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CENTRAL BANK DIGITAL CURRENCIES: THE CASE OF UNIVERSAL CENTRAL BANK RESERVES

PAOLO FEGATELLI

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CENTRAL BANK DIGITAL CURRENCIES:

THE CASE OF UNIVERSAL CENTRAL BANK RESERVES

Paolo Fegatelli [·]

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Abstract: We analyse several motivations for the introduction of a widely accessible central bank digital currency (CBDC). If a central bank decided to offer a CBDC, its design would have to consider different areas of central bank activity, taking into account multiple policy principles, objectives and constraints. In addition, the introduction of a CBDC on a large scale may have a non-trivial impact on the architecture of the financial system. From this perspective, some common arguments in favor of CBDC may seem simplistic and the field of feasible options may be narrower than often believed. We reconsider Tobin's idea to establish a system of universal access to central bank reserves, and clarify its feasibility and advantages as an account-based CBDC.

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[·] Banque centrale du Luxembourg, Economics and Research Department, 2 boulevard Royal, L-2983 Luxembourg (e-mail: paolo.fegatelli@bcl.lu). Special thanks in particular to Paolo Guarda, as well as to Jean-Pierre Schoder, Martin Summer, Pierre Thissen and Patrick Fève for valuable comments and suggestions on earlier versions of this paper. I would also like to thank Cedric Crelo, Nicolas Weber, Emmanuel Thibault, Martial Dupaigne, Paul Mercier, participants at a BCL/TSE internal workshop on "Virtual Currencies" on 22-23 November 2018 and at the 34th SUERF Colloquium/Banque de France Symposium on "The Euro Area: Staying the Course through Uncertainties" on 28-29 March 2019 for feedback. Any errors or omissions are the responsibility of the author.

Résumé non-technique

L'émission par la banque centrale d'une monnaie numérique destinée au grand public (en anglais : « *central bank digital currency* » ou « CBDC ») est souvent avancée comme possible réaction à l'émergence des monnaies numériques privées, tel que Bitcoin, ou le recul de l'utilisation des pièces et billets de banque dans certains pays. Selon plusieurs experts, l'introduction d'une CBDC permettrait aux banques centrales de faire face à une menace potentielle pour les monnaies officielles et de relever différents défis liés à leurs nombreuses activités. En particulier, le concept de CBDC a été proposé pour atteindre certains objectifs spécifiques (mise en œuvre de taux d'intérêt négatifs, réduction du rôle des banques dans l'économie, contrôle de la création du crédit, etc.), souvent sur la base d'une perspective unilatérale ou d'une analyse seulement partielle de son impact.

C'est pourquoi cette étude vise à réexaminer différentes propositions pour l'introduction d'une CBDC en prenant en compte les divers principes, objectifs et contraintes imposés aux banques centrales. L'analyse des alternatives s'articule au travers de trois dimensions: i) le niveau de « perturbation » du système actuel causée par l'introduction d'une CBDC; ii) la compatibilité de la CBDC proposée avec les infrastructures techniques et les outils opérationnels déjà existants, réduisant ainsi les coûts et les risques liés à la mise en œuvre; et iii) la cohérence et l'attractivité du résultat pour les utilisateurs de la CBDC. Une telle approche nous amène à mettre en garde contre certaines des motivations et propositions les plus communes. Elle nous amène aussi à revisiter l'idée initiale de James Tobin d'établir un système de « réserves universelles » auprès de la banque centrale (en anglais : « *universal central bank reserves* »), en précisant de manière plus détaillée les conditions pour sa mise en place à l'époque actuelle.

Les résultats de cette analyse confirment que l'introduction d'une CBDC n'est pas une question anodine. Une banque centrale qui décide de suivre ce chemin devra soigneusement étudier la conception de la CBDC à travers différents cadres d'analyse. La solution choisie devrait s'adapter à plusieurs contraintes de nature politique, économique, institutionnelle et opérationnelle. Une telle solution serait inévitablement un compromis, voire le résultat d'une médiation entre différentes perspectives. Cela explique la prudence d'un grand nombre de banques centrales quant aux mesures concrètes à prendre en ce qui concerne l'émission d'une CBDC.

Toute solution visant à introduire une CBDC à grande échelle pourrait avoir un impact non négligeable sur l'architecture du système financier. Cela impliquerait la possibilité d'une séparation fonctionnelle plus ou moins accentuée des activités bancaires (« *narrow banking* »). Les solutions les plus radicales envisagent de réduire drastiquement le rôle des banques dans l'allocation du crédit à l'économie réelle. De telles solutions reposeraient essentiellement sur deux hypothèses « fortes » : l'existence de marchés (presque) parfaits et un degré élevé de synchronisation entre la politique monétaire et la politique budgétaire. Un scénario plus réaliste et moins déstabilisant serait l'introduction d'une CBDC sous forme de réserves universelles non rémunérées mais avec des frais variables liés aux taux de référence. Cependant, cette solution pourrait imposer des contraintes aux banques centrales dans le choix du cadre opérationnel pour la mise en œuvre de la politique monétaire. Il faudrait – entre autres – que la banque centrale soit prête à garantir en permanence la

fourniture de liquidités à taux fixe aux banques, afin de pouvoir faire face à une possible fuite accélérée de leurs dépôts en cas de crise.

Cela ne va pas de soi. Même lorsque des instruments à cet effet existent déjà et ont été utilisés (comme dans la zone euro), d'autres raisons pourraient suggérer une approche plus prudente. Une banque centrale qui s'engage formellement à fournir tout financement résiduel à un taux fixe, en remplacement des dépôts bancaires, pourrait être soumise à une pression politique bien plus forte, étant donné son niveau de visibilité et de responsabilité beaucoup plus élevé. Un tel rôle rendrait plus explicite sa fonction de « prêteur en dernier ressort » en cas de crise bancaire. En fonction du calibrage de son dispositif de prêts contre garanties, la banque centrale pourrait influer directement sur les volumes de prêts octroyés par les banques, aussi bien que sur les conditions sous-jacentes, même secteur par secteur. Les banques privées continueraient à se charger de l'allocation du crédit au reste de l'économie, mais la discipline de marché exercée par les déposants vis-à-vis des banques serait alors partiellement remplacée par un contrôle opéré par la banque centrale. Cela pourrait avoir du sens – d'un point de vue économique – surtout dans les pays où la banque centrale est déjà chargée de la supervision bancaire. Cependant, il faudrait que ce changement ne se fasse pas au détriment de l'indépendance et de la neutralité de la banque centrale, sous prétexte de limiter la concentration d'un pouvoir économique qui pourrait être perçu comme excessif.

1. Introduction

Policy-makers, experts and academics have recently focused on the possibility of issuing central bank digital currencies (CBDC) in response to the rise of Fintech, distributed ledger technology and private virtual currencies[1]. The financial crisis catalyzed mistrust in established institutions, favoring the emergence of Bitcoin and other private "monies"[2], but also stimulating interest in possible improvements to the current financial system. Confronted by private virtual currencies and the declining use of physical cash for retail payments in certain jurisdictions, a growing number of central banks have started to consider the possibility of issuing their own digital monies[3]. According to a recent survey by the BIS Committee on Payments and Market Infrastructures, 69 percent of the 80 central banks in the panel are now conducting work related to CBDCs (Barontini and Holden, 2019). Motivations for this interest are often idiosyncratic and reflect a wide spectrum of domestic specificities. Most of them are related to payments' safety and efficiency and, to a lesser extent, financial stability, monetary policy implementation, cross-border payments efficiency and financial inclusion[4].

However, the desirable characteristics of a CBDC are still not entirely clear. In part, this is due to an incomplete understanding of how blockchain and other Fintech developments will be integrated into monetary and banking frameworks. In part, this is because the overall impact of introducing a CBDC critically depends on the specific design chosen. Based on a broad review of the most recent debate, we will see that not all that is technically possible is also desirable from a central bank's perspective. On the other hand, the adoption of new central bank tools and operational modalities during the

[1] Recent examples include a speech by the Swedish central bank governor (Ingves, 2018), one by the IMF Managing Director (Lagarde, 2018), one by the BIS General Manager (Carstens, 2018), another by the BIS Head of the Monetary and Economic Department (Borio, 2018); one by an ECB Executive Board member (Coeuré, 2018b) and an article by N. Roubini (2018).

[2] Whether virtual currencies are "money" is an open question. The European Union does not consider them "money" (cf. Art. 2 of the 2014/62/EU directive), the European Central Bank refers to them as Virtual Currency Schemes (ECB, 2015), while the European Banking Authority describe them as a "digital representation of value" (European Banking Authority, 2019).

[3] In particular, see the two Reports on the e-krona project (Sveriges Riksbank, 2017 and 2018a) and accompanying articles (Sveriges Riksbank, 2018b). Other relevant studies were published by the Bank of England (Barrdear and Kumhof, 2016; Meaning et al., 2018; Kumhof and Noone, 2018), Bank of Finland (Grym et al., 2017; Grym, 2018), Bank of Canada (Engert and Fung, 2017), National Bank of Belgium (Stevens, 2017), Banque de France (Pfister, 2017), Danmarks NationalBank (2017), Federal Reserve (Berentsen and Schär, 2018), Norges Bank (2018), Oesterreichische Nationalbank (Pichler et al., 2018), BIS (Bech and Garratt, 2017; BIS, 2018) and IMF (Mancini-Griffoli et al., 2018).

[4] As we will see, the results of our analysis provide a key to interpret the different 'intensities' of such motivations. Note that those mentioned above are domains typically involving a public interest, in the context of current market economies. As such, payment systems safety and efficiency, financial stability and monetary policy (among other) inspire the current institutional infrastructure (or "institutional technology", cf Borio, 2018) and constitute a major *raison d'être* for central banks worldwide. It would be, therefore, too reductive and misleading to interpret the ongoing debate on CBDC as merely attempting to address some kind of 'market failure'.

crisis now offers an opportunity to reconsider some 'old' ideas that suddenly appear to be much more viable from an economic and technical point of view.

One such idea involves granting private individuals direct access to central bank digital money accounts. Where the central bank offers a state-of-the-art real-time gross settlement (RTGS) system (as in the euro area), the payment system would then be more secure, more resilient and more efficient, because a proven and consolidated technology would allow for instant settlement of any retail payment in central bank money, i.e. with no counterparty risk and no credit risk. In the spirit of the original proposal by James Tobin to create a system of "deposited currency accounts" (see later Section 3), an account-based CBDC could also offer an attractive alternative to deposit insurance. Finally, by providing universal access to a truly riskless and liquid asset, an account-based CBDC could make the financial system safer, at least in principle[5].

