IV. The economic consequences of central bank digital currencies

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Abstract: Central bank digital currencies (CBDC) have probably become the most prominent feature in the discussion on the future of payment systems and on money more generally. This section proposes an overview of the macroeconomic benefits and risks of introducing a retail CBDC for non-experts, based on a literature review, with a focus on the euro area and a 'digital euro'. Such a euro-area retail CBDC would be a new form of money. It would tackle a possible decline in the use or acceptance of cash by ensuring the continued provision of public money and improve the functioning of the payment system. It would also support the European economy's digitalisation and the European Union's strategic independence in the context of dominant foreign-based payment providers and the possible emergence of new digital means of payment. However, designing a retail CBDC entails several trade-offs which may have implications for the financial sector. If not properly designed, a retail CBDC may produce disintermediation in the banking system, reduce banks' funding and lead to increased risk-taking, with consequences for lending and financial stability. However, this should be assessed against the current context of excess reserves. Thus, to reap the benefits of a CBDC the trade-off between more efficient payment systems and risks to the banking system needs to be well managed by choosing an appropriate design for the CBDC. The section does not aim at proposing any specific design option for the digital euro, nor does it preempt content of a possible legislative proposal by of the Commission in any manner, as the concrete implications of the introduction of the digital euro will very much depend on the practical design choices made.

Since the beginning of 2021, the Commission and the ECB have engaged in joint technical work to assess a broad range of policy, legal and technical questions emerging from a possible introduction of a digital euro ([52]). The common work goes in parallel with the ECB decision to launch a more structured step of the digital euro project on 14 July 2021 (the 'investigation phase') following the report issued in October 2020 ([53]). This could lead to a legislative proposal based on Article 133 TFEU establishing the digital euro and regulating its essential elements. The aim of this article is to highlight the key macroeconomic issues related to the introduction of a retail central bank digital currency (CBDC). As a central bank liability accessible in digital form for households and firms, a digital euro would be a new form of money. As such, it may compete with other means of payment, including cash and sight deposits. This could have implications for banks' funding and financial stability that need to be analysed. The concrete implications will depend on the design choices made, which are beyond the scope of this section.

IV.1. What is a central bank digital currency?

IV.1.1. Classifying the different types of money

Money is usually defined by its three functions as a medium of exchange, a store of value and a unit of account. Historically, several commodities, such as seashells, salt, silver and gold, played the role of money. Under this physical form, money is an asset for its holder, but it is not the liability of someone else. In the middle of the 17th century, banknotes certifying that a certain quantity of gold was stored in secured vaults became themselves a form of money. Contrary to commodities, banknotes were the liability of their issuer who committed to exchange them upon request against gold. The last link between banknotes and gold ultimately disappeared in 1971 when the international convertibility of the US dollar to gold was suspended. Since then, the values of the different currencies fluctuate, between themselves and against commodities, and nowadays the value of money in all economies is not linked to a specific good. In the euro area, banknotes are a liability of the Eurosystem, and the value of the currency relies on the central bank's commitment to maintain price stability and on their legal tender status. From an economic perspective, banknotes and coins are not the only form of money. As

([52]) Joint statement by the European Commission and the European Central Bank on their cooperation on a digital euro, 19 January 2021

([53]) ECB (2020), Report on a digital euro. The report is available at https://www.ecb.europa.eu/pub/pdf/other/Report_on_a_digital_euro~4d7268b458.en.pdf

money is defined by its three basic functions, other instruments, including overnight ([54]) and term deposits with commercial banks, can play the role of money. These instruments are accounted for in the different monetary aggregates M1, M2 and M3 ([55]) depending on their liquidity. As an example, to provide an order of magnitude, currently overnight deposits held at commercial banks account for more than 60% of the euro-area broad money aggregate M3, while coins and banknotes represent less than 10% of M3 ([56]). The importance of deposits can be explained by their convenience as a means of payment and store of value, especially in an increasingly digitalised economy. However, in recent years, new assets aiming to fulfil the functions of money emerged in the form of stable coins and cryptocurrencies ([57]), while central banks started to investigate the possible issuance of CBDCs (BIS, 2021) ([58]). Classifying the different types of money helps to highlight their differences. In this respect, the following criteria appear useful (BIS, 2017): accessibility (wide versus restricted), form (digital versus physical), issuer (central banks versus other issuers) and transactions (peer-to-peer versus approved by a trusted third party) ([59]). Other features that distinguish the different types of money include their intrinsic value, which can rely on scarcity, use or trust. Although it could share some of the features with other types of money, a CBDC would be a new type of money irrespective of its design.

([54]) In this article, overnight deposits refer to an ECB-defined category comprising mainly sight and demand deposits that are fully transferable.

([55]) In the euro area, these monetary aggregates are defined by the ECB and derived from the consolidated balance sheet of monetary financial institutions. See https://www.ecb.europa.eu/stats/money_credit_banking/monetary_aggregates/html/index.en.html

([56]) Source: ECB, Statistical Data Warehouse, Balance Sheet Items

([57]) Cryptocurrencies are also referred to as crypto-assets. They are cryptographically secured digital assets that can be held and exchanged. Their creation, storage and transfer is recorded on a blockchain. Stablecoins are crypto-assets whose value is pegged to currencies.

