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THE IMPACT OF CENTRAL BANK DIGITAL CURRENCY: HOW TO PREVENT BANKING DISINTERMEDIATION[1]

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***ABSTRACT**. This article analyzes the effectiveness of measures to reduce the risk of bank breakdowns that have arisen with the introduction of two new types of money: the Central Bank Digital Currency (CBSV) and the CBSV-backed stable cryptocurrency. Firstly, we apply the taxonomy of money and the structure of the sectoral balance in order to compare the basic form of money in the current economies - bank deposits - with these two new types of money, which are superior to bank deposits under certain conditions. Secondly, we are dealing with the issue of the fragmentation of banks arising from digital expansion, paying particular attention to how the introduction of stable cryptocurrency supported by CBSV and CBSV can further increase this risk. Finally, we examine the effectiveness of five measures that central banks can use to reduce the risk of bank breakdowns and propose an optimal combination of these measures.*

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JEL classification: E02, E51, E58, G28

Introduction

"There have been three great inventions since the beginning of time: fire, the wheel and central banking". (Will Rogers)

The primary aim of this paper is to analyse the effectiveness of a set of instruments designed to mitigate the risk of banking disintermediation arising from the introduction of two new types of money: CBDC and CBDC-backed stablecoin. The secondary aim is to propose the optimal combination of these instruments for achieving a stable and enduring balance between low levels of banking disintermediation risk and the efficient issuance of CBDC.

The current monetary debate explains the relevance of this paper. Specifically, countries around the world are developing projects to issue CBDC because the benefits of CBDC are clear, but they are also worried about the potential impact of CBDC in the banking system—banking disintermediation—because CBDC would be both a means of payment and a store of value. Therefore, this paper has a two-fold relevance.

In this paper, we set out a three-pillar monetary-financial framework to analyse, categorise and compare current and emerging means of payment and to capture their creation and destruction processes through sectoral balance sheet dynamics. This methodology is mainly based on (Bindseil, 2020; Cœuré, Loh, 2018).

Our results show that a stable and enduring balance between low levels of banking disintermediation risk and an efficient CBDC could be achieved by the implementation of two tools: (i) restricting access to payment services and deposit-taking linked to CBDC to commercial banks and (ii) the provision by the central bank of temporary or structural liquidity credit lines.

Therefore, our contribution to the CBDC debate is two-fold. Firstly, we initiate a debate around which tools are the most optimal for achieving the two conflicting objectives of financial stability and high demand for CBDC. Secondly, we propose that the two tools mentioned in the paragraph above will limit banking disintermediation while guaranteeing the relative success of CBDC projects.

1. The Theoretical Framework

Money has been one of the most important factors in the progress of humanity during the last 5,000 years because so many human actions are linked with the three functions of money: paying, saving and valuing. Indeed, the quest for the form of money that best fulfils these three functions—medium of exchange, store of value and unit of account—remains the main task facing policymakers and researchers.

In the 19th century, the advent and consolidation of central banks and public and regulated money, in the form of cash and bank deposits, laid the foundations for unprecedented progress on the real side of the economy, with industrialisation and globalisation as the major milestones.

Currently, digitalisation is also having a significant impact on the real economy and, thus, on the monetary side, with three main transformations during the last decade (Carstens, 2019; Zlyvko *et al.*, 2021; Marino, Picariello, 2022; Czechowska, Florczak, 2022).

Firstly, bank deposits—today's most demanded form of money—are undergoing a major transformation as a medium of exchange. New payment services and payment instruments have emerged, such as mobile wallets linked to payment initiation services like GooglePay, instant P2P transfers like Bizum in Spain and QR code payment instruments (Popova, 2021).

Secondly, the declining use of cash has raised three main concerns for policymakers. The first is that of the financial exclusion of unbanked and underbanked people (Radavičius, Tvaronavičienė, 2022; Stoyanova, Markova, 2022). The second is that payment becomes concentrated in bank deposits, which prevents people from paying and saving in a credit-risk-free way. The third is that monetary policy becomes less effective, since the disappearance of cash would reduce the central bank's balance sheet and the commercial banks' demand for legally required reserves.

Finally, the digitalisation of the monetary side of the economy is also creating new forms of unregulated private means of payment: forms that aim to rival and displace sovereign currencies (Krajčík *et al.*, 2023; Khalatur *et al.*, 2022; Szostak, 2022). The main examples of this explosion of unregulated and privately issued means of payments are cryptocurrencies — such as Bitcoin (which emerged in 2009) (Korauš *et al.*, 2021), Ethereum, and Binance Coin—and stablecoins such as Tether. In 2021, the combined market capitalization of cryptocurrencies and stablecoins reached 3 trillion USD.

One particularly interesting case was Facebook´s project to issue its private and unregulated stablecoins, the Libra (Members, 2019). This project, now discontinued, has triggered an unprecedented set of proposals at the institutional level aiming to preserve monetary and financial stability. The main policy response has been to propose a new type of money accessible to the general public, issued by the central bank itself and recorded in a digital ledger, the so-called Central Bank Digital Currency (CBDC).