Nevertheless, a number of drawbacks may arise, depending on how exactly this idea is implemented in the overall financial architecture. For example, commercial banks may see their deposits decline, restricting an important source of (cheap) funding, and possibly reducing their supply of loans to the real sector, with unintended second-round effects (e.g., slower economic growth, further reliance on non-bank lending, financial stability risks, etc.).

In this work, we will carefully examine different aspects of the account-based CBDC idea, including a) the central bank objective(s) involved, and b) the best design to maximize effectiveness, while minimizing costs and risks. Special emphasis will be put on the possible impact on the banking system and financial stability, as well as on monetary policy implementation[6].

Previous studies in this literature have focused on the possible options or technical functionalities that a CBDC *might* or *should* have as a means of payment, often adopting a functional view rather than fully analyzing the economic rationale for its introduction. This has prompted some commentators to complain that blockchain, cryptocurrencies and, ultimately, CBDCs represent 'a solution in search of a problem' (Hernaes, 2018; Hampl, 2018). Other studies have identified the optimal 'economic' characteristics of a CBDC, but only from a single perspective: monetary policy, financial stability or payment system efficiency.

This study starts from a systematic, pragmatic assessment of the economic reasons by which an account-based CBDC might be contemplated. It considers the pros and cons of each alternative, not only with regard to the specific problem it aims to address, but also with reference to its broader

[5] Greenwood et al. (2016) argue that the provision of a safe and ultra-liquid asset would help reduce rollover risks and excessive maturity transformation, potentially improving financial stability. See also Sveriges Riksbank (2018a) and Dyson and Hodgson (2016).

[6] Note that granting direct access to central bank money accounts is not the only manner of offering a CBDC to the public at large. Other methods do exist, focusing on latest technologies: the blockchain, *in primis*. Indeed, early ideas envisaging CBDCs were mostly considering the value-based option (see the next section), similar to private cryptocurrencies. However, for reasons that will be discussed later, issuing a 'value-based' or 'token-based' CBDC on a very large scale – such as to affect monetary policy implementation and financial stability – is currently considered thoroughly unviable. That explains much of the focus in this paper on the account-based version of the CBDC idea.

impact on other areas. The conclusions seek to identify a 'compromise solution' that takes into account different policy constraints and reconciles different objectives in a realistic fashion. Ultimately, our goal is not to establish whether issuing a CBDC on a large scale is desirable. Instead, we aim to shed light on what such a CBDC should look like if a major central bank decided to introduce one.

This paper includes seven parts. Section 2 will present a taxonomy of different CBDC types and will consider which options are viable for a central bank wishing to issue a CBDC. Section 3 will review the main 'pros' of issuing an account-based CBDC, i.e., those uncontroversial aspects of its economic rationale. Section 4 will deal with financial stability questions and Section 5 with CBDC's optimal design for monetary policy implementation, also in light of other central bank policy principles and constraints. Section 6 will discuss some technical and legal questions, and then summarize by sketching out a solution that would probably best take into account different principles and serve different objectives. Section 7 will conclude and state the caveats of implementing this solution.

2. What do we mean by "central bank digital currency"?

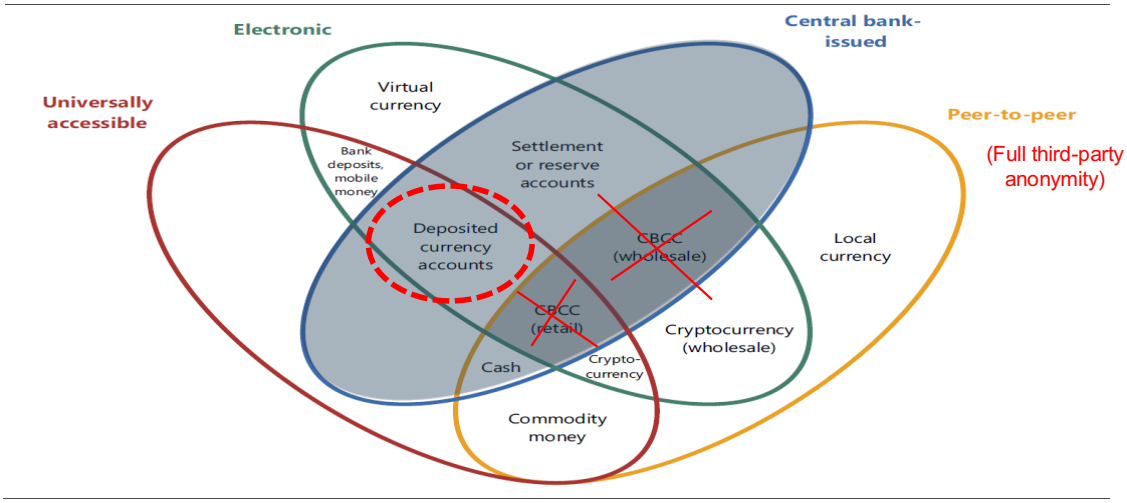
Our starting point is the taxonomy of money established by Bech and Garratt (2017). They define four basic properties of money:

1. Issuer (central bank or other);
2. Form (electronic or physical);
3. Accessibility (universal or limited);
4. Transfer mechanism (centralized or decentralized, i.e., peer-to-peer)[7].

Different combinations of these properties generate different types of "money", as illustrated in Fig. 1 below (note: "CBCC" here stands for "Central Bank CryptoCurrencies").

[7] In a similar fashion, Mersch (2017) contrasts account-based Digital Base Money – built on 'traditional' central ledger technology – with value-based Digital Based Money – built on Distributed Ledger Technology (DLT).

Fig. 1.



Source: Author's adaptation from Bech and Garratt (2017)

While the definition of a CBDC along the first two dimensions is immediate and self-evident, different combinations of properties 3 and 4 can originate four distinct types of central-bank electronic money:

i. Universal access and account-based: e.g., deposited currency accounts (Tobin, 1985 and 1987);
ii. Universal access and value-based: i.e., proposed retail central-bank monies using DLT technology (cryptocurrencies);
iii. Limited access and account-based: e.g., current central-bank reserves;
iv. Limited access and value-based: e.g., wholesale central-bank cryptocurrencies.

At present, most central banks worldwide only offer (iii), limiting access to settlement or reserve accounts to monetary policy counterparties only.

The classification scheme defined by Bech and Garratt (2017) according to a functional view, can be opportunely translated into product characteristics that are relevant for users (customer view) by turning property 4, 'transfer mechanism', into 'full anonymity', which includes both 'counterparty anonymity' and 'third-party anonymity'. Bitcoin and most cryptocurrencies based on the blockchain are distinguished by full anonymity, meaning that a person sending bitcoins to a public address does not need to reveal her identity (as a physical person) to the receiver or to any third party. In our picture above, this corresponds to the two areas shaded in darker blue (central bank cryptocurrencies).

Interestingly, what appears to be a trump card for cryptocurrencies is not necessarily attractive for an 'official' currency. Should a central bank issue fully anonymous electronic money to the public at

large without limits? According to a recent paper published by the Federal Reserve Bank of St. Louis (Berentsen and Schär, 2018), the answer is 'no'. First, the reputational risk linked to possibly illegal actions by anonymous users would be too high. Second, there would also be a high operational risk related to relying on a very young and relatively untested technology (Grym et al., 2017; Pichler et al., 2018). Third, a fully anonymous CBDC would contradict the AML/KYC regulations imposed on commercial banks and payment service providers[8]. Fourth, in the euro area a fully anonymous CBDC issued with no limit would violate the current policy of neutrality with regard to the different payment instruments, as it would contradict the stance adopted by the Eurosystem in the last few years to limit the use of high-value denomination banknotes[9]. The e-krona project of the Swedish central bank shares the same concern, from an AML point of view[10]. Thus, contrary to the opinion of cryptocurrency promoters, there exists today a unanimous consensus among central bankers and policy-makers that even a value-based CBDC should allow for some kind of transaction/counterparty identification and traceability for amounts exceeding the current thresholds for physical cash's withdrawals and payments[11].

Berentsen and Schär (2018) note that once we exclude full anonymity as a desirable property of a CBDC, cryptocurrencies should be directly excluded from the menu of options (dark blue shaded areas in the picture above). Indeed, other advantages advanced by cryptocurrency promoters[12] (e.g., execution speed) seem insignificant compared to recent innovations in central bank payment and settlement systems in some jurisdictions, like the euro area[13].

Nonetheless, the decreasing use of physical cash in certain jurisdictions is still pushing public authorities to consider the possibility of developing a 'token-based' or 'value-based' CBDC by levering DLT technology, even if just as a possible substitute for physical banknotes and coins[14]. While at present this should be considered a complement, rather than an alternative, to the possible development of an account-based CBDC[15], such a value-based CBDC or central bank cryptocurrency would then be subject to the same usage limits as are currently imposed on physical banknotes and

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[8] AML: Anti-Money Laundering. KYC: Know Your Customer. In the euro area, the 5th EU AML Directive (2018/843) imposes very strict conditions (Art. 12) on possible exemptions from due diligence requirements. EU Regulation 2015/847 notes that information requirements accompanying any transfer of funds, including payer and payee identification, also apply to electronic means of payment used for peer-to-peer transfers.

[9] On 4 May 2016 the Governing Council decided to stop issuing €500 banknotes to take account of "concerns that this banknote may facilitate illicit activities" (https://www.ecb.europa.eu/press/pr/date/2016/html/pr160504.en.html). Notice that €500 banknotes already in circulation continue to be legal tender acceptable in any amount.

[10] Cf. Sveriges Riksbank (2018a), p. 17: "At present, the banknote with the highest denomination is the 1,000-krona banknote. The Project would not advocate the introduction of a new anonymous means of payment, in the form of a value-based e-krona that had a higher denomination".

[11] Ibid. See also Lagarde (2018).

[12] See for instance Tapscott and Tapscott (2016).

[13] See Mersch (2018a, 2018b). On using DLT to implement a wholesale CBDC, see the report of IBM and OMFIF (2018).