([58]) Boar C., Wehrli A. (2021), Ready, steady, go? – Results of the third BIS survey on central bank digital currency, BIS Papers, N°114

([59]) Bech M., Garratt R. (2017), Central Bank Cryptocurrencies, *BIS Quarterly Review* September 2017, pp.55-70.

IV.1.2. How would a CBDC compare to banknotes, deposits and reserves?

As a CBDC, a digital euro would be a central bank liability accessible in digital form for retail use by households and firms (ECB, 2020) ([60]). Currently, banknotes are the only form of central bank liability accessible to firms and households, but they are not digital. Deposits held by households and firms on their bank accounts, which are accessible in digital form, are liabilities of commercial banks and not of the central bank. They can be referred to as commercial bank money while banknotes are central bank money. The only digital currency holdings that are also a central bank liability are the reserves and deposits held by commercial banks on their accounts at the central bank. However, households and firms have no access to such central bank deposits. A CBDC would allow firms and households to hold a central bank liability in digital form, just as banknotes allow them to hold a central bank liability in physical form. In this respect, the main difference between holding bank deposits and holding a central bank liability relates to the credit risk. While deposits expose their owners to their bank's credit risk, a CBDC bears no credit risk, just like cash. However, deposit insurance schemes offset this distinction for most retail users in the EU, where deposits are fully insured up to 100 000 euros.

Table IV.1: **Different types of money**

	Form	Available for households and firms	Liability of…
banknotes	physical	yes	the central bank
deposits	digital	yes	commercial banks
e-money	digital	yes	e-money institutions (incl. banks), backed by matching funds
reserves	digital	no	the central bank
retail CBDC	digital	yes	the central bank

Source: own presentation

IV.1.3. Reasons for introducing a CBDC

CBDCs are to be issued within the framework of central bank mandates. Central banks serve a public interest in a jurisdiction-specific context. The current CBDC projects and pilots thus reflect local challenges. For instance, promoting financial inclusion and digital payments while reducing the costs of cash management on an archipelago were

([60]) ECB (2020), Report on a digital euro

challenges that the digital version of the Bahamian dollar (the 'Sand Dollar') ([61]) could alleviate. The fact that people in Sweden are finding it increasingly difficult to pay with cash given that most retailers and consumers have switched to digital payments has incited the Swedish central bank to reflect on an e-krona. In China, the dominance of digital payments by an oligopoly of non-bank tech companies (the 'BATX') has posed a threat to political and financial stability and opened the way to the creation of a digital yuan.

In the euro area, challenges that could motivate the EU to legislate the establishment of a CBDC have been identified and analysed by the ECB (*op. cit.)*: 'A digital euro could be issued (i) to support the digitalisation of the European economy and the strategic independence of the European Union ([62]); (ii) in response to a significant decline in the role of cash as a means of payment, (iii) if there is significant potential for foreign CBDCs or private digital payments to become widely used in the euro area; (iv) as a new monetary policy transmission channel; (v) to mitigate risks to the normal provision of payment services; (vi) to foster the international role of the euro; and (vii) to support improvements in the overall costs and ecological footprint of the monetary and payment systems'. This list proposes the reasons that can justify the issuance of a CBDC in advanced economies. Some of these motivations are defensive: they aim at protecting financial stability and the good functioning of payment systems or at preserving the ability of the euro-area institutions to exercise the role set for them in the Treaties. Other motivations are more assertive. A CBDC can help foster the spreading of digitalisation across the economy and bring innovation to money and payments.

However, the adoption of a CBDC by users in an environment offering various alternatives for digital payments will depend on its ability to appear as a neutral, reliable and efficient means of payment, as is the case of cash in the physical world. Therefore, it is probable that not all of the objectives set out by a CBDC will materialise. Central banks, legislators and other stakeholders will probably decide to focus on the few most relevant issues for their jurisdiction that will everywhere include ensuring user confidence (i.e. a design that is highly reliable and attractive for users).

IV.2. What are the potential effects of a CBDC on the banking sector?

IV.2.1. The substitution between CBDC, cash and deposits

Depending on the design choices made, the CBDC could be extensively used. In this case, whether used as a means of payment or as a store of value, the CBDC will, to a certain extent, compete with deposits and cash.

The existing literature on payments stresses that the choice between payment instruments is driven primarily by their characteristics in terms of convenience, safety, privacy, cost and network effects. The interplay between these different characteristics is complex. The cost of a payment instrument can significantly affect its use (Schuh and Stavins, 2011, Koulayev et al., 2015) ([63]). In terms of service to the user, a CBDC can both be a partial substitute and a partial complement to the use of banknotes and existing digital forms of money, including deposits. Design options will play a role in framing these substitution and complementarity effects, in particular when it comes to choosing between an account-based or a token-based one ([64]) or between a centralised or a decentralised ledger ([65]). However, this section highlights how a CBDC would compare to banknotes, deposits and reserves for economic agents without assuming a specific design. In particular, both account and token-based CBDCs could be remunerated, although it may be

([61]) See: https://www.sanddollar.bs/

([62]) By providing an alternative for fast and efficient digital payments in Europe, a digital euro could reduce the dependence on existing foreign payment providers as well as prevent further dependence on new digital means of payment such as privately issued stablecoins with money-like features and foreign-issued CBDC.