Central Banks around the world agree that issuing a CBDC provides the following benefits (Canada, 2020; Riksbank, 2020): (i) they foster the financial inclusion of unbanked and underbanked households and companies; (ii) they offer a public-issued and credit-risk-free form of money in the context of the demand-cash decline; (iii) they ensure that public money remains the most demanded unit of account in the face of private digital currencies; and (iv) they provide stronger and more competitive payment services and payment systems.

These benefits are mainly related to the current decline in the demand for cash, in which context low-income and older people are increasingly excluded from banking payment systems that require digital knowledge and have different service costs. Moreover, the displacement of cash by bank deposits means that payments are increasingly concentrated in a banking-controlled oligopolistic market, which increases operational risk and the lack of innovation and competition. Issuing a CBDC could mitigate all these adverse consequences of the disappearance of cash. Finally, a CBDC would also give central banks more power to compete with any future private or public digital currencies that could compromise its monetary and financial sovereignty.

But monetary authorities must also consider the serious risks stemming from the issuance of CBDC, in particular the issue of banking disintermediation (Auer *et al.*, 2021), which refers to the takeover of the main banking services provided by banks—deposit taking, payment services, credit activity and investment services—by other financial entities, whether regulated or unregulated. This phenomenon is already real because of digitalisation, which has

accelerated the entry of Bigtech and Fintech into the finance sector. The core of the problem is that the issuance of CBDC could consolidate the place of Bigtech and Fintech in finance and, therefore, increase the risk of banking disintermediation. This risk results from the high degree of demand-side substitutability with regard to deposit-taking activity between bank deposits and CBDC, which in turn results from the potential of CBDC, in ordinary times, to be a more effective means of payment and store of value than bank deposits. In addition, in times of crisis, this migration from bank deposits to CBDCs would accelerate due to CBDCs' being considered a free-risk asset in a process known as Flight to Safety.

Interest has grown in the last two years in CBDC-backed Stablecoins, a new form of digital currency that offers the same benefits and risks as CBDC, although it would be issued by a regulated private entity, which must back 100% of its issuance with central bank reserves.

2. Methodology

We set out a two-pillar monetary-financial framework in order to create a sound understanding of the CBDC impact. This conceptual research is more effective and relevant than an empirical approach because the lack of data precludes conclusions on the impacts of CBDCs in commercial banks and in the economy.

The first pillar of the framework is a monetary-financial taxonomy with six design features. Two relate to the technology: the format of the mean of payment (i) and the payment system (ii). Four relate to economic features: the value of the monetary asset (iii), its nature (iv), the issuance (v) and the rate of interest (vi).

The second pillar is sectoral balance sheet dynamics. We describe the processes of creation and destruction of bank deposits, and we focus on the impact of CBDC on commercial banks.

2.1 Monetary Taxonomy

In *Table 1*, we show a monetary-financial taxonomy based on the current work of the International Monetary Fund (Adrian, Mancini-Griffoli, 2019) and the Bank of International Settlements (Cœuré, Loh, 2018).

Table 1. Monetary taxonomy of the deposits, CBDCs and CBDC-backed stablecoins

Design Features	Bank deposits	CBDC	CBDC-backed Stablecoins
Value	EUR	EUR	EUR
Format	Account-based	Account-based	Account-based
Payment systems	Synthetic *(Open)*	**?**	**?**
Nature	Claim	Real asset	Real asset
Issuer	Commercial Bank	Central Bank	Regulated-private
Issuance rule	Active	Passive	Passive
Interest bearing	YES	**?**	**?**

Source: created by the authors.

Before analysing these three forms of money, we will study the format and payment-system design features of the taxonomy, in order to understand CBDCs better. These three forms of money have no material existence, so they must be registered somewhere. Different

infrastructures could be designed for keeping and updating the ledgers, that is to say, the payment system.

We classify ledgers and payment systems based on the following three characteristics: the entity in which the ledger is located, the on-balance or off-balance accounting of the ledger and the degree of the private-public partnership participation in services and payment systems.

Following the BIS criteria (Auer et al., 2020), we define four different infrastructures: Direct, Hybrid, Intermediated and Synthetic. In Direct infrastructure there is a sole retail on-balance sheet ledger run by the central bank and with the payment services it provides. In the Hybrid System, there is also a sole retail on-balance sheet ledger run by the central bank, but private payment services providers register the clients' payment accounts off-balance and provide payment services. The third proposed system, the Intermediated, differs from the previous system in that the central bank runs a wholesale ledger instead of a retail ledger. The fourth infrastructure, the Synthetic system, differs from the Intermediated in that the private payment services providers register the clients' payment accounts on-balance, backing its issuances with central bank reserves in a certain percentage set out in the regulation.

Four types of monetary assets are circulating in the Eurozone economy and in other countries. These monetary assets are central bank notes, bank deposits, electronic money and crypto assets. All these means of payment, except cash, are already electronic, and the asset that best fulfils the three functions of money is bank deposits, which is why it is the most demanded form of money.

Of the four types of monetary assets mentioned, only the first three are regulated and, therefore, can be "formally" considered as money. The European Union regulation—Article 1 (3) (b) of Directive 2000/46/EC—defines funds as the set of three types of money: cash, bank deposits and electronic money. In this sense, these three regulated types of money are issued or guaranteed by the central bank and, therefore, are denominated in the sovereign unit of account, which for the Eurozone is the EUR.