[14] Sveriges Riksbank (2018a). However, even in such cases, like Sweden, where the adoption of the DLT technology is envisaged, authorities would make the CBDC traceable for any transaction above a certain amount: "Even a value-based e-krona needs to be linked to a register so that it is possible to ensure that the money is not used more than once [...] and also to enable statistics to be produced" (p. 16).

[15] A value-based CBDC could coexist with both physical banknotes and an account-based CBDC.

coins[16]. Being the electronic equivalent of physical cash, the impact of a value-based CBDC on monetary policy and financial stability would be relatively marginal (Danmarks NationalBank, 2017), and will not be further discussed in this study.

Returning to the four types of central bank electronic money listed above, option (ii) would then have to be discarded. Option (iii) is already available, while option (iv) would be redundant where a state-of-the-art RTGS system is already available for cash settlement in central bank money (see Section 3.2.). This only leaves option (i) 'deposited currency accounts' (Tobin, 1985 and 1987) *alias* 'universal central bank reserves' (UCBR; Coeuré, 2018a). The rest of this study will focus on the arguments for UCBR, major problems related to its implementation, and possible solutions to overcome them.

3. Digital reserves for all: what for?

More than thirty years ago, Nobel Prize winner James Tobin suggested that access to central bank reserves should be extended to private individuals and other non-bank economic agents[17]. For Tobin, the main objective was to find an alternative to deposit insurance, which had proved useful in those years to prevent bank runs in the U.S, but also highly inefficient in terms of costs for tax-payers, as it provides wrong incentives to bank managers (for risk-taking) and to depositors (for bank monitoring)[18]. Therefore, "the government should make available to the public a medium with the convenience of deposits and the safety of currency, essentially currency on deposits, transferable in any amount by check or other order"[19]. The difficult EU discussions on the proposal to set up a European Deposit Insurance Scheme (EDIS) for bank deposits[20] suggest that Tobin's rationale still makes a lot of sense.

[16] Domestic laws and regulations impose limits on the value of cash payments in many countries. These limits are much stronger than the AML requirement of flagging (electronic) cash transfers above a certain threshold (e.g., 15,000 euros). See again Sveriges Riksbank (2018a), pp. 16-17.

[17] Ibid. In 1975, Rolf Gocht, a Bundesbank director, formulated a similar proposal suggesting that all regular payment functions should be assigned to the post office to clearly separate banks' credit and investment business.

[18] Tobin (1985) explicitly mentions the case of Continental Illinois, which was lent 7 billion USD by the Fed, while the Fed's normal lending to the whole banking system in those years rarely exceeded 1 billion USD. "Deposit insurance [...] is a massive extension and delegation of the government's monetary fiat – a blank check, so to speak, which might be an enormous obligation in certain contingencies. The federal deposit insurance agencies have reserves less than 1% of the deposits they have guaranteed. Any big bank failure would wipe them out and require Congress to appropriate additional funds" (pp. 24-25).

[19] Tobin (1987), p. 172.

[20] EDIS was proposed by the European Commission on 24 November 2015 with the aim of completing the Banking Union (https://ec.europa.eu/info/business-economy-euro/banking-and-finance/banking-union/european-deposit-insurance-scheme_en).

3.1. An alternative to deposit insurance

As history repeats itself, it is not surprising that the debate on deposit insurance continues more than thirty years later on the other side of the Atlantic. In the EU, the banking sector should provide at least 43.65 billion euros of ex-ante contributions over a period of eight years (until 2024) to finance the European Deposit Insurance Fund (EDIF), an integral part of EDIS[21].

However, this is not the biggest obstacle to an EU consensus on the Commission's proposal. Other technical and political questions impede moving forward (Stuchlik, 2016). Probably the most sensitive issue concerns the possibility of cross-subsidization across member states. Since 2015, several variants of the initial proposal have been suggested. In April 2018, an ECB study tried to dissipate many of these concerns (Carmassi et al., 2018), and in June 2018 the EU Council took note of progress on the EDIS proposal[22]. Nevertheless, a positive conclusion seems still far.

Universal central bank reserves would cut this question at its roots. Since UCBR would be riskless deposits accessible to anybody, common bank deposits would no longer need a public guarantee: private individuals could transfer savings to a UCBR account. Note that such a transfer would not be mandatory, given that deposits at the central bank would be less remunerative for savers and, therefore, would be a priced option[23].

Access to UCBR could be offered in principle not only to private individuals, but also to private entities and non-bank companies. This would extend the possibility of a deposit insurance guarantee to the entire private sector, including any agent in the financial business and in the real economy, with an important positive impact in terms of financial stability. Moreover, this would preempt any potential threat of systemic disruption, linked to private narrow banking initiatives[24].

In this manner, depositors would be fully guaranteed, possibly for more than today's limit of 100,000 euros, without needing to monitor their respective bank. Banks with good-quality collateral could replace any outflow of customer deposits with interbank and central bank credit at a relatively low opportunity cost, while saving money on deposit insurance contributions and possibly retaining their customer relationships (and related fees) by acting as service providers – or cash agents – for savers using UCBR[25]. Governments could save money on the 'safety nets' offered to the banking sector, also because banks would enjoy a more stable funding source in case of crisis, so they would be less prone to bank runs. Central banks may increase their seignorage revenues, as compensation for the risk-

[21] This corresponds to 0.8% of covered deposits of all banks in the Banking Union, based on Eurozone banks' balance sheet data at end-2017 (as reported by Schoenmaker, 2018). The full text of the EC proposal is available online: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52015PC0586&from=EN .

[22] See related online documents under http://www.consilium.europa.eu/media/35761/st10203-en18.pdf and http://data.consilium.europa.eu/doc/document/ST-9819-2018-INIT/en/pdf .

[23] We analyze this issue in Section 5.2. This framework is consistent with the principle that those who benefit from an insurance contract should pay for it ('no free-lunch').

[24] See for instance the recent controversy about the application of The Narrow Bank ('TNB') for opening an account at the New York Fed (https://www.bloomberg.com/news/articles/2018-09-17/why-is-this-supersafe-bank-scaring-the-fed).

[25] See Sections 4.2.2. and 6.1.

taking associated with larger monetary policy lending activity and the provision of deposit insurance to the public at large. Finally, the overall economy would benefit from greater financial stability.

This framework would certainly enhance central bank monitoring of the banking system, as well as the central bank's role as lender of last resort (LoLR). On one hand, the central bank would have to extend its broad collateral policy and fixed-rate full allotment (FRFA) tender procedure for monetary policy lending, to support banks losing part of their cheapest funding (deposits). On the other hand, as underlined by Pfister (2017), central banks would need to conceive a more rule-based access to LoLR operations, to limit moral hazard incentives. Early detection of crisis signals would be facilitated by central bank directly observing bank balance-sheet inflows and outflows. At the Eurosystem level, synergies between the LoLR function and the supervisory function (Single Supervisory Mechanism) could benefit. A better early-warning system could make up for larger risk-taking.

Compared to EDIS, a UCBR system could probably be in place more rapidly (see Section 6 for more details). On the central bank's operational side, implementation could follow a gradual approach, initially limiting the amount that could be deposited in any UCBR account, with an overall cross-account individual limit[26]. The central bank could also offer an all-in negative remuneration rate for UCBR near the lower boundary (see par. 5.2.3. below), in order to contain demand for this new instrument and leave adequate time to adjust to the new environment.

3.2. Payment system security and efficiency

In principle, any CBDC – whether account-based or value-based – may increase safety, efficiency and contestability in retail payments as well as in large-value payments (Engert and Fung, 2017). It could also promote innovation, by enabling new entrants – smaller banks and non-banks – to offer payment accounts and services to the public at large (Dyson and Hodgson, 2016). However, an account-based CBDC could easily and directly lever the existing real-time gross settlement (RTGS) infrastructures operating under the control of the central bank. For example, at the Eurosystem level, CBDC/UCBR accounts could be immediately integrated in the new TARGET Instant Payment Settlement (TIPS) system[27]. Assuming that any private individual or non-bank company could indirectly participate in TIPS via the same financial intermediary operating its CBDC/UCBR account, this would create an extremely efficient, real-time, integrated and totally riskless settlement and custody system for cash, servicing the entire euro area economy, not just the financial sector. To ensure that any private individual or firm would be able to participate, minimum financial requirements for opening a CBDC/UCBR account may need to be less stringent than for opening a

[26] In the EU, commercial banks already enforce the limits in the 2010 Deposit Guarantee Scheme Directive, along with AML/KYC obligations.

[27] The TIPS service enables payment service providers to offer fund transfers in real time and around the clock, 365 days a year. Funds should be available to the beneficiary in, at most, 10 seconds for 0.2 euro cents. For more details, cf. TARGET Instant Payment Settlement – User Handbook V1.0.0, available online under https://www.ecb.europa.eu/paym/initiatives/shared/docs/tipsuhbv100.pdf .

standard commercial bank account[28]. With the partial exception of third-party anonymity and certain cross-border retail settlements, such a system would be superior to virtual currency schemes based on blockchain technology (Mersch, 2018a and 2018b).

Although less effective than a token-based or value-based CBDC (He and al., 2017), even an account-based CBDC could facilitate more rapid and secure settlement of retail cross-border financial transactions. Lower-income households and small businesses, who face substantial costs for handling cash or high interchange fees for taking payments via debit/credit cards, would probably benefit more. However, an account-based CBDC may not be able to contribute significantly to financial inclusion on a global scale, by reducing transaction costs for individuals and small enterprises located in foreign countries or regions. Ultimately, this would depend on the modalities to grant UCBR access to private individuals, especially those residing outside the central bank's jurisdiction (if feasible), and to convert UCBR payments across borders.

3.3. A 'defensive' strategy

Probably, the most compelling argument for a central bank to issue digital money is necessity[29]. As of today, such a necessity does not appear to have the character of urgency for most central banks (Barontini and Holden, 2019). However, this may change over the medium/long-term, depending on the joint dynamics of different factors.

An irreversible decline in the use of cash (as in Sweden or Norway), a widespread adoption of one or more cryptocurrencies, potentially threatening a 'dollarization' of the economy and the loss of monetary control by domestic authorities, or even a rising digitalization of the economy, could all make the issue of a CBDC necessary. An account-based CBDC could also be part of a central bank's contingency plan to counter a prolonged disruption of traditional (private) electronic payment infrastructures, or even to respond to a dollarization threat if a foreign central bank issues its own CBDC. In all these circumstances, CBDC issuance could be part of a defense strategy by the central bank, to preserve its institutional role and accomplish its mission, as defined by law. Last but not least,

[28] ... even when the commercial bank itself would ultimately be responsible for the third-party administration of the account and the accomplishment of all the KYC/AML duties (same as today). See later, Section 6.