([63]) Schuh S. and Stavins J., (2011), How Consumers Pay: Adoption and Use of Payments, FRB of Boston Working Paper, No. 12-2. Koulayev S., M. Rysman, Stavins J., (2015), Explaining adoption and use of payment instruments by US consumers, *RAND Journal of Economics*, vol. 47, issue 2, 293-325.

([64]) Under the account-based option, CBDC ownership is tied to an identity and claims are recorded in a database matching identities and values, equal to today's bank accounts. The token-based approach implies that the assets can be stored locally in compatible devices and e-wallets and the transfer can be made with just a digital signature validation, giving universal access.

([65]) The ledger, on which CBDC payments are recorded, can be decentralised, for instance through the use of distributed ledger technology (DLT), or centralised in one entity, e.g. at the central bank.

technically more challenging with the latter (ECB, 2021) ([66]).

According to the literature, the use of cash appears to be mostly driven by consumers' preferences, especially for small transactions (Wakamori et al., 2015) and by the context in which the payment is made (Koulayev et al., 2015) ([67]). In turn, these preferences are influenced by the characteristics of the payment instrument and the level of acceptance of alternative payment instruments, which can make them appear more costly (Arango-Arango et al., 2018) ([68]). Agur et al. (2019), model the CBDC as different from both cash and deposits, but from a user perspective the CBDC is located somewhere between cash and deposits depending on the design chosen. Hence, the substitution between CBDCs and deposits or cash depends on whether the CBDC has cash-like features, like anonymity, and on the interest differential with respect to bank deposits ([69]). A cash-like CBDC can, on the one hand, cause the decline of cash due to network effects while, on the other hand, a deposit-like CBDC which bears an interest rate can cause an erosion of bank deposits against which banks may increase interest rates on deposits and loans. It should be noted that the increase in interest rates on deposits would not only be driven by the existence of interest rates on the CBDC, but could also be driven by the existence of convenience yields provided by the CBDC. The latter can be related, for example, to factors such as the ease of use and the comparative costs of a CBDC that influence the substitution between it and other means of payments. Moreover, different forms of money also compete regarding their store-of-value function. To this end, quantitative limits, such as limits on individual CBDC holdings or transaction limits, could effectively curb the substitution between CBDC and bank deposits. To avoid that hard limits block payment orders, solutions can be developed based on a "tiering" of CBDC remuneration ([70]) or a waterfall between CBDC holdings and an associated payment account.

IV.2.2. The link between deposits, bank funding and bank lending

In the modern economy, new money is essentially created when banks issue new loans. When banks lend, they create deposits and the creation of deposits is the accounting counterpart of new loans on banks' balance sheets. Therefore, deposits play a crucial role in generating broad money and constitute the main source of funding for most banks. Using the euro area as an example, loans to non-financial corporations (NFC) and households account for nearly three quarters of the broad money aggregate M3 ([71]).

The aggregated balance sheet of euro-area banks highlights the importance of deposits for banks' funding (Graph IV.1). In April 2021, the total aggregated balance sheet of banks in the euro area amounted to EUR 36.4trn, with deposits accounting for 40% of this figure ([72]). In particular, household deposits amounted to EUR 8.5trn and NFC deposits to EUR 3.1trn, representing respectively 23% and 9% of banks' liabilities in the euro area ([73]). Within deposits, overnight deposits are particularly important ([74]) and more likely to be easily substitutable for digital currencies. Overnight deposits from NFC and households represented about half of all deposits recorded in banks' balance sheets and amounted to 21% of their total liabilities, which points to the importance of deposits for the banking system. However, overall, the importance of deposits in banks' liabilities depends also on banks' business models, although even predominantly wholesale-funded banks rely on deposits to a significant extent (Farnè et al., 2017) ([75]).

([66]) ECB (2021), Digital euro experimentation scope and key Learnings.

([67]) Wakamori N., Welte A., (2017), Why Do Shoppers Use Cash? Evidence from Shopping Diary Data, *Journal of Money, Credit and Banking*, vol. 49, issue 1, pp. 115-169.

([68]) Arango-Arango C., Bouhdaoui Y., Bounie D., Eschelbach M., Hernandez L. (2018), Cash remains top-of-wallet! International evidence from payment diaries, *Economic Modelling*, Volume 69, pp. 38-48.

([69]) Agur I., Ari A., Dell'Ariccia G. (2019), Designing Central Bank Digital Currencies, IMF Working Paper, WP/19/252.

([70]) Bindseil U. (2020), Tiered CBDC and the financial system, ECB Working Paper Series, N° 2351.

([71]) Source: ECB, Statistical Data Warehouse, Balance Sheet Items.

([72]) *ibid.* Deposits from non-MFIs excluding general government.