On the other hand, crypto assets—Directive (UE) 2018/843—are a digital representation of value that is not issued or guaranteed by a central bank or a public authority, is not necessarily attached to a legally established currency and does not possess the legal status of currency or money, but is accepted by natural or legal persons as a means of exchange. We distinguish between stablecoins (G7, 2019): crypto assets linked to a legal currency, and other crypto assets.

Regulation in the monetary field is based on a framework of three pillars, each of which aims to improve each of the money functions, especially those of bank deposits.

The first regulatory pillar is intended to enhance the means of exchange function of money through supervision of the main services—such as those provided by banks and payment institutions—and payment systems, like TARGET2, the Spanish SCNE and Mastercard, among others. The second pillar aims to improve the store of value function of bank deposits by means of prudential regulation—to minimise the probability of bank failure and, therefore, mitigate the credit risk of the deposits. This is achieved by a regulation, a LOLR framework and deposit guarantee schemes, which, in the event of a bank failure, guarantee bank deposits up to a maximum of EUR 100,000 per person. The third pillar is intended to enhance the unit of account function of money through a monetary policy framework aiming at stabilising inflation.

In addition to the three regulated types of money and crypto assets, two forms of money are likely to be seen in circulation in the Eurozone over the coming years: CBDCs and CBDC-backed stablecoins.

2.2 Balance Sheet Dynamics

Issuance design features are studied through sectoral balance sheet dynamics based on double-entry bookkeeping principles. This approach is based on the following works: (Cœuré, Loh, 2018) (Bindseil, Tiered CBDC and the financial system, 2020) (Bindseil, 2018) (McLeay *et al.*, 2014) (Gross, Siebenbrunner, 2019).

Our sectoral balance sheet dynamics is based on a model that represents the current situation of four economic sectors which hoard, issue and transfer means of payment. The financial figures in the balance sheet of each sector do not represent real data, only flows of funds through different sectors.

As is shown in Table A1 of Appendix A, the first economic sector is the central bank, the first level participant in the current fractional reserve banking system. Central banks issue two means of payments, cash and reserves, and on the asset side they own international reserves, main refinancing operations (MRO) and public debt. Commercial banks at a consolidated level are the second tier in the current system. They issue bank deposits, receive MRO funding from the central bank and are linked to foreign banks through a deposit and asset account to facilitate foreign trade and other cross-border capital flows. On the asset side, commercial banks make loans, purchase public debt and use and hoard reserves.

The third sector is households and companies who demand money (mainly cash and bank deposits), own real assets as their main source of wealth and, on the liability side, receive loans. A fourth sector would be Bigtechs, which would issue CBDC-backed stablecoins.

The financial accounting of the flow of funds is implemented in one, two or more steps and in quantities of 10, which will be represented as follows: 1(+10)2(-10) and 3(+10)2(-10)4(+10), among others

2.3 Bank Deposits, CBDC and CBDC-backed Stablecoins

Bank deposits are issued by commercial banks in a synthetic payment system with an obligation on each bank to hold reserves at the central bank equalling 1% of its total deposits.. Since commercial banks are supervised and guaranteed by monetary authorities, the value of bank deposits is denominated in sovereign units of account, such as the EUR.

Commercial banks, as payment services providers, have developed various open or closed infrastructures, in collaboration with central banks, to update their ledgers through a set of payment instruments (like debit cards and mobile Apps to P2P transfers) and payment systems (in Spain, mainly SNCE, MasterCard and Visa).

Bank deposits are financial assets since the holder has the right to require the issuer to redeem them for cash or deposits in another bank. This credit risk is mitigated through prudential regulation and supervision, resolution regulation and deposit guarantee schemes.

Finally, commercial banks follow an active issuance rule; that is, commercial banks create new money. Commercial banks create three sources of money: by lending to households and companies, by purchasing public debt and via net external monetary flows.

The process of money creation (Bindseil, 2020) via bank lending is illustrated in Table A1 of Appendix 1. When commercial banks at a consolidated level make a loan, they simultaneously create a matching deposit in the borrower's bank account and both the balance sheets of the private and the commercial banking sector increase. Conversely, when that loan is repaid, the new bank deposit is destroyed and both balance sheets decrease by the loaned amount.

As mentioned above, bank deposits are today the most demanded form of money—monetary aggregate M2 amounts to 13.46 Billion EUR, of which 1.33 are banknotes, and 12.13 are bank deposits—because it is more effective than others in fulfilling the three functions of money. In this sense, the current monetary system has served the public well. As a medium of exchange, several banks and other payment institutions act as payment services providers, giving clients a range of digital, low cost, scalable and rapid payment products. Regarding the deposit value function, the credit risks of bank deposits are highly mitigated. Finally, central bank monetary policy attempts to keep inflation within its target range, to maximise the unit of account function of money.

Although much has been written about CBDCs, there is currently no standardised definition for a CBDC. However, there is a widespread consensus, both academically and institutionally, on some design features, such as those defined in our taxonomy. Based on these features, a CBDC is a new form of account-based money issued by the central bank—and, therefore, denominated in sovereign units of account (EUR)—and with a real nature since although these CBDC would be convertible into cash, the issuer of both monetary assets—the CBDCs and the cash—is the same institution, the central bank. The passive issuance of a CBDC implies that its quantity directly depends on its demand by the people in substitution for cash and bank deposits.