[29] As explained in the first Riksbank Report (Sveriges Riksbank, 2017), digitalization in modern societies may induce "a movement towards a mediation of payments [...] that could be entirely driven by private actors and consolidated among a small number of commercial participants, payment services and infrastructures. In the long run, this concentration could restrain competitiveness in the market and make society vulnerable. [] The development towards an almost cashless society also entail households having little opportunity to save and pay with risk-free central bank money and this can ultimately lead to a decline in the resilience of the payments system. [...] [C]ertain groups [...] at present do not have the opportunity to use digital payment solutions, or quite simply prefer cash to other means of payment. For these groups it is important that society can offer alternatives" (p. 4).

in several of the cases outlined above, CBDC issuance would protect (and even strengthen) the central bank's financial autonomy, by limiting any drop in seignorage revenues[30].

4. The financial stability argument

A systematic review of the reasons why a central bank may choose to issue digital money appears in Dyson and Hodgson (2016) and, more recently, in Engert and Fung (2017). Both papers consider financial stability and aggregate risk reduction as a major argument. CBDCs may improve financial stability by eliminating the distortions induced by deposit insurance, as well as the concentration of liquidity risk and credit risk resulting from commercial banks' deposit function. At a macro level, CBDC could reduce the procyclicality of "inside money"[31] supply, with positive implications for the economy especially in periods of recession (Barrdear and Kumhof, 2016). This argument essentially revives the narrow banking or full-reserve money proposals that appeared during the the 1930s debate on the separation of banks' credit and deposit functions. The "Chicago Plan" proposed by Henry Simons of the University of Chicago and Irving Fisher of Yale University envisaged mandatory 100% backing of deposits by government-issued money, so that deposits could no longer be used to refinance bank credit (Fisher, 1935 and 1936). This would ensure that the quantity of credit would become completely independent of the quantity of money, allowing "much better control of what Fisher and many of his contemporaries perceived to be the major source of business cycle fluctuations, sudden increases and contractions of bank credit that are not necessarily driven by the fundamentals of the real economy, but that themselves change those fundamentals" (Benes and Kumhof, 2012). Another major advantage attributed to the Chicago Plan was the elimination of bank runs (assuming that banks supplied their refinancing needs via non-monetary liabilities that are not subject to runs).

4.1. Criticisms

From the perspective of CBDCs, both arguments – reduction of the procyclicality of inside money and elimination of bank runs – are prone to criticism. A crucial point to understand this controversy is that an account-based CBDC could in principle coexist with commercial bank money; while in the Chicago Plan the 100% reserve requirement is mandatory, implying the total absence of private "inside" money. If the CBDC provides an attractive alternative to commercial-bank deposits, this could restrict an important source of bank funding. That is, even assuming that the switch to CBDC were not imposed by law or regulation, the availability of 'universal' central bank reserves could

[30] Even the partial replacement of banknotes and coins with a CBDC might significantly reduce costs of maintaining physical cash. Between November 2017 and April 2018, the Central Bank of Uruguay implemented a pilot plan to issue a value-based CBDC called 'e-Peso', mostly to reduce costs of printing, logistics and cash management. See https://www.suerf.org/docx/l_d1c38a09acc34845c6be3a127a5aacaf_16719_suerf.pdf .

[31] Central banks provide "outside money" to the banking system, while private sector banking intermediation activities (deposits and lending) create "inside money". See Lagos (2006) for definitions and discussion.

potentially crowd out the demand for commercial bank deposits, possibly reducing the overall supply of credit to the economy. To retain at least part of this volume, banks would need to increase the remuneration of deposits, or to "bundle" them with other ancillary services. Thus, bank loans would probably become more expensive, closely tracking the implicit cost of the funding alternatives. A credit crunch might follow[32]. Conceptually, the incapacity of the banking system to find alternative funding sources at no extra cost (in the long term, at least) is equivalent to assuming that the necessary conditions for the Modigliani-Miller theorem (1958) do not hold, as for Diamond & Dybvig (1983) and, more recently, Diamond & Rajan (2001).

Referring to this literature leads us to treat bank runs. If we assume the coexistence of CBDC with commercial bank deposits, in crisis times "digital runs" from commercial bank accounts to CBDC accounts might occur at unprecedented scale and speed[33]. In this respect, proposed CBDC schemes differ from the Chicago Plan, which required banks to fund their loans exclusively with non-monetary liabilities not subject to runs, such as equity and loans from the government treasury.

4.2. Possible solutions

Ultimately, the diverging views on the financial stability effects of introducing a CBDC arise fundamentally from one issue: which alternative funding sources banks could tap to replace those deposits shifting to CBDC accounts. To overcome this problem, different solutions can be envisaged.

4.2.1. Strict narrow banking with government intervention

The first one refers explicitly to the Chicago Plan: the possibility that sight deposits, as a source of funding for commercial banks, be replaced first and foremost by equities and government credit. Interestingly, even those versions of the Chicago Plan that have been suggested in recent years still envisage this idea. So, for instance, the model of Benes and Kumhof (2012), following those versions of the Plan formulated by Means (1933), Currie (1934) and Angell (1935), assumes that "the remaining credit function of banks is carried out by private institutions that fund conventional investment loans with a combination of equity and treasury credit provided at a policy-determined rate". A crucial role for government debt is also foreseen in the DSGE model of Barrdear and Kumhof (2016), in which CBDC deposits can only be obtained from the central bank in exchange for government bonds, whose increased demand would lower the real interest rate and, via this channel, the cost of refinancing for banks. This would attenuate the necessity for banks to find new funding sources after the loss of those commercial bank deposits converted into central bank deposits.

Note that the two models of Kumhof et al. (2012, 2016) just mentioned above are actually based on two fundamental assumptions (among others): first, as we just said, the possibility for government debt to play a pivotal role for refinancing banks and for the issuance of CBDC, respectively; second,

[32] See BIS (2018), Stevens (2017), and Jordan (2018a).
[33] See again BIS (2018), Stevens (2017), and Jordan (2018a).

the absence of frictions in capital markets and bank competition[34]. Again, the validity of the Modigliani-Miller theorem is essential in this stream of literature, with all its consequential implications about the irrelevance of the intermediary role of banks in our financial system. It follows that the feasibility of such Chicago Plan-derived solutions depends directly on two factors:

1. The fiscal policy space and constraints: i.e., the extent by which fiscal policy could effectively interact with monetary policy and be used to put in place the envisaged measures, both from an economic and from an institutional point of view[35];
2. The market characteristics and nature of the financial sector: i.e., a high degree of competition, perfect information, the absence of substantial entry barriers (also due to regulatory and institutional constraints), the development of financial markets as an "easy" alternative to bank intermediation for financing the real sector etc.

Taken together, these two sets of hypotheses seem rather unrealistic, at least at the euro area level. An alternative though even more radical narrow-banking solution is the model supported by proponents of the Sovereign Money ("Vollgeld") Initiative in Switzerland[36]. Appendix A provides a review of how this system would work, both in the short- and in the long-term, jointly with its main implications. Notice that in the Vollgeld end-state scenario *a)* either Modigliani-Miller conditions occur, so that banks would find alternative finding sources at no significant extra-cost; *b)* or, in case of a credit squeeze induced by banks' lack of funding, the central bank is supposed to directly target the monetary aggregate (e.g., via helicopter money). This second case would have important implications, as both the current free-market economic mechanism and monetary policy implementation would be deeply affected.

4.2.2. Mild narrow banking with central bank support ("Tobin 2.0")

A much less disruptive solution would build on the original idea of Tobin (1985, 1987) mentioned above. In the spirit of Tobin's proposal, deposited currency accounts would be "means of payment like currency but without its disadvantages". Unlike the Chicago Plan and the Vollgeld initiative, Tobin's idea does not call for a 100% reserve requirement for all deposits, nor for an equivalent prohibition regarding the issuance of sight deposits by commercial banks. Different financial instruments and deposit accounts at both private and public entities could co-exist, which makes Tobin's idea truly similar to most of the current proposals for CBDC. Indeed, Tobin's main purpose

[34] In Barrdear-Kumhof (2016) this assumption is made explicit, while Benes-Kumhof (2012) assume nonetheless that "the deposit function of banks is perfectly competitive, and that banks face zero marginal costs in providing deposit services".

[35] For example, in the context of a monetary union with a rigid separation between fiscal policy and monetary policy decision-makers, we can see hardly any space for such solutions. By contrast, see for instance the assumption of Barrdear-Kumhof (2016) about "a government that determines fiscal *and* monetary policies".

[36] Culminated in the unsuccessful referendum of 10 June 2018, the aim of the Sovereign Money ("Vollgeld") Initiative was to give the monopoly of issuing (electronic) book money to the Swiss National Bank. As credit institutions would have been forbidden to create "private" money in the form of commercial bank deposits, this would have entailed a clear-cut separation between banks' credit and deposit functions, and therefore between money and commercial bank credit. Ultimately, inside money would have been entirely replaced by outside or central bank money. See www.Vollgeld-Initiative.ch/en .

was just to find a system to eliminate the need for a deposit insurance guarantee, at least for a big chunk of the payment system.

Tobin (1985) admitted that one possibility was for private individuals to have access to their central bank accounts via the intermediation of private banks or depository institutions. This would certainly represent an advantage from the point of view of the technical implementation and legal framework: as central banks would not have a direct relation with any private individual, licensed banking institutions, merely acting as agents, would continue to manage clients' access to the payment network exactly as today. This would allow commercial banks to preserve their client relationships, along with a source of revenue (fees and commissions), without being completely disintermediated.