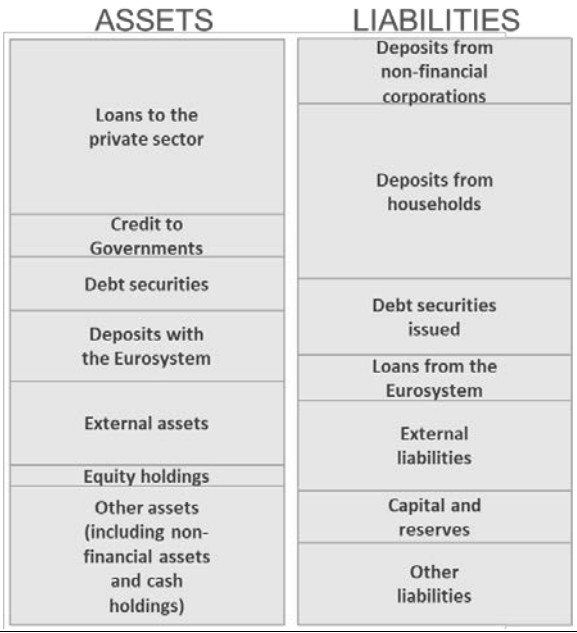
([73]) i.e. of the total aggregated balance sheet (with liabilities defined as including capital).

([74]) Deposits comprise overnight deposits (defined by the ECB as mainly comprising 'sight deposits'), deposits with agreed maturity and deposits redeemable at notice.

([75]) Farnè F., Vouldis A., (2017) Business models of the banks in the euro area, ECB Working Paper Series, N° 2070.

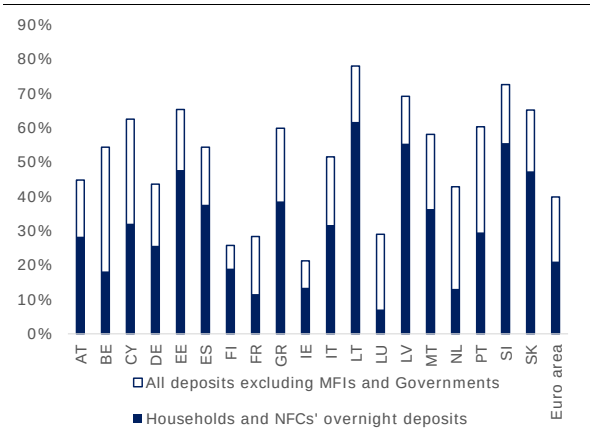
Despite the importance of deposits at the aggregate level, the euro area average masks an important heterogeneity at the country and bank level. Deposits represent more than 50% of banks' funding in twelve countries, a figure that still remains at eight countries if we take into account the sole deposits of households and NFC. The share of deposits in banks' liabilities reaches 78% in Lithuania, 72% in Slovenia, 69% in Latvia, 65% in Estonia and Slovakia. Among the euro area's four largest countries, deposits represent more than 50% of banks' liabilities in Spain and Italy, 44% in Germany but only 28% in France ([76]). Banks rely the least on deposits for their funding in Ireland (21%), Finland, France and Luxembourg (less than 30%).

Graph IV.1: **Simplified aggregated balance sheet of euro area banks**



Source: own presentation based on the Balance Sheet Items statistics of the ECB

Graph IV.2: **Banks' deposit funding as % of their balance sheets**



Source: ECB, Statistical Data Warehouse, Balance Sheet Items statistics. Aggregated balance sheet values of banks licenced in each Member State.

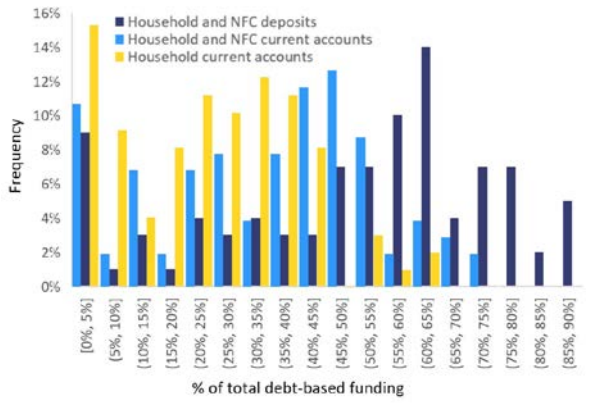
Bank-level data confirms that most euro area banks rely on household and NFC deposits as their main source of funding, i.e. they account for more than half of bank debt in more than half of the banks in our sample (see Graph IV.3). When restricting ourselves to current accounts ([77]), which are more likely to be partly substituted by CBDC, banks' deposit funding dependence is seen to diminish markedly, even if most banks continue to display fairly high figures.

At the same time, bank-level data also illustrates how diverse bank funding models can be, with deposits playing a comparatively small role in a non-negligible share of banks, while representing more than 60% of bank debt in the most deposit-dependent institutions (Graph IV.4). It is this category of banks, highly reliant on retail funding, that is more likely to be put under pressure should an unrestricted CBDC design be chosen.