It is, therefore, logical that the various designs of CBDC by the different central banks will depend on the payment system, the interest rates and a certain type of passive issuance. Regarding payment systems, CBDCs can be direct, hybrid, intermediated or synthetic. In addition, we will also make two distinctions. The first is between CBDCs that circulate through newly built infrastructures and those that operate through existing payment systems. The second is between (i) new or existing CBDC infrastructures in which only banks can provide payment services and (ii) those open to any payment service provider.

Regarding CBDC-backed stablecoins, the two differences between them and CBDC are the issuer—not the central bank—and the payment system: CBDC-backed stablecoins are designed as a Synthetic system with an obligation to back the issuances 100% with central bank reserves.

2.4 Banking Disintermediation

Banking disintermediation occurs when commercial banks lose customers' business in their main markets, and this business is gained by non-bank financial entities, both regulated and unregulated. The main financial business activities listed as subject to mutual recognition (Directive 2013/36/UE), are the following: deposit taking, payment services, lending activity and securities services, mainly safekeeping and brokerage.

A disintermediated banking system is much less profitable, solvent and liquid and, therefore, more unstable. This would adversely impact the three money functions of bank deposits: an unstable commercial banking system will be much less efficient in processing payment operations, in redeeming bank deposits and in the transmission of the monetary policy.

Currently, commercial banks are the main point of contact for customers requiring the four financial services mentioned because banks have a monopoly on deposit-taking activities, which is the main financial service demanded by all customers. But the digitalisation of financial services, mainly in payments, partially reverses this implicit hierarchy. New non-bank-regulated players such as Fintechs and Bigtechs—Google, Amazon, Facebook and Apple—are offering payment platforms, linked to payment accounts and new payment

instruments that are more user-friendly and offer more functionalities than those provided by commercial banks.

Therefore, a new consumer's point of contact for financial services has emerged: the Bigtech and Fintech payment platforms, regulated either as payment institutions or as electronic money institutions. This situation has developed for two reasons. Firstly, Bigtechs' business models were already fully digitalised—such as e-commerce or social messaging—and, secondly, Fintechs are better than banks at digitalising their business models because current banking operating structures are so costly.

However, in most countries, the impact of digitalisation on banking disintermediation has been limited, and banks have been able to remain the main deposit-taking point of contact for financial services customers. The Bank of International Settlements (Cos, 2019) defines five possible scenarios regarding the impact of digitalisation on banking disintermediation, from less to more disintermediated.

In the first and the second scenarios—respectively, *better bank* and *new bank* scenarios—there is no banking disintermediation since both current commercial banks and new banks have efficiently adapted their business models to digitalisation and, therefore, there is neither customer loss nor any impact on bank profitability, solvency and liquidity.

In the third scenario, several Bigtechs and Fintechs enter the payment services market, gaining new customers that were previously exclusive to commercial banks by offering new products such as m-wallets, QR payments, payment initiation services, and P2P instant transfers. Although payment institutions and electronic money institutions, such as GooglePay, PayPal, ApplePay and Wise, can offer customers a payment account and electronic money, this type of money is not considered an effective substitute for bank deposits for three reasons. These are the high cost that these entities bear to access traditional banking payment networks, the absence of remuneration and the higher credit risks of these accounts, since they are not covered by the deposit guarantee schemes. In this case of a low level of banking disintermediation, which applies to Europe, the USA and Japan, some banks are called distributed banks because they lose payment services fees and have to pay fees for the Bigtechs' intermediation in other financial markets.

The fourth scenario is called *Relegated Bank*, in which Bigtechs issue electronic money highly substitutable for bank deposits and linked to a fully digital and efficient payment platform. Most customers use this platform to replace some of their bank deposits with electronic money accounts. In this scenario, commercial banks have lost a significant part of their deposit-taking and payment services activities with customers, so the degree of banking disintermediation is high, bringing significant reductions in the profitability, solvency and liquidity of banks. The most characteristic example of this type of disintermediation is the Chinese economy, with the giants AntFinancial and Tencent. These Bigtechs, under Chinese financial legislation, issued interest-bearing electronic money in a highly demanded m-wallet and linked to highly innovated payment services. In this sense, these Bigtechs created a new point of contact for consumers for financial services. In order to offset the high risk of banking disintermediation, the People's Bank of China (PBoC) has implemented a series of measures (BIS, 2019).

The fifth and last scenario, the *Disintermediated bank*, is a deterioration of the fourth because more people are substituting electronic money for bank deposits, demanding all financial services through Bigtechs. In this scenario, digitalisation has completely disrupted commercial banks, which have lost direct contact with their customers; their sole function now would be to take wholesale deposits from electronic money institutions (Adrian & Mancini-Griffoli, 2019). Therefore, the only income commercial banks would gain would be

account fees or negative interest rates associated with those accounts. In this scenario, banks would likely disappear, and the electronic money institutions would back the funds issued with 100% central bank reserves: that is, they would issue CBDC-backed stablecoins.