The crucial issue in this Section, however, is how commercial banks could continue their lending activity after losing part of their customer deposits, and how to avoid a possible credit squeeze triggered by the introduction of a deposited currency account system (UCBR). To the best of our knowledge, James Tobin did not address this question[37]. Incidentally, the Great Financial Crisis of the past decade has pushed a number of central banks to enhance their monetary policy toolkits with new instruments to face the financial stability risks linked to a possible credit crunch. Such instruments did not exist at the time when Tobin pronounced his speeches. We will see how some of these instruments could 'complete' Tobin's deposited currency accounts idea, so to mitigate possible disruption risks for bank funding. In particular, we will focus on certain tools and changes in the monetary policy implementation modalities that have been developed by the Eurosystem starting from 2008.

a) Monetary policy with enhanced credit support

On 8 October 2008, twenty-three days after the Lehman's default, the ECB Governing Council announced the switch to a fixed-rate tender procedure with full allotment in Main Refinancing Operations (MROs), in which banks' bids would be satisfied in full at the fixed MRO rate. This event marked the first step of the implementation of the Eurosystem policy of "enhanced credit support"[38]. The second step, the enlargement of the collateral eligibility criteria, was put in place with effect on 22 October 2008. Overall, the joint implementation of these measures was very successful and avoided a complete breakdown of the interbank market: during the following three months, the volume of credit granted by the Eurosystem nearly doubled, compared to the average level before October 2008. In an attempt to minimize the impact of the Lehman shock, the Eurosystem's liquidity

[37] ...probably due to the economic conditions of that period (ongoing deregulation, along with a financial sector that was inflating) in contrast to the situation today.

[38] "[E]nhanced credit support constitutes the special and primarily bank-based measures that are being taken to enhance the flow of credit above and beyond what could be achieved through policy interest rate reductions alone" (Trichet, 2009). In its original concept, enhanced credit support was founded on five building blocks: *i)* unlimited provision of liquidity through fixed rate tenders with full allotment; *ii)* enlargement of collateral eligibility criteria for Eurosystem's monetary policy operations; *iii)* lengthening of the maturities of the Eurosystem's refinancing operations; *iv)* provision of liquidity in foreign currencies (particularly in US dollars) via foreign exchange swap operations; *v)* outright purchases of covered bonds.

provision had *de facto* replaced market-based borrowing as the main source of short-term funding for many banks.

The first two blocks of enhanced credit support were equally important. First, the fixed-rate full-allotment (FRFA) modality put a cap on banks' refinancing cost, therefore lowering the spreads and stabilizing the rates passed on to the real sector. Second, the enlargement of collateral eligibility criteria ensured that collateral would not be a constraint for bank borrowing, as too binding collateral requirements might have represented a serious bottleneck for injecting substantial liquidity into the banking system in a very short time frame. A third element, the extension of maturities of the Eurosystem refinancing operations, was also critical to reduce the maturity gap in bank balance sheets, improve liquidity ratios and facilitate granting of credit[39].

Over time, these elements – initially conceived as temporary measures – confirmed their fundamental role, especially in periods of renewed instability (e.g. the sovereign debt crisis of 2011-2012). Interestingly, the recent attention of policy-makers, analysts and public opinion has focused on the wind-down of the Asset Purchase Programme (APP) and the calendar for a gradual rate 'normalization', with little discussion of FRFA and collateral framework as monetary policy tools.

b) UCBR, credit crunches and the collateral channel of monetary policy

One of the core ideas of this paper is that, if a central bank decided to offer UCBR *à la* Tobin, it could jointly use FRFA and a broad collateral framework to prevent any risk of credit crunch, following the same approach adopted by the Eurosystem over the last decade. Of course, a major difference would be the much higher borrowing volumes that might be demanded by banks, even compared to periods of high stress in the recent past. In the case of the Eurosystem, this would certainly require a big adaptation effort in terms of processing capacity, though only with minimal "qualitative" changes as regards monetary policy implementation.

A summary view of bank figures and statistics reveals that in the euro area, banks on aggregate would still have plenty of collateral for borrowing from the central bank, even after losing up to 100% of their overnight deposits from households and Non-Financial Corporations (NFCs). In particular, data from the ECB and the European Banking Federation show that, at the end of 2016, banks had still almost 12.5 trillion euros of Eurosystem-collateral eligible marketable assets[40], after deduction of the securities already used as collateral, while overnight deposits from households and NFCs only equaled 7 trillion euros.

As for the eligible non-marketable assets, the Eurosystem's single list comprises three distinct asset classes: 1) credit claims, 2) fixed-term and cash deposits, and 3) non-marketable retail mortgage-backed debt instruments. Of the three, credit claims currently account for the only significant source of non-marketable collateral used by Eurosystem counterparties. At the end of 2016, 386.8 billion

[39] Starting from end-December 2011, the Eurosystem has implemented Longer Term Refinancing Operations (LTRO) and Targeted Longer Term Refinancing Operations (TLTRO).
[40] The figures refer to market values after haircuts.

euros of credit claims were used as collateral by Eurosystem counterparties[41], equal to more than 30% of the posted collateral. As regards the total volumes of credit claims potentially eligible as Eurosystem collateral, there are no official statistics available, since credit claims need to be first "mobilized" in order to become eligible. The operational procedure for mobilizing credit claims is relatively cumbersome, and implies high operational costs for monetary policy counterparties (Tamura and Tabakis, 2013). In addition, the legal requirements for mobilization and the related operational infrastructures vary in each euro area jurisdiction. As a result, the use of credit claims as collateral has not developed in a uniform manner across the euro area, depending also on the relative opportunity cost for the counterparty, compared to alternative sources of available collateral. Historically, credit claims have been largely used in France, for instance, where at the end of 2012 the total use of non-marketable assets – including credit claims, Additional Credit Claims (ACC) and other non-marketable assets – represented up to 55.5% of the collateral posted by resident institutions (Bignon et al., 2016).

Not surprisingly, recent studies by the Banque de France show that extending the Eurosystem collateral framework to include ACCs and other non-marketable assets in crisis periods had a very positive impact on domestic bank lending to the real sector, especially with regard to small and medium enterprises (Barthélemy et al., 2017; Mésonnier et al., 2017; Cahn et al., 2017). Overall, this stream of literature suggests the existence of a collateral channel of monetary policy. This implies that the use of the collateral framework could be envisaged as an active instrument of monetary policy, since, by affecting banks' borrowing constraints, it could directly influence the price and volume of credit in aggregate. In the context of the UCBR framework described above, in which the central bank may massively refinance a large part of the banking system in a crisis, such a role would become critical for monetary policy transmission. Note that this use of collateral eligibility criteria as a monetary policy tool could be countercyclical and bidirectional, and it would provide the central bank with more scope for fine-tuning, compared to the classical interest rate instrument. For example, an extension of eligible collateral could be used to further reduce banks' funding costs at a time when interest rate policy is constrained by the zero-lower bound, as an alternative or in association with other instruments (e.g., asset purchases). On the other hand, a targeted tightening in collateral requirements could be adopted during the expansionary phase of the cycle to prevent overheating in specific sectors of the economy, without the drawback of acting via a powerful though blunt tool (interest rate) that would affect all sectors indistinctly. For example, faced with the risk of a real-estate bubble, instead of rising rates, the central bank might decide to increase haircuts on certain marketable assets (MBS and RMBS) and/or certain categories of non-marketable collateral (ACC on mortgage loans and non-marketable RMBS), either discretionally or according to pre-determined rules. Given also the higher degree of heterogeneity of current economic and financial conditions across the euro area, this might represent a considerable advantage.

In principle, all the "new" unconventional monetary policy instruments that have been developed during the crisis could be usefully applied in a UCBR scenario, given the identical objectives: the prevention of a credit squeeze by lowering banks' funding cost and the preservation of the monetary

[41] Again, after taking haircuts into account.

policy transmission mechanism via the bank lending channel. For example, in case of insufficient supply of bank credit to the economy, rather than pursuing monetary targeting via direct cash injections to replace bank credit itself, as argued by Vollgeld proponents, a QE policy in a UCBR framework might be implemented with the explicit goal of flattening the yield curve, so lowering banks' medium/long-term refinancing costs. From a theoretical point of view, this acknowledges that financial frictions and informational asymmetries do exist, and that banks are there to address them[42].

5. The monetary policy argument

The introduction of CBDCs has often been motivated by monetary policy considerations. In general, adopting a sovereign digital currency has been presented as an appropriate policy response to curb the risks stemming from widespread use of private monies and cryptocurrencies, which could significantly reduce a central bank's control over monetary conditions. In addition, the implementation of CBDC is claimed to improve monetary policy transmission and widen the range of monetary policy options and instruments by facilitating the implementation of unconventional monetary policies. Thus, for instance, a CBDC could help to relax the effective lower bound constraint on nominal interest rates by allowing the central bank to implement negative policy rates if this were necessary. A CBDC could also be used to put in place "helicopter money", in case of a strategy targeting the monetary volume in order to stimulate aggregate demand.

Following Meaning et al. (2018), a number of characteristics and key parameters of an account-based CBDC (like UCBR) could be modulated depending on the specific purposes motivating its issuance. In particular, from a monetary policy point of view, three parameters are critical:

i. Access to CBDC;
ii. CBDC trading at par with other central bank liabilities;
iii. Interest paid on CBDC.

i. Access to CBDC

A CBDC could be universally accessible (i.e., it could be held by anybody for any purpose, like UCBR) or restricted to a subset of economic agents, possibly for a limited range of purposes (like bank reserves today). As we have already considered this distinction in an earlier paragraph, we will not discuss it further here. Once again, this study focuses on the impact from the possible introduction of UCBR.