([76]) Deposits represent a smaller part of the banks' liabilities when banks benefit from a large and liquid market of covered bonds to refinance a significant part of their loan book. The figure for the share of deposits in banks' financing can also be reduced in Member States where banks rely more on intragroup financing inside larger and more complex groups.

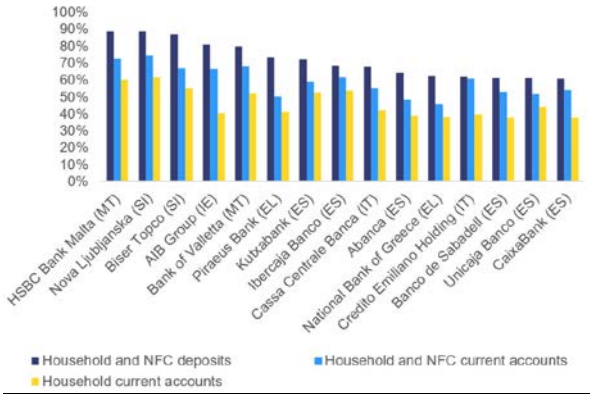
([77]) The current account figures shown in Graphs IV.2 and IV.3 refer to the EBA data item labelled as 'Deposits - of which: Current accounts / overnight deposits'.

Graph IV.3: **Empirical distribution of deposit shares in total bank debt**



(1) As at mid-2020 and based on a sample of 94 euro area banks included in the EBA's transparency exercise; the graph plots the empirical distribution of the share in total debt of three deposit categories, from a narrowly defined one (household current accounts) to broader concepts (total household and NFC deposits).
Source: EBA, own calculations

Graph IV.4: **Deposits as a % of total bank debt: top 15 EA banks**



(1) As at mid-2020 and based on a sample of 94 euro area banks included in the EBA's transparency exercise; banks ordered according to household and NFC deposits as a % of total debt.
Source: EBA, own calculations

Deposits compare favourably to other sources of banks' funding, be it short- and long-term wholesale debt (including securitisation) or equity. In particular, deposits are a widely available and very stable source of funding, thanks to the long-term relations that banks have with their clients. Moreover, their cost is very low, as in general they pay less than other forms of market funding with an equivalent regulatory treatment. Finally, they do not require collateralisation. By comparison, debt securities issued by banks are either collateralised ([78]) or usually pay higher interest rates, and are subject to rollover risk. Banks also have access to central bank funding. Currently, the main refinancing operations of the ECB are offered at 0% with full allotment and the interest rate on TLTRO III can reach -1%, a level which is extraordinarily low by historical standards. Moreover, central bank funding is provided against collateral, and TLTRO III loans are also subject to specific conditions.

IV.2.3. How could banks react to the introduction of a CBDC?

Whatever design is chosen, in the euro area, a digital euro would exist alongside cash and deposits and not replace them (ECB, *op. cit.*) so that, the introduction of a CBDC would not threaten banks' ability to create deposits. However, if a CBDC is successfully issued, households and firms will own it and use it, leading to a partial substitution of their bank deposits. The substitution will most likely be only partial, as it expected to be limited by design choices. As per the balance sheet identity, a decrease in deposits on the liability side needs to be matched either by an increase in other liabilities or by a corresponding decrease in assets. From a macroeconomic perspective, the possible decrease in deposits is a key issue related to the creation of a CBDC. It is worth mentioning that the issue of financial intermediation is not specific to a digital euro. The wide use of any other form of digital money, including stable coins, foreign CBDCs or cryptocurrencies, could disintermediate banks by diminishing the role of deposits as a means of payment and store of value. In this respect, a CBDC would allow policy-makers to define an intermediation design, where in any case actors other than banks may increasingly play the intermediary function.

The literature is not conclusive on the implications of a retail CBDC for banks' deposits but highlights how banks could react to a possible loss of deposits in different manners. Whether a CBDC in the euro area would bear interest is unknown and the extent to which it would compete with deposits would also depend on other features like possible holding limits. In any case, it has to be noted that the key variable for the determination of deposits is

([78]) Covered bonds, which are debt securities issued by banks and collateralised against a pool of mortgage loans or public-sector debt, are a case in point.

not the interest rate on the CBDC itself but the spreads between it and the interest rate on commercial bank deposits and their reserves at the central bank. According to the ECB's Report on a digital euro, the interest rate on a digital euro should not be below 0%, at least within a certain holding limit, and a positive interest-bearing digital euro would pose a risk of large-scale substitution away from deposits.