The impact of crypto assets in banking disintermediation is still negligible because crypto assets are not a substitute for bank deposits since they do not effectively fulfil the functions of medium of exchange, store of value and unit of account.

In today's banking system, money and credit are linked. For this reason, another adverse consequence of banking disintermediation is reduced aggregate credit supply. Therefore, in the event of banking disintermediation, such as in scenarios four and five, lending activity would initially decrease, and therefore the business models of both commercial banks and borrowers would be significantly affected. Although Bigtechs and Fintechs would eventually replace banks in lending markets, commercial banks usually finance certain secured loans such as mortgages, while Bigtechs tend to finance other, unsecured markets.

As mentioned at the beginning of this section, despite digitalisation and the Bigtech phenomenon, today's commercial banks remain customers' main point of contact for the four financial services due to their monopoly on deposit-taking activities. Therefore, a new type of money with the same features as bank deposits and distributed by banks and non-banks would effectively compete with bank deposits, as mentioned in section 2, and would lead to seriously disintermediated commercial banks. These types of money are CBDCs and CBDC-backed stablecoins, and monetary authorities are considering a range of tools to mitigate the risk of banking disintermediation steaming from CBDC issuances.

With CBDCs and CBDC-backed stablecoins issuances, a third or fourth banking disintermediation scenario is highly likely in which Bigtechs such as Google and Meta could offer deposits in the central bank or issue CBDC-backed stablecoins. Consumers would replace bank deposits with CBDCs provided by Bigtechs, which act as payment services providers and, in time, as lenders and securities services providers. This would replace the present hierarchy, moving the consumers' point of contact from deposit-taking banking to digitalised CBDC providers. Moreover, commercial banks would not only lose customers in the event of a CBDC issuance because, even if they distributed the new CBDC, they would also lose structural liquidity and balance size, as shown in *Table 2*.

3. Results and Discussion

Applying the balance sheet dynamics methodology to CBDCs and CBDC-backed stablecoins shows that their passive issuing means that consumers can unlimitedly replace their bank deposits and cash with CBDCs. The balance sheet dynamic in Table A2 shows the monetary effects of substituting CBDCs for bank deposits. This substitution of bank deposits with CBDCs reduces commercial banks' balances by the same amount demanded. On the other hand, as shown in Table A3, if consumers replace some of their bank deposits with CBDC-backed stablecoins issued by a commercial bank, the financial and prudential effects would be the same, since although the central bank reserves do not leave the bank, they would be included in the 100% requirement. In Table A4, we show the same effects if CBDC-backed stablecoins are issued by Bigtechs.

The CBDC-backed stablecoins issuance resembles the set of narrow banking proposals, such as the Chicago Plan and the Irving Fisher proposal (Laina, 2016). In these proposals, all bank deposits are 100% backed by central bank reserves, which in this paper we define as CBDC-backed stablecoins.

Regarding the monetary taxonomy, we offer a CBDC with an intermediated payment system and a synthetic CBDC, or CBDC-Backed stablecoin. The payment systems of these two new types of money, as shown in the following taxonomy, *Table 2*, are open to bank and non-bank payment services providers, with the same functionality as today´s bank deposits. Moreover, they are not interest-bearing, and the passive issuance is unlimited, so consumers could replace any deposit and cash they have with CBDC and CBDC-backed stablecoins.

Table 2. Monetary taxonomy of CBDCs and CBDC-backed stablecoins

Design Features	CBDC	CBDC-backed Stablecoins
Value	EUR	EUR
Format	Account-based	Account-based
Payment systems	Intermediated *(Open)*	Synthetic *(Open)*
Nature	Real asset	Real asset
Issuer	Central Bank	Regulated-private
Issuance rule	Passive	Passive
Interest bearing	NO	NO

Source: created by the authors.

Although bank deposits have served the public well, these two money designs are preferable to bank deposits because they effectively fulfil the three functions of money. CBDC offer the same medium of exchange functionality in terms of payment services and payment systems. Moreover, introducing CBDCs and CBDC-backed stablecoins will foster competition in payments, reducing costs and increasing innovation, by enabling Bigtechs and Fintechs to offer CBDC payment accounts in the same way as banks.

CBDC and CBDC-backed stablecoins are credit-risk-free deposits of value assets, whereas bank deposits bear credit risk. Finally, the unit of account function of CBDCs and CBDC-backed stablecoins will also be denominated in EUR, making them as stable in value as bank deposits. Moreover, bank deposits already create financial and monetary instability, in the form of financial bubbles, stemming from the active issuance rule. Therefore, if more bank deposits are replaced by CBDCs, there would be less risk of the functions of money being affected from the macroeconomic point of view.

Moreover, a given CBDC or a CBDC-backed stablecoin issuance significantly increases the banking disintermediation risk, which impacts banking profitability, solvency and liquidity through loss of customers and a structural balance sheet reduction.

Researchers in academia and institutions are focused on defining and analysing different policy tools that aim to mitigate this banking disintermediation risk and the resulting adverse consequences in banking and the economy as a whole. We have gathered all the tools in order to determine the best combination to put forward the most appropriate CBDC design. These tools are the following five:

Quantitative caps on the demand for CBDC payment accounts and for CBDC transaction amounts.