[42] The existence of financial intermediaries could be economically justified even in the presence of (approximately) complete markets. Cf. Freixas and Rochet (1997), p. 15: "in the ideal world of frictionless and complete financial markets, both investors and borrowers would be able to diversify perfectly and obtain optimal risk sharing. But as soon as one introduces even small indivisibilities and nonconvexities in transaction technologies, this perfect diversification is no longer feasible and FIs [Financial Intermediaries] are needed". For an exhaustive review of the related literature (ranging from transaction costs to informational asymmetries, delegated monitoring and direct vs intermediate finance), see their Chapter 2, "Why do financial intermediaries exist?".

ii. CBDC trading at par with other central bank liabilities

Previous literature has considered the eventuality that CBDC could be exchanged against other central bank liabilities – e.g., against bank reserves – at a rate different from par (Agarwal and Kimball, 2015), or even that CBDC could not be converted at all into bank reserves and bank deposits (Kumhof and Noone, 2018). As underlined by Meaning et al. (2018), this would imply the simultaneous existence of two distinct fiat currencies, possibly with an exchange rate between the two managed by the central bank. Apart from the concrete possibility of arbitrage by the private sector[43], we share the concerns of Meaning et al. that in practice this setup would pose serious problems for the conduct of monetary policy. First, it would be unclear which currency would be the unit of account in the economy. As the prices of goods and services could be quoted in both, administrative costs might be quite important. In terms of monetary policy signal, such a system would pose a significant challenge for a central bank still focused on interest rate policy, as the central bank itself would need to clarify which serves as its reference rate (also with regard to its operational target). In any case, this system would represent a significant deviation from the current operational framework. Therefore, in accordance with the reflections of Meaning et al. and with our "minimalist" approach (in terms of refraining from the introduction of drastic institutional and/or operational changes), in the rest of this paper we discard this possibility and we assume that all forms of central bank money are exchanged at par. For CBDC/UCBR, this implies that the central bank would be ready to satisfy any level of the demand by savers, at the same interest rate (see hereafter).

iii. Interest paid on CBDC

A CBDC could be non-interest bearing, analogously to cash, or it could be interest-bearing, i.e., paying positive, zero or negative rate rates at various points in the economic cycle. Based on our discussion above, the choice between these two options is the most "open" though the most critical one, because of its potential effects on monetary policy implementation. In order to evaluate those effects, we need first to consider the "equilibrium rate" for CBDC in relation to other financial assets. As shown by Meaning et al. (2018) on the basis of no-arbitrage arguments, the interest rate that clears the market for CBDC, let's say R^C, would equal the theoretical risk-free rate, R, minus the transactional utility premium of CBDC, ϕ^C:

$$R^C = R - \phi^C$$

while all the other interest rates in the economy could be written according to the general form:

$$R^x = R^C + \phi^x$$

with ϕ^x equal to the risk premium for asset *x*, which could be a function of several factors (relative probability of default compared to CBDC, relative transactional utility provided by the asset, etc.).

The point to be retained here is that, independently of the use of UCBR for monetary policy, their simple existence implies that their rate would anchor the whole structure of interest rates in the economy. In other words, the decision not to pay any interest on UCBR would be equivalent to

[43] See the recent case of The Narrow Bank, already mentioned in Section 3.1.

decide that UCBR as an asset would be permanently assigned a fixed interest rate equal to zero (i.e. $R^C = 0$ *always*). We will see that this is not neutral from a monetary policy point of view, shortly after illustrating some of the main arguments against the introduction of CBDC merely for monetary policy reasons.

5.1. Criticisms

5.1.1. About the use of CBDC to implement deeply negative interest rates

The adoption of unconventional monetary policy measures by many central banks worldwide during the Great Financial Crisis has induced academics and policy-makers to speculate about the use of CBDC, in combination with the progressive decline of cash as a medium of payment, to push the reference rate below the effective lower bound (ELB) limit. Levering the ideas of Gesell (1906) to effectively tax paper currency, Goodfriend (2000) had already proposed an analogous mechanism envisaging electronic strips on banknotes. In the same spirit, later works by Buiter (2009, among others) and Goodfriend (2016) focus on stamped currency, abolition of paper currency, and arranging an exchange rate between paper currency and electronic money. Rogoff (2014) suggests that a complete abolition of paper currency would eliminate the possibility of massive paper currency storage, therefore eliminating the zero lower bound[44]. The exchange rate idea is also investigated by Agarwal and Kimball (2015), who propose the adoption of a time-varying paper currency deposit fee between commercial banks and the central bank. Among policy-makers, Haldane (2015) admits that "a government-backed currency [...] issued in an electronic rather than paper form [...] would allow negative interest rates to be levied on currency easily and speedily, so relaxing the ZLB constraint". More recently, Bordo and Levin (2017) suggest the adoption of a graduated schedule of fees on transfers between cash and CBDC, as a "wedge" that would make it unprofitable to convert CBDC into physical cash during periods of negative interest rates on CBDC (with effects analogous to the exchange rate proposals). In this manner, Bordo and Levin claim that the interest rate on CBDC could be utilized "as the primary tool of monetary policy", without the need for unconventional measures such as quantitative easing during periods of deflation or depressed aggregate demand. Interestingly, the same view on the pivotal role of the CBDC interest rate is shared by the above-mentioned Bank of England paper of Meaning et al. (2018).

As summarized by Stevens (2017), this approach is subject to shortcomings and caveats. At least three of them are particularly relevant. First, the need for an enlargement of the central bank monetary policy toolkit to overcome the ELB constraint is not a *fait acquis* and should not be taken for granted (Bindseil, 2016). Other conventional tools (e.g., central bank bills, time deposits and standing reverse repo facilities) could accomplish the same objective (BIS, 2018). Moreover, unconventional monetary policy measures (e.g., asset purchases) targeted at flattening the yield curve have already been successful to offset the effects of the ELB constraint on longer term rates, both in the U.S. and

[44] By the same token, the discontinuation of largest banknote denominations would increase the average carrying cost of holding cash and, therefore, enlarge the scope for negative policy rates via CBDC (Rogoff, 2016).

in the euro area[45], lessening the relevance of the ELB problem. A second problem concerns the impact of deeply negative rates on bank intermediation and the rate transmission mechanism: the responsiveness of bank deposit rates to negative CBDC rates is unclear *a priori*, given that the spreads between the policy rate and bank retail rates may include compensation for various risks and transaction costs, as well as banks' cross-subsidization strategies (BIS, 2018).

Even more decisive, in our view, is a third set of issues: competition from virtual currencies and other private monies (in addition to other official currencies). Here is a paradox. A central bank may first encourage economic agents to abandon the use of physical cash by offering an attractive CBDC. At a later stage, under the pressure of a crisis, the central bank may wish to implement deeply negative rates on its CBDC – this should be now easier, given the lack of competition from physical cash. However, once the educational and psychological barriers to adopting digital money have been overcome, many individuals may realize that bitcoin and its likes are valid substitutes for a CBDC whose nominal value decreases day after day, regardless of any legal prohibitions and constraints eventually imposed on the use of such virtual currencies[46]. Possibly, up to the point where private money starts to crowd out CBDC as a means of payment (as well as a reserve of value) and becomes a serious threat to monetary policy transmission itself. As reported by Raskin and Yermack (2016), recent cases in Argentina (2015), Cyprus (2013) and Iran (2012) prove that this can happen whenever the future value of money denominated in the official currency is compromised, whether due to "forced" currency/deposit conversions, capital controls or negative interest rates. In the spirit of Fernandez-Villaverde and Sanchez (2018), who revive previous work by Hayek (1976) on private monies, "currency competition provides market discipline to monetary policy implementation by inducing the government to provide 'good' money to support exchange in the economy". All this would add to public opinion's opposition and political obstacles that the implementation of deeply negative rates would have to face, and the consequential risks for central bank independence. We can conclude that, in general, there is a well-founded consensus among central bankers that overcoming the ELB limit is not a compelling argument in itself for the implementation of a CBDC[47].

5.1.2. About the use of CBDC for other monetary policy reasons

Outside academia, even the most fervent proponents of narrow banking and sovereign money do not consider the ELB limit a fundamental reason to issue a CBDC. For example, Dyson and Hodgson (2016) envisage "helicopter money" as a much more effective monetary policy measure – compared to QE and any other policy aimed at stimulating bank lending – that could be easily and directly implemented in case of a problem of aggregate demand, once a universal CBDC were in place. Whatever the merits of helicopter money as a monetary policy instrument and its politically controversial nature, it is important to stress that other alternative (though less direct) methods to transfer central bank funds to households and firms already exist[48]. Nonetheless, Engert and Fung

[45] Swanson and Williams (2014), Coeuré (2015), Task Force on the use of monetary policy instruments (2018), Alvarez *et al.* (2017).
[46] Currently, a number of developing countries – including big powers like China and India – have either imposed severe limits or even totally prohibited cryptocurrency activities.
[47] See again BIS (2018) and Engert and Fung (2017), among others.
[48] Cf. Engert and Fung (2017) for relevant cases in Hong Kong and Canada.

(2017) underline that such operations are extremely rare and of limited importance, so that, as with ELB, easier implementation of helicopter money does not appear enough in itself to justify the effort and risks of issuing a CBDC.

After excluding the ELB and helicopter money as major reasons to issue CBDC, it remains to be analyzed how a CBDC could be integrated in current monetary policy frameworks, in a manner that could possibly strengthen monetary policy transmission. Our working scenario hereafter is that a central bank may still wish, after all, to issue a CBDC in the form of UCBR, even if just to maintain control over monetary conditions or for other reasons not strictly linked to monetary policy. We will assume that:

A1. The central bank continues to implement monetary policy via interest rates without compromising transmission via the bank lending channel;
A2. The central bank does not want to influence economic agents' choice among different means of payment (no active support for electronic money);
A3. The central bank wishes to preserve its financial and political independence.

5.2. Possible solutions

Given the set of assumptions just outlined and our previous discussion of the CBDC's key parameters that are most relevant for monetary policy, it follows that the integration of a CBDC/UCBR in the current monetary policy framework should hinge on the applicable interest rate. We will consider here three options:

i. Zero-interest (cash/e-cash-like);
ii. Interest-bearing, as (one of) the main policy rate(s);
iii. Non-interest-bearing, but with a variable-rate deposit fee.

5.2.1. Zero-interest (cash/e-cash-like)

The first option – the simplest one – consists in offering UCBR that would not pay any remuneration. Funds in UCBR accounts would maintain a constant nominal value, similar to physical cash and its electronic equivalent (token-based CBDC). Based on our assumptions, the central bank would continue to operate its monetary policy exactly as today, using an overnight rate as its operational target (see Meaning et al. [2018] for a detailed explanation on different manners to pursue this task). Therefore, under FRFA, the operational target would still be constrained within the corridor between the rate of interest paid by the central bank on excess reserves (the Deposit Facility Rate in the Eurosystem) and the interest rate asked for standard lending to monetary policy counterparties (the Main Refinancing Operations rate in the Eurosystem).

In practice, this scenario presents two severe contraindications for monetary policy implementation. First, as underlined by Bordo and Levin (2017), the introduction of a zero-interest account-based CBDC would automatically raise the ELB limit to zero. Because of our assumption of full convertibility among bank reserves, deposits and CBDC/UCBR, if the central bank decided to

impose even a slightly negative rate on (excess) reserves, banks would have an incentive to immediately convert their available funds from reserves into UCBR[49]. The possible regulatory prohibition of bank access to UCBR accounts would likely not change this outcome[50].