Banks could try to retain deposits…

Banks could try to avoid deposit outflows by making the remuneration on deposits more attractive. The increase in deposit rates needed to retain at least some of the potential outflows would be higher, the stronger the demand for CBDC, the lower the interest rate elasticity of this demand and would also depend on whether the CBDC is interest-bearing or not. In the case of remunerated CBDC, assuming that the CBDC is a perfect substitute for deposits and that banks are monopolists in the market for deposits, banks would have incentives to match the interest rate on the CBDC as long as it stays below the interest rate on reserves (Andolfatto, 2019) ([79]). Interestingly, introducing a CBDC could then lead to an increase in the supply of deposits because banks would offer a more attractive interest rate. The increase in deposits in turn could lead to a decrease in the lending rate and an expansion in bank lending. Other studies find that a CBDC may expand bank intermediation by introducing more competition in the banking sector, even if it is not used as a means of payment (Chiu et al., 2019) ([80]). This result is interesting, in that it stresses the existence of a competition effect and that banks can respond to deposit losses by increasing rates. However, the result is extreme and model dependent: as indicated above, Agur et al. (2019) show that, in a setting in which deposits and CBDC are not perfect substitutes, the introduction of a CBDC decreases deposits, even if this effect is smaller when banks have market power. This is also the view of practitioners ([81]). Similarly, any increase in deposit rates to avoid large-scale conversion to CBDC may in reality be passed on to lending rates, thus having a contractionary effect on bank lending.

…or adjust their balance sheets

Banks can also choose to adjust their balance sheets in response to a CBDC-induced deposit outflow, be it on the liability or on the asset side.

On the liability side, banks could replace deposits with alternative funding such as market funding or central bank funding. Regarding the latter, the central bank could decide to offset any decrease in deposits by providing substitute central bank funding. In this case, bank funding would not be reduced. Its composition would change but this need not have an impact on credit supply or on the stability of the financial sector (these are the 'equivalence results', see Brunnermeier and Niepelt, 2019) ([82]). However, alternative funding sources can be subject to collateral requirements and might have an impact on profitability and prudential ratios, which would invalidate this equivalence in practice.

On the asset side, banks could decide to draw on their excess reserves to the extent possible, especially when they are partially charged a negative interest rate ([83]). The mechanism would be similar to current cash withdrawals. In the euro area, excess reserves stood at EUR 3.3 trillion euros in April 2021, while households and firms' sight deposits amounted to EUR 7.6 trillion euros. However, the availability of large excess reserves at the euro area aggregate level does not imply that each bank would have sufficient excess reserves to match a deposit withdrawal ([84]). Banks could also

([79]) Andolfatto D. (2019), Assessing the Impact of Central Bank Digital Currency on Private Banks, FRB St. Louis Working Paper No. 2018-25. Note that this also covers the case of a non-interest bearing CBDC, in which case the interest rate would simply be zero.

([80]) Chiu J., Davoodalhosseini M., Jiang JH., Zhu Y. (2019), Central bank digital currency and banking, Bank of Canada Staff Working Paper, N° 2019-20.

([81]) Among many, see Bank of England (2020), Central Bank Digital Currency: opportunities, challenges and design, working paper available at Central Bank Digital Currency: opportunities, challenges and design | Bank of England

([82]) Brunnermeier M., Niepelt D. (2019), On the equivalence of private and public money, *Journal of Monetary Economics*, N°106, pp. 27-41.

([83]) Currently, in the euro area, the interest rate on banks' minimum reserves stands at 0% and excess reserves are subject to a tiered remuneration whose interest rate can reach -0.50%. Therefore, the average remuneration on banks' reserves is negative while the average remuneration of firms and households' sight deposits is close to zero.

([84]) Nonetheless, at the banking sector aggregate level, deposit outflows could be entirely matched by drawing down excess

decide to shrink other assets, for instance by selling securities or by diminishing lending. However, if the literature provides some evidence that banks may adjust lending supply downwards, the overall results are ambiguous as these effects could be mitigated by a reduction in banks' monopolistic power and by central bank intervention. It is also possible that banks would adjust their business models, possibly by securitising loans or acting as intermediaries in the provision of the CBDC, assuming that the latter option would be legally endorsed. Alternatively, the negative effects could be cushioned by the central bank intervening and providing banks with cheap funding to substitute deposits, although this could have repercussions of its own (see also Section IV.3.2. below) ([85]).

For banks, deposits are not only a stable, low-cost source of funding. They also attract customers and support the provision of loans and other financial services, including payment services. These are a source of information for banks when assessing customers' creditworthiness as well as a source of interest and non-interest income. The design of a CBDC and, in particular, its possible intermediation by the private sector as a gatekeeper or settlement agent will be key in gauging its impact on the risk assessment capacities of commercial banks. Indeed, if banks can act as settlement agents on CBDC transactions, they should have access to the same level of information on the operations and incomes of their customers as they have today.

IV.2.4. Possible intermediation designs

Several intermediation designs can handle the day-to-day functioning of a CBDC. First, a direct CBDC would centralise all functions at the level of the central bank. Alternatively, a hybrid CBDC would centralise the issuance of the digital currency, with the central bank playing a supervisory role, while dedicated supervised intermediaries would ensure the know-your-customer regulatory checks, distribute the CBDC to clients and provide them with services allowing the use of the CBDC (Auer and Böhme, 2019) ([86]).

A third kind of intermediation design does not pass the criterion of being a central bank liability ([87]) but offers a service to users fully comparable to a CBDC. In the case of a 'synthetic CBDC', intermediaries ensure the role they have in a hybrid model but are also in charge of issuing, managing and redeeming the digital currencies. To ensure that the credit risk does not weaken the framework, each intermediary should hold reserves at the central bank for an amount equal to the value of the synthetic CBDC it has issued. These reserves could be a wholesale CBDC. This system is a digital version of the scheme used in the United Kingdom for commercial banks to issue the Scottish and Irish pound banknotes.