Negative interest rates on CBDC balances.

Restrict access to payment services and deposit-taking linked to CBDC to commercial banks only.

Limit the range of payment services that can be linked to CBDC.

Central bank provision of temporary or structural extraordinary liquidity credit lines.

The first policy tool involves setting a limit on the CBDC amount demanded by businesses and consumers. For example, we could have a CBDC account with a maximum

outstanding balance of 5.000 EUR. This tool effectively limits the substitution of bank deposits with CBDCs and hence the bank deposit outflow, although customers could replace the financial services provided by the bank for those provided by the Bigtech CBDC provider. These mitigation effects could be extended by additional limits on the payment services linked to CBDCs. This tool limits the ability of the CBDC to serve as a means of payment and as a store of value.

The second tool is negative interest rates on CBDC balances, which aims to limit the substitution of bank deposits by CBDCs by negatively remunerating CBDC accounts over a certain quantity, for example, a -4% interest rate over any balances above 5.000 EUR. This tool limits the ability of the CBDC to serve as a store of value.

The third tool allows only commercial banks access to payment services and deposit-taking linked to CBDCs. If this option is applied, Bigtechs and Fintechs would be excluded from providing payment accounts and payment services. Although this does not directly weaken the money functions of CBDC as a medium of exchange and store of value, it does weaken competition and innovation in payments. This option effectively limits banks' loss of customers, since they keep their monopoly on deposit-taking, both their own deposit issuances and CBDCs. On the other hand, the substitution of CBDCs for bank deposits—and therefore the outflow of bank deposits—has no limits.

The fourth tool aims to reduce the ability of CBDCs to serve as a means of payment by limiting the range of different payment services that can be linked to CBDCs. For example, CBDCs can be restricted to making P2P transfers: that is, excluded from direct debits, proximity payments, e-commerce payments and payments in commercial establishments. This would increase the preferability of bank deposits as means of payment over CBDCs, because most payments in daily life are related to direct debits and proximity payments.

The fifth and last option is the provision by the central bank of extraordinary liquidity credit lines, temporary or structural. As we saw in Table 2, a migration from bank deposits to CBDC always implies an outflow of bank liquidity in the form of central bank reserves and hence in the bank's ability to finance the real economy. In order to offset this loss of deposit funding, the central bank would grant commercial banks credit lines of reserves, increasing the bank's ability to lend to the economy and thus mitigating the risk of bank disintermediation.

At present, the central bank defines some credit line schemes for monetary policy purposes and for liquidity difficulties, that is, acting as the Lender of Last Resort (LOLR). These new credit lines to mitigate banking disintermediation were first proposed by Brunemiaer and Landau (Brunnermeier, Landau, 2022). These authors suggested the creation of specific refinancing modalities for compensating any deposit loss due to the CBDC, particularly due to the *Digital Euro Project*. They also define two modalities, one transitory—to absorb the initial shock of the CBDC introduction—and the other permanent—to compensate for a structural shift.

The objective of the transitory liquidity lines would be to progressively adapt banking credit activity to the new conditions of the lending market, i.e. granting non-deposit-funded loans. On the other hand, the goal of permanent liquidity lines would be for banks to continue lending with central bank funding in the same way as with deposit funding. To equalise the funding conditions of deposits and central bank credit lines, the monetary authority must lend to commercial banks at low interest rates and long maturities.

Below in *Table 3* we analyse three early CBDC adopters—the Bahamas (Bahamas, 2020), Nigeria (Nigeria, 2019), and China (The Digital Currency Electronic Payment; DC/EP) (Turrin, 2021)—and the Eurozone's pilot CBDC project, the *Digital Euro* (Bank, 2020). On

14 July 2021, the European Central Bank decided to launch a two-year investigation phase of a possible CBDC, so the decisions on the design features highlighted in red are still pending.

Table 3. Monetary taxonomy of four CBDC projects

Design Features	Sand Dollar	E-Naira	DC/EP	Digital Euro
Value	BSD	NGN	CHY	EUR
Format	Account-based	Account-based	Account-based	Account-based
Payment systems	Hybrid *(Open)*	Hybrid *(Open)*	Hybrid *(Closed)*	**Hybrid *(Open)***
Nature	Real asset	Real asset	Real asset	Real asset
Issuer	Central Bank	Central Bank	Central Bank	Central Bank
Issuance rule	Passive *(with caps)*	Passive *(with caps)*	Passive *(without caps)*	**Passive *(with caps)***
Interest bearing	NO	NO	NO	**NO**

Source: created by the authors.

All these CBDCs, denominated in their own unit of account and issued by the central bank, have an account-based format with a hybrid payment system, i.e. the central bank keeps the ledger with all CBDC accounts and private services providers keep their own ledger in which they record the CBDC accounts of their clients and also provide payment services to them.

The main difference between these four projects lies in the design features, such as the payment system, the issuance rule and the interest rate, which are related to the tools to mitigate banking disintermediation. Therefore, these projects define different tools to mitigate banking disintermediation. In *Table 4* we show the options chosen for the three CBDCs in circulation.