Second, and even more important, under a zero-interest scenario the dynamics of the public's demand for CBDC/UCBR would always offset central bank changes to interest rates. As explained by Meaning et al. (2018), an increase of policy rates would raise the differential between bank deposit rates and the zero remuneration offered by CBDC. This would likely trigger a shift of funds from CBDC to bank deposits, and therefore a larger availability of funds for bank lending, loosening credit conditions (all else equal) contrary to the intentions of the policy-maker. By the same token, a reduction of policy rates would reduce the spread between bank deposits and CBDC rate, inducing a shift out of bank deposits and a consequent loss of available funds for bank lending, again contrary to the central bank's purpose[51]. In addition to hampering monetary policy implementation, such flows in and out of the banking sector might create problems for banks' liquidity management, irrespective of the possible refinancing price ceiling provided by the central bank's FRFA (still useful to prevent a sudden bank credit squeeze).

5.2.2. Interest-bearing, as (one of) the main policy rate(s)

It is on the basis of such considerations that one stream of literature warmly recommends that CBDC/UCBR should be interest-bearing. Since they would compete with bank deposits at large and with sight deposits in particular, their rate would anchor the whole structure of interest rates in the economy, thanks to universal access and their truly "riskless" feature. This explains why the CBDC/UCBR rate has been proposed "as the primary tool of monetary policy" (Bordo and Levin, 2017). Notice that, analogously to any other risky asset, in equilibrium deposit rates would be at premium versus the CBDC/UCBR rate:

$$R^D = R^C + \phi^D$$

where ϕ^D is a function of the probability of loss given bank default, the relative transactional utility provided by those deposits, and the term structure.

This implies that, following an increase of the UCBR rate, banks would have to follow by raising their deposit rates by an equal amount, in order to avoid a shift of funds from deposits to UCBR. On the positive side, this aspect may offer a new opportunity to the policy-maker to improve the monetary policy pass-through: given its direct control of the CBDC/UCBR rate, the central bank could immediately influence the cost and availability of bank funding. As far as the *ex-ante* pass-through from policy rates to deposit and wholesale rates were less than one, UCBR would likely strengthen monetary policy transmission. The downside of this story is that a universal CBDC could potentially

[49] As in Meaning et al. (2018), we assume that the two forms of electronic money would offer the same non-pecuniary utility (e.g., for transactional services, capital regulation etc.).

[50] For example, banks could turn their available reserves into overnight reverse repos vs other shadow banks – or any non-bank counterparty with whom they have a customer relationship – having access to UCBR. Again, consider the recent case of The Narrow Bank in the U.S.

[51] Appendix B illustrates this mechanism by adapting the basic model of Meaning et al. (2018).

compromise the two-tier structure of modern financial systems centered on bank intermediation, disrupting the main mechanism by which credit is allocated to the economy (especially private individuals and small firms)[52]. At present, the solutions and conditions envisaged by most proponents of universal CBDCs to prevent this risk appear quite unrealistic (see for instance Barrdear-Kumhof [2016] and Kumhof-Noone [2018]), when this problem is not neglected *tout-court*[53].

One exception is the work by Meaning et al. (2018), who suggest that the CBDC/UCBR rate could be synchronized with other relevant policy rates to maintain unchanged spreads across the overall term structure independently of the direction taken by interest rate policy. This would warrant a steady-state impact on bank balance-sheets when policy rates are changed, without sudden shifts between bank deposits and UCBR. Such a result could be achieved either by differentiating the UCBR rate paid to banks and non-banks, or by keeping bank reserves and UCBR as two distinct assets, each paying its own interest rate, with the rate on bank reserves (slightly) higher than the rate on UCBR[54]. In this manner, the differential between the rate paid to banks and non-banks would be set as a positive fixed spread, with the two rates always moving together within the system of main policy rates.

Two things are remarkable in this system. First, the authors justify the higher rate paid to banks by their special role and function in monetary transmission and in the economy in general. In this way, banks would not be too penalized for holding liquidity with the central bank, given also that the rate they pay on customer deposits would be certainly higher than the central bank rates. This would attenuate the competitive pressure on banks and their profit margins, following the introduction of CBDC/UCBR, whilst the fixed spread would prevent the possibility of bank runs and excess deposit volatility induced by policy rate movements. Whether such a solution would be enough, however, remains an open question, as the same authors acknowledge.

The second thing to be noticed is that the Meaning et al. solution would fit perfectly into the current Eurosystem monetary policy framework. On one hand, as explained above, FRFA and the Eurosystem collateral framework already guarantee euro area banks that their refinancing costs are capped at the Main Refinancing Operations (MRO) rate. Even a sudden run from deposits to UCBR could be managed smoothly, provided that a bank has enough eligible assets to pledge with the central bank. On the other hand, the UCBR rate would provide a hard floor that Eurosystem policy-makers would likely welcome to limit the current dispersion of money market rates below the Deposit Facility (DF) rate[55]. While access to central bank reserves is restricted to monetary policy counterparties

[52] Clearly, this concerns certain macro-regions (E.U.) more than others (U.S.).
[53] Bordo and Levin (2017) argue that the CBDC rate should assume the role of main reference/policy rate, though without fully considering its impact on bank intermediation and lending.
[54] If the rate on bank reserves were lower, banks would have no incentive to keep any reserves other than UCBR. Note that Meaning et al. explicitly assume that bank reserves and UCBR should have the same functional utility and regulatory treatment for commercial banks, while the central bank should guarantee free conversion at par between the two forms of reserves.
[55] As explained by Coeuré (2018a), the dispersion of short-term rates raises social costs and competition issues between banks and non-banks, as well as hindering transmission of the monetary policy stance. Maintaining the spread between DF rate and UCBR within a few basis points would be a big achievement, if we consider

(banks), UCBR would be open in principle to any economic agent. When safe and liquid short-term assets become scarce, UCBR would be the only riskless, universal-access asset by definition.

5.2.3. Non-interest-bearing, but with a variable-rate deposit fee

A major problem with the Meaning et al. solution is that it might not always be consistent with the three central bank policy principles that we assumed as working hypotheses for our analysis (see par. 5.1.2., points *A1-A2-A3*). More precisely, this consistency requires that the CBDC/UCBR net remuneration per unit remain within a narrow range. We have already discussed earlier why the mere existence of private monies imposes a hard constraint on monetary policy authorities in terms of implementing deeply negative rates. This would add to other political difficulties, even disregarding any technical issue. Moreover, monetary policy transmission under deeply negative rates would be somewhat uncertain. Meaning et al. suggest that a universal CBDC would allow the central bank to carry out much more targeted Quantitative Easing (QE) directly with non-banks, bypassing the banking system *tout-court*. An important implication of this view is that a more effective QE may make it unnecessary to lower interest rates below a certain threshold. Such a position looks antithetical to the vision of Bordo and Levin (2017), who support a much more radical use of the negative rates option offered by UCBR in periods of depressed aggregate demand, to avoid recourse to QE and other unconventional monetary policies.

So far, we have seen the lower boundary. But there may also exist an upper boundary to the interest rate of UCBR, depending on the central bank's policy constraints. Our working assumption *A2* implies that the central bank should remain neutral regarding the media of payment chosen by the public at large[56]. A major peculiarity of interest-bearing UCBR is that they would fulfill a twofold role: *i)* as an asset (the *riskless* asset by definition), and *ii)* as a medium of payment. As such, they would be a close substitute both for bank deposits, on one side, and for banknotes, coins and (possibly) e-cash, on the other[57]. Compared to cash and e-cash, one could assume that UCBR would have a higher transactional utility (in spite of the lack of third-party anonymity), given the less binding legal constraints (e.g. in terms of immediate availability and maximum amounts that could be transferred), the absence of theft risk and possible safekeeping costs. Assuming that the nominal value of physical cash and e-cash would remain constant (same as today), i.e., with an invariable interest rate equal to zero, then in equilibrium the UCBR nominal rate of return should be slightly negative. Indeed, whenever the UCBR rate increases along with other policy rates, people would have an incentive to switch from cash/e-cash to UCBR[58]. Thus, based on an extension of the simple model by Meaning et al., the following two propositions are valid:

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that the Bund's "specialness" premium has widened to nearly 60 bps below the DF rate over the past two years.

[56] This is the current position of the ECB and the Eurosystem: https://www.ecb.europa.eu/euro/intro/html/index.en.html .

[57] As in Meaning et al., we assume that UCBR accounts would not offer any credit facilities, such as overdrafts: therefore, they would be a close (but not perfect) substitute for bank deposits.

[58] ... unless they attribute quite a high value to third-party anonymity in payments (which should not be the most common case, at least for legal activities).

Proposition 1: Assuming that the non-pecuniary transactional expected utility of UCBR is greater than that of cash/e-cash, both supposed constant, in equilibrium the UCBR nominal rate of return should be negative and equal to the difference between the two: $R^C = \bar{\phi}^B - \bar{\phi}^C < 0$.

Proposition 2: When the UCBR nominal rate of return is positively linked to the main policy rate, then any upward (downward) move of the policy rate would imply a higher (lower) total expected return for UCBR over cash.

Proofs: See Appendix C.

Proposition 1 defines the equilibrium interest rate for CBDC/UCBR versus cash/e-cash with central bank's medium-of-payment neutrality (assumption *A2*). This equilibrium rate is negative in order to reflect the higher transactional utility of CBDC/UCBR compared to cash/e-cash. This equilibrium rate is also independent of the level of the policy rate. Proposition 2 means that, in the framework mutuated from Meaning et al., monetary policy directly influences the preferences for physical cash/e-cash vs CBDC/UCBR. While it is well-known that the opportunity cost for holding cash is affected (to a certain extent) by the interest rate level, what is new here is the existence of a close substitute for physical cash/e-cash, which does not have the same opportunity cost. This exacerbates the sensitivity of cash/e-cash preferences to interest rate changes. Since above a certain interest rate level, the demand for cash/e-cash reduces to a minimum, and becomes completely inelastic, people will need to have a special reason to hold cash/e-cash. Clearly, this is the most favorable scenario to the "extinction" of non-interest-bearing physical cash[59].