The question of intermediation design is essential from a legal point of view and will need a policy decision by the legislature but the interface and service options for the end-user will derive more from technological choices than from the intermediation structure. Furthermore, the choice on intermediation does not affect the choice of the principal technological solution (account-based or token-based). It affects the economics of CBDCs only through the question of fees, or alternative ways for intermediaries to monetise their customer relationship and network effects, and of how easily banks may or may not lose a part of their financial intermediation function.

IV.3. What could be the implications of a CBDC for financial stability and monetary policy?

IV.3.1. Effects on financial stability depend on the design

As indicated in the literature, the implications of a CBDC for financial stability depend on a number of factors, such as the demand for it, the degree of substitution with respect to commercial bank deposits, banks' response to the introduction of a CBDC, as well as the easiness of conversion of deposits into a CBDC in case of a crisis. A CBDC

reserves if those reserves were redistributed via interbank markets.

([85]) Note that if the central bank offsets a decrease in deposits, the size of the aggregated balance sheets of commercial banks is unchanged whereas if banks draw on their reserves, their aggregated balance sheet shrinks.

([86]) Auer R. and Böhme R. (2020), The technology of retail central bank digital currency, BIS Quarterly Review, March 2020, pp.85-100.

([87]) BIS et al. (2020), Central bank digital currencies: foundational principles and core features

will have to carefully designed so as to minimise negative impacts. Nonetheless, a few general principles and channels can be identified, distinguishing broadly between those arising from structural bank disintermediation and those connected to decreased stability of bank deposit funding in crisis times.

As regards potentially structurally lower bank deposits resulting from the introduction of CBDC, the financial stability implications depend chiefly on how banks adjust their balance sheets in response. For instance, if banks are able to respond to the decrease of deposit funding by drawing down excess reserve holdings on the asset side, adverse effects for financial stability should be limited ([88]). Conversely, if deposit funding were substituted by other, less stable sources of funding, banks could be more prone to episodes of liquidity stress due to their larger rollover risk. This should also be reflected in mechanical decreases in key regulatory metrics such as liquidity coverage ratios (LCR) and the net stable funding ratio (NSFR) ([89]). Consequently, optimal holdings of high quality liquid assets should increase given that a shift towards less stable funding requires higher coverage, while the presence of a CBDC as an outside option, if not properly designed and framed, may at the same time reduce the stability of the remaining deposits especially in crisis times (see below).

Financial stability risks might furthermore arise in connection with lower bank profitability. This could be the case for instance if banks increase deposit rates to compete with the CBDC, if the decrease in deposits was compensated by more expensive sources of funding and/or if it implied lower fee income (e.g. from debit card usage, payment services, cross-selling of products). Any of those might induce higher bank risk taking in order to keep profit margins stable. If banks' profitability was to be durably affected by the loss of deposits, the traditional trade-off between competition and stability could emerge under a new form, even if the recent literature has shown that this nexus has to be analysed on a case-by-case basis ([90]).

As regards the impact of a CBDC on bank funding in crisis times and the threat of bank runs, results from the available literature are inconclusive. On the one hand, it seems theoretically possible for digital bank runs to happen very quickly, a possibility facilitated by the fact that the technology in principle allows money to be withdrawn from banks into the CBDC with a simple click. Moreover, the very possibility that banks may lose deposits and face more competition in the payments market could leave banks weaker and increase the possibility of bank runs (Williamson, 2020) ([91]). On the other hand, however, there are reasons to believe that the introduction of a CBDC could lower the probability of a run. First, because, in the absence of quantitative limits on CBDC holdings, the central bank would in practice be committing towards depositors that all deposits can be transformed into CBDC very rapidly. If agents are rational, this should have an effect similar to deposit insurance schemes and diminish the reason to panic (Fernández-Villaverde et al, 2021) ([92]). Second, because the central bank can use timely information obtained from demand for a CBDC to intervene faster than in the current system, potential panics could be managed faster by the central bank and be less damaging (Keister and Monnet, 2020) ([93]).

In view of this theoretical ambiguity, a few practical remarks are in order. First, a potential heightened probability of bank runs should mainly apply to the case of systemic banking crises, in which an electronic transfer to another bank account does not eliminate a depositor's risk (as the option of an electronic transfer already exists in

([88]) In the current environment of large excess reserve holdings and negative deposit facility rates, this would even have positive effects on bank profitability.

([89]) LCR and NSFR are part of the liquidity requirements under the Basel III regulatory framework. The LCR is defined as the ratio of High Quality Liquid Assets (HQLA) to a bank's liquidity needs in a 30-day liquidity stress scenario and needs to be at least 100%. The NSFR sets 'Available Stable Funding', which includes deposits but does not include short-term wholesale funding (including interbank lending), in relation to 'Required Stable Funding', which is calculated with respect to banks' asset side. Deposits are a stable, cheap and liquid form of financing for banks. Retail deposits improve liquidity ratios.