Table 4. Five tools to mitigate banking disintermediation

Tools to mitigate banking disintermediation	DC/EP	Sand Dollar	E-Naira
(1) Quantitative caps	NO	**YES**	**YES**
(2) Interest rates	NO	NO	NO
(3) Closed payment systems	**YES**	NO	NO
(4) Limits on the range of payment services	NO	NO	NO
(5) Central bank credit lines	NO	NO	NO

Source: created by the authors.

The PBoC has designed a CBDC with no limits on its demand, whether under quantitative caps or interest rates, although there are certain caps if clients open CBDC accounts with some degree of anonymity. The lack of limits on demand and payment services makes this CBDC a more attractive form of money than bank deposits, so the level of bank disintermediation would be expected to be high. But, as discussed in the previous section, the Chinese financial system started this CBDC project with a moderate level of bank disintermediation due to digitalisation and Bigtech. In order to limit bank disintermediation stemming from digitalisation and CBDC issuance, the PBoC has decided that the tool will

restrict access to payment services and deposit-taking linked to CBDC to commercial banks. Currently, there is no relevant data by which to assess the efficiency of the demand for this CBDC.

For its CBDC, the Sand Dollar, the Central Bank of The Bahamas has implemented quantitative caps on the demand for CBDC payment accounts and for CBDC amounts of transactions in order to mitigate the risk of banking disintermediation. Any bank and non-bank payment services provider can offer CBDC accounts and payment services with certain limits. As an example of these limits, consumers with the highest degree of identification can hold a maximum balance of USD 8,000 in their CBDC accounts with a limit on monthly transactions of USD 10,000. The Central Bank of The Bahamas defined different limits for companies, with a maximum CBDC balance of USD 100,000 and no transaction limits. In all instances, the CBDC account must be linked to a bank deposit account in case the cap is breached.

This CBDC was launched in October 2020, but currently there is no relevant data to assess the efficiency of the demand for this CBDC because of the size and other features of the Bahamas´ financial system. The monetary authority's January 2022 report stated that the assets and liabilities of CBDC issued amounted to 303,685 BSD, which represents 0.003% of the total money supply.

The E-Naira CBDC of the Central Bank of Nigeria has applied the same mitigation tool as the Central Bank of The Bahamas, with a maximum balance for consumers of USD 12,048 (NGN 5,000,000) and with a daily amount transaction limit of 1,205 USD (500.00 NGN). For companies, there are no limits on CBDC balances and transactions.

The latest ECB´s statements on the Digital Euro Project suggest that the tool chosen to limit banking disintermediation could be a cap on CBDC balances of EUR 3,000 per consumer. So it seems that this option will be the prevailing tool in most CBDC designs for mitigating bank disintermediation. However, this tool adversely affects the store of value money function of CBDCs, especially when the maximum limits are significantly low, discouraging demand for CBDCs in substitution for bank deposits. This lack of demand could lead to the failure of these CBDC projects.

Having analysed these five options and applied the methodology of this study, we propose a CBDC design with tools that do not adversely impact the medium of exchange and store of value money functions of CBDC. This should encourage high levels of demand for CBDC, ensuring the continuity of the projects and, at the same time, mitigate banking disintermediation. Therefore, in our view, the two best tools to choose are: allow only commercial banks access to payment services and deposit-taking linked to CBDC; and the central bank to provide temporary or structural extraordinary liquidity credit lines.

With this design, banks could offer limitless CBDC accounts and payment services to customers and companies. In an extreme scenario, if the real sector replaces all these bank deposits with CBDCs, commercial banks will still retain all financial customers and will not see a deterioration in their financial and solvency situation. However, regarding liquidity, commercial banks would have lost all their deposit funding, and their capacity to lend to the real economy would be significantly affected. To counter this, the central bank would grant credit lines to commercial banks. In Table A5, we show how a commercial banking system with less deposit funding first uses central bank credit lines, temporarily, in order to adapt and then, secondly, under the new funding conditions, lends to the customers in CBDCs.

Therefore, we find that a stable and enduring balance between low levels of banking disintermediation risk and an efficient CBDC could be achieved by the implementation of the following two tools: (i) restrict access to payment services and deposit-taking linked to CBDC

to commercial banks only, and (ii) central bank provision of temporary or structural extraordinary liquidity credit lines.

So far, the academic and institutional discussion has focused only on quantitative limits as the measure by which to limit bank disintermediation, ignoring the likelihood that this limit would significantly discourage demand for CBDCs and, therefore, could jeopardise institutional projects for CBDC issuance.

We propose that a debate be established around which tools are the most optimal to achieve the conflicting objectives of financial stability and high demand for CBDCs. We also propose that future lines of research and development of CBDC projects assess the effectiveness of these two tools.

