postal bank and on the distribution network of the post office. Data on two instruments is provided by the committee for the post office's history[54]: the *livret de caisse d'épargne nationale*,

[53] As part of NBER's Macro-history databases, available here: https://www.nber.org/databases/macrohistory/contents/

[54] Available (in French) at https://www.laposte.fr/chp/pages/statistiques.php

a state-saving program and the *chèque de compte postal,* which functioned as a means of payment emitted by the post office. The sources used are the annual reports of the post office and the government department responsible for the post office. The NBER also provides a database for all post office deposits between 1882 and 1939, though it does not indicate how these amounts were computed[55]. This data is relevant for our article but we couldn't match it with data on bank deposits and cash in France in the first half of the 20th century. While the National Bureau of Economic Research provides a database on bank deposits, it does not indicate how the database is built. Furthermore, as argued by Baubeau, Monnet, Riva and Ungaro (2018), datasets on French bank deposits have usually relied on data from the largest banks. For the purpose of our analysis, because largest banks are deemed safer and less prone to bank runs, using this data would be problematic. Instead, we choose to rely on the data provided by Baubeau, Monnet, Riva and Ungaro (2018).

United Kingdom

To our knowledge, no database on the United Kingdom's post office bank has been compiled to this day. For the most recent period, since 2003, the NS&I's annual reports provide a lot of data on the bank's activity and the interest it pays to investors. Some parliamentary records provide sparse data before 2003. We therefore focus on the 2008 crisis in the United Kingdom given those limitations.

Other countries

Postal banking systems have been implemented in many countries. In some countries, these banks date back to the 19th century (for example, Germany and Japan). However, we did not find any reliable data source for these countries.

[55] Available at http://www.nber.org/databases/macrohistory/contents/chapter10.html

Should Central Banks issue digital currencies? Consequences for the financial system, implications for monetary policy and concerns for privacy

Gardin, Paul

Abstract

This paper studies the possibility that central banks issue digital currencies and the consequences of issuing a public form of digital money, focusing on four aspects: the impact for the stability of the financial system and its ability to channel savings to provide credit, the potential benefits for the conduct of monetary policy and the consequences for the privacy of means of payment. The paper analyzes past experiences of public money issuance such as postal banking and the latest literature to provide insights for the CBDC debate. Overall, the results show that a central bank digital currency could generate important risks for the financial sector, while benefits for the conduct of monetary policy are less certain. Furthermore, we find strong arguments in favor of taking into account the political economy consequences of issuing a CBDC, as the introduction of a digital currency could have adverse effects on central banks' independence. We recommend further investigations into the empirical consequences of issuing widely accessible public money using the methodology developed in this paper.

Key words

Central Bank Digital Currencies, digital cash, monetary policy

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