([90]) For a discussion, see among many Carletti E. and Hartmann, P. (2002), Competition and stability: what is special about banking? ECB WP no. 146.

([91]) Williamson S.D. (2020), Central Bank Digital Currency and Flight to Safety, University of Western Ontario

([92]) Fernández-Villaverde J., Sanches D., Schilling L.M., Uhlig H. (2021), Central bank digital currency: Central banking for all?, *Review of Economic Dynamics*, vol. 41, pp. 225-242.

([93]) Keister T., Monnet C. (2020), "Central Bank Digital Currency: Stability and Information", mimeo

the status quo). Indeed, Rainone (2021) shows that in idiosyncratic bank stress episodes deposits are mainly shifted to large domestic banks generating a size premium and that under a fixed-rate, full allotment regime, the liquidity drain is mostly offset through open market operations ([94]). Second, such runs in the presence of a systemic crisis clearly represent a tail risk, especially in the presence of European deposit insurance frameworks. In practice, in the euro area context, such systemic withdrawals of bank deposits have only been observed in case of perceived redenomination risk connected to concerns over an exit from the common currency area. Lastly, CBDC design choices such as individual holding limits, transaction limits or tiered remuneration of CBDC holdings can mitigate any remaining risks of bank runs connected with the introduction of CBDC. More generally, any design choice that limits the store of value function for a CBDC and thus limits the extent of potential bank disintermediation should be able to mitigate financial stability concerns.

Financial stability implications of a CBDC should also be assessed against an appropriate counterfactual scenario, which is likely not to be the current status quo. That is, the emergence of new private means of payments such as global stable coins or even foreign-issued CBDC might have implications for financial stability (e.g. disintermediation, credit risk) that a domestically issued CBDC could mitigate. Lastly, regulatory policies are a further important lever to tackle potential financial stability concerns.

IV.3.2. Possible macroeconomic effects of a CBDC

The creation of a CBDC allows the continued strong presence of public money also in the digital era. By ensuring the continued 1:1 convertibility of private payment instruments into legal tender, it therefore safeguards the role of public money as the anchor for the monetary system, which ultimately also supports monetary policy transmission. While a digital euro would in first instance not aim at being used as a monetary policy tool, the literature furthermore considers the benefits for monetary policy of a CBDC that bears an interest rate. In particular, the literature highlights that an interest-bearing CBDC can act as a stabilisation tool if it can circumvent the zero-lower-bound on interest rates, bringing significant improvements for the economy ([95]). However, as tracking the policy rate could imply negative interest rates on the CBDC, most central banks do not consider such a possibility in their design, at least up to a certain threshold of CBDC holdings. Conversely, not tracking the monetary rate would also create concern because, as a safe asset, a CBDC could set a floor for all other interest rates. In the euro area, a non-interest-bearing CBDC could threaten the current monetary policy stance because the risk-free interest rate is currently below -0.5% (ECB, 2020). Hence, the ECB advocates that a CBDC should be a means of payment, while its use as store of value should be limited.

The literature also highlights that introducing a CBDC can have a broad macroeconomic effect. Using a DSGE model calibrated on the United States, Barrdear and Kumhof (2016) find that a CBDC could increase the steady-state level of GDP by nearly 3% under the assumption that a stock of CBDC amounting to 30% of GDP is issued against government debt ([96]). This increase would be driven by lower real rates and the improved efficiency of the economy with a reduction in transaction costs. The latter would compensate for the potential negative impact on the banking system, provided that the central bank intervenes to provide liquidity to the banking system that could lower real interest rates. A further positive element would be the reduction in distortionary tax rates due to the increased demand from the public for the CBDC, which constitutes a monetary form of debt. More modest effects are found by Chiu et al., op. cit. By calibrating their model on the US economy, the authors show that the effects of a CBDC on bank lending and output depend on the CBDC's interest rate, with a maximum increase in bank lending of 3.55% and a related increase in output of 0.5%.

([94]) Rainone E., (2021), Identifying deposits' outflows in real-time, Bank of Italy WP 1319.

([95]) Gross J., Schiller J. (2020), A Model for Central Bank Digital Currencies: Do CBDCs Disrupt the Financial Sector?, *SSRN Electronic Journal*, October 2020

([96]) Barrdear J., Kumhof M. (2016), The macroeconomics of central bank issued digital currencies, Bank of England, Staff Working Paper N° 605

IV.4.Concluding reflections

The decision of whether to establish a CBDC is a complex endeavour that needs to take into account many different motivations, of which the economic motivations, as discussed in this section, constitute only a part.

Ultimately, the economic benefits of the establishment of a CBDC will depend on the capacity of managing well the trade-off between the positive impact from the increased efficiency in payment systems and the risks that this introduction could pose to the banking system.

It is important to notice when analysing the relevant trade-offs that the challenges posed by a CBDC, in particular for the role of the banking sector, may arise anyway in connection with the development of stable coins, foreign-based CBDC and the entry of new large foreign competitors in the payments market.

In practice, an in-depth analysis of the relevant design choices will be necessary before deciding which are the most appropriate for the jurisdiction concerned.