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CENTRINIO BANKO SKAITMENINĖS VALIUTOS ĮTAKA: KAIP UŽKIRSTI KELIĄ BANKŲ IŠSKAIDYMUI

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SANTRAUKA

Šiame straipsnyje analizuojamas priemonių efektyvumas, skirtas mažinti bankų išskaidymo riziką, kuri iškilo įvedus dvi naujas pinigų rūšis: centrinio banko skaitmeninę valiutą (CBSV) ir CBSV remiamą stabilią kriptovaliutą. Pirma, taikoma pinigų taksonomija ir sektorių balanso struktūra siekiant palyginti pagrindinę pinigų formą dabartinėse ekonomikose – banko indėlius – su šiais dviem naujais pinigų tipais, kurie yra pranašesni už banko indėlius susidarius tam tikroms sąlygoms. Antra, nagrinėjamas bankų išskaidymo, kylančio dėl skaitmeninio plėtimo, klausimas, ypatingą dėmesį skiriant tam, kaip CBSV ir CBSV remiamos stabilios kriptovaliutos įvedimas gali dar labiau padidinti šią riziką. Galiausiai, nagrinėjamas penkių priemonių, kuriomis centriniai bankai gali sumažinti bankų išskaidymo riziką, efektyvumas ir siūlomas optimalus šių priemonių derinys.

REIKŠMINIAI ŽODŽIAI: centriniai bankai; CBSV; stabilios kriptovaliutos; bankų išskaidymas; Bigtechs; skaitmeninės valiutos.

APPENDIX A

Table A1. Active issuance of deposits by commercial banks making loans. Source: authors' own elaboration

Assets			Liabilities		
Central Bank					
Intern. Reserves		724	Cash		1.231
MRO		734	Reserves		2.098
Public debt		2.899	Others		1.028
Commercial Banks					
Reserves		1.882	Equity		1.524
Public debt		1.457	MRO		734
Loans	**$_1$(+10)**	**18.974**	Bank deposits	**$_1$(+10)**	**22.712**
Others		3.496	Others		839
Households and companies					
Cash		1.231	Equity		104.571
Bank deposits	**$_1$(+10)**	**22.712**	Loans	**$_1$(+10)**	**18.974**
Real assets		99.602			

Table A2. CBDC issuance. Source: authors' own elaboration

Assets			Liabilities		
Central Bank					
Intern. Reserves		724	Cash		1.231
MRO		734	Reserves	**$_1$(-10)**	**2.088**
Public debt		2.899	CBDC	**$_1$(+10)**	**160**
			Others		878
Commercial Banks					
Reserves	**$_1$(-10)**	**1.872**	Equity		2.524
Public debt		1.457	MRO		734
Loans		18.974	Bank deposits	**$_1$(-10)**	**22.692**
Others		4.486	Others		839
Households and companies					
Cash		1.231	Equity		104.571
Bank deposits	**$_1$(-10)**	**22.692**	Loans		18.974
CBDC	**$_1$(+10)**	**160**			
Real assets		99.462			

Table A3. CBDC-backed stablecoin issuance by commercial banks. Source: authors' own elaboration

Assets			Liabilities		
Central Bank					
Intern. Reserves		724	Cash		1.231
MRO		734	Reserves		2.098
Public debt		2.899	Others		1.028
Commercial Banks					
Reserves		1.882	Equity		2.524
Public debt		1.457	MRO		734
Loans		18.974	Bank deposits	**$_1$(-10)**	**22.692**
Others		4.626	Stablecoins	**$_1$(+10)**	**160**
			Others		829
Households and companies					
Cash		1.231	Equity		102.711
Bank deposits	**$_1$(-10)**	**22.692**	Loans		18.974
Stablecoins	**$_1$(+10)**	**160**			
Real assets		97.602			

Table A4. CBDC-backed stablecoin issuance by Bigtechs. Source: authors' own elaboration.

Assets			Liabilities		
Central Bank					
Intern. Reserves		724	Cash		1.231
MRO		734	Reserves		2.098
Public debt		2.899	Others		1.028
Commercial Banks					
Reserves	**$_{1}$(-10)**	**1.872**	Equity		2.524
Public debt		1.457	MRO		734
Loans		18.974	Bank deposits	**$_{1}$(-10)**	**22.692**
Others		4.626	Others		979
Bigtechs					
Reserves	**$_{1}$(+10)**	**510**	Stablecoins	**$_{1}$(+10)**	**510**
Loans		3.120	Equity		600
Real assets		1.200	Funding		3.720
Households and companies					
Cash		1.231	Equity		99.941
Bank deposits	**$_{1}$(-10)**	**22.692**	Loans		22.094
Stablecoins	**$_{1}$(+10)**	**510**			
Real assets		97.602			

Table A5. Central bank credit lines to commercial banks in order to mitigate the banking disintermediation risk. Source: authors' own elaboration

Assets			Liabilities		
Central Bank					
Intern. Reserves		1.169	Cash		541
CB liquidity	**$_{1}$(+10)**	3.509	Reserves	**$_{1}$(+10)$_{1}$(-10)**	**765**
Public debt		8.438	CBDC	**$_{1}$(+10)**	**10.932**
			Others		878
Commercial Banks					
Reserves	**$_{1}$(+10) $_{1}$(-10)**	**765**	Equity		1.524
Public debt		5.457	CB liquidity		3.509
Loans	**$_{1}$(+10)**	**11.974**	Bank deposits		12.467
Others		486	Others		1.182
Households and companies					
Cash		541	Equity		111.428
Bank deposits		12.467	Loans	**$_{1}$(+10)**	**11.974**
CBDC	**$_{1}$(+10)**	**10.932**			
Real assets		99.462			