A further reason for an upper boundary to the interest rate applied to CBDC/UCBR is linked to assumption *A3*: the preservation of the central bank's political and financial independence. As UCBR would appear as a liability on the central bank balance sheet, a positive interest rate paid on UCBR would require the central bank to invest an equivalent amount in assets paying at least the same interest rate. In principle, this should not be too difficult, given the natural role of UCBR as the riskless asset by definition, paying the lowest market rate. However, the possibility of asset-side losses cannot be excluded (undermining the central bank's financial independence). More importantly, a central bank offering UCBR may find itself managing a huge asset portfolio, proportionally even bigger than those of the Fed, the Eurosystem and the Bank of Japan, following QE. This would exacerbate two problems: 1) it would heavily interfere with the normal functioning of market economies and credit allocation by the financial industry; 2) it would make it virtually unavoidable for the central bank to refinance government budgets on a permanent basis, creating all the conditions for monetary financing[60]. Ultimately, this overlapping with fiscal policies as well as the mere size (and

[59] In practice, the only factor contributing to the 'survival' of cash/e-cash in this scenario is its 'idiosyncratic' (non-pecuniary) transactional utility, i.e., that part of its transactional utility that is not shared with universal CBCD/UCBR. This is the case for the transactional utility related to third-party anonymity, or to preferences linked to cultural, educational, psychological motivations, or even to technical barriers.

[60] As long as government debt represents the biggest securities market in most countries with an investment-grade credit rating, sovereign bond yields would closely follow the UCBR interest rate (on the left-hand side

potential riskiness) of seignorage revenues may allow governments to claim *de facto* control of the central bank, so compromising its monetary policy independence.

The discussion above allows us to define a precise interval of values for the CBDC/UCBR nominal rate of return, R^C, as follows (see Appendix C):

$$LB(\overline{U}_{CC}) < R^C < \min(R^B = 0\,; R)$$

where $LB(\overline{U}_{CC})$ indicates the lower boundary, which is a function of the expected utility of private monies (cryptocurrencies), foreign currencies and any other viable payment alternative that could induce a "dollarization" of the economy. On the other side, the upper boundary is given by the lower between zero (the physical cash/e-cash nominal rate of return) and the key policy rate (the theoretical risk-free rate)[61].

This (slightly) negative interest rate could be charged to CBDC/UCBR holders in the form of a variable-rate deposit fee, based on the outstanding amounts held in UCBR accounts. From an economic point of view, this fee would be perfectly justified by the operational and maintenance costs borne by the central bank, either directly or indirectly, if UCBR accounts were operated by a third-party service provider[62]. This would be broadly similar to current practice with many commercial bank retail deposit accounts. Thus, only the UCBR account fees would be anchored to the main policy rate(s), always within the interval above, while the UCBR nominal interest rate would remain constant at zero.

While at the current level of euro area policy rates this system would be similar to the proposal of Meaning et al., for significantly positive policy rates ($R > \bar{\phi}^C$) UCBR would become a fixed, zero-interest asset (like cash/e-cash). Once the policy rate exceeds the UCBR rate equilibrium, $\bar{\phi}^C$, we would have the same issue already discussed: funds from CBDC/UCBR would switch to bank deposits or back, depending on the direction of change in the policy rate, with all the related risks for banks' liquidity management and financial stability.

One way to avoid this problem would be for the central bank to adjust another monetary policy instrument whose practical use has almost sunk into oblivion in the last decades, at least in Western countries: reserve requirements[63]. The central bank could raise (lower) the reserve requirement on bank deposits when an increase of the policy rate raises (reduces) the differential with the CBDC/UCBR rate, in order to offset an increase (decrease) of the public's supply of bank deposits

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of the yield curve, at least). Thus, we should expect a very large fraction of the new central bank asset portfolio to be invested in such securities, independently of any 'political' argument.

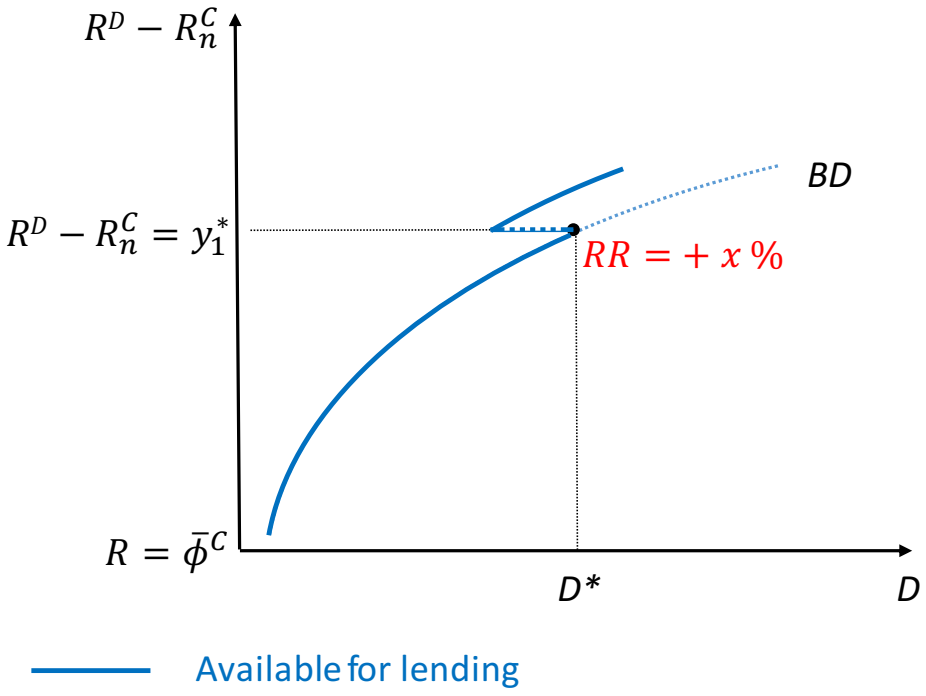
[61] Notice that, within this interval, UCBR could be (slightly) more or less attractive than physical cash and e-cash, depending on the differential between R^C and the difference between the two non-pecuniary transactional expected utilities, $\bar{\phi}^B - \bar{\phi}^C$ (cf. Proposition 1 above). However, within the said interval this differential would always remain relatively small, such that it should not affect the public's preferences between UCBR and cash/e-cash significantly.

[62] More on this in Section 6.1. Again, cf. Tobin (1985).

[63] A number of central banks worldwide (e.g., UK, Canada, New Zealand, Australia, Sweden and Hong Kong) currently have no reserve requirement (though some of them had it in the past). However, the People's Bank of China raised the reserve requirement more than twenty times since 2007.

(Fig. 2). This should reduce the flow volatility between CBDC/UCBR and bank deposits, associated with a policy rate move in positive territory. Note that, from an operational point of view, the central bank could always directly observe the flows in and out of the CBDC/UCBR accounts. In principle, this would permit a very quick response whenever the rise of a new flow imbalance might threaten financial stability or curb the implementation of monetary policy.

Fig. 2.



6. Universal central bank reserves

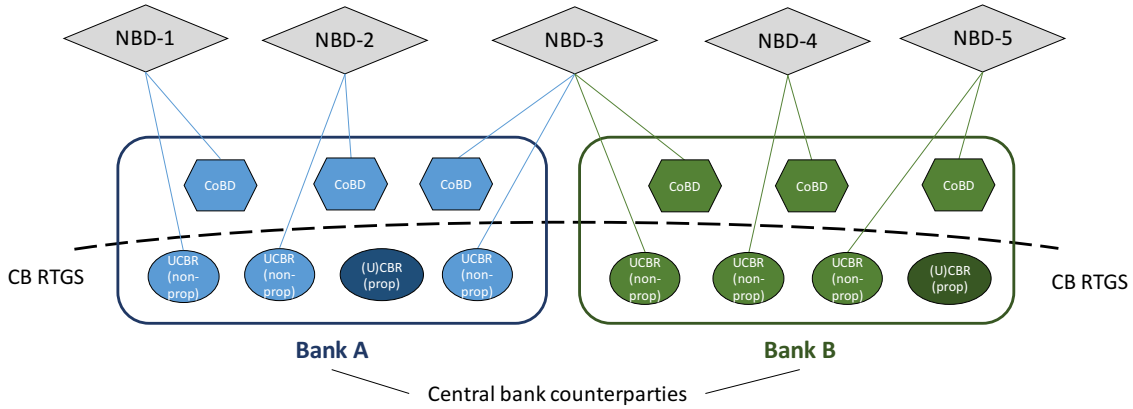
6.1. Technical setup

From the operational point of view, probably the most efficient, easiest and quickest way to offer UCBR would be to enlist interested monetary policy counterparties as service providers to operate the UCBR accounts. In practice, private individuals and non-banking firms would access UCBR accounts through their respective bank, acting as agent[64]. Banks that are monetary policy

[64] Dyson and Hodgson (2014, 2016) already considered synergies between the central bank and the private sector (banks and technology companies) in offering digital cash. In proposing a CBDC to be issued by the Bank of England, they envisage private "Digital Cash Accounts" providers offering – on a competitive basis – a wide variety of payment services and customer support. In the same vein, Bordo and Levin (2017) suggest that a CBDC could be supplied to the public via specially designated accounts at supervised commercial banks, holding the matching deposits in segregated reserve accounts at the central bank. Meaning et al. (2018)

counterparties would then have two types of accounts in the central bank RTGS system: *i)* proprietary accounts – to manage their own payment activities, and *ii)* third-party client accounts – to manage UCBR payment activities on behalf of their non-bank customers[65]. Proprietary accounts would normally be analogous to current reserve accounts, and they would be remunerated in the same manner as today. Since the remuneration of UCBR accounts would be lower than for reserve accounts, banks should not have any incentive to open proprietary UCBR accounts, although this would not be prohibited in principle. Fig. 3 below presents a schematic view of the contemplated UCBR account setup.

Fig. 3.



NBD: *Non-bank depositor*

CB RTGS: *central bank real-time gross settlement system environment*

CoBD: *Commercial bank deposits*

UCBR: *Universal central bank reserves*

Note that – for simplicity – we assume that only monetary policy counterparties, i.e., banks, would offer UCBR access to those who are not monetary policy counterparties. While this assumption could be relaxed to allow, for instance, also fintech companies to act as UCBR agents, it should be observed that the EU Directive 2015/2366[66] on payment services in the internal market (PSD2) has *de facto* removed obstacles to single-access 'open banking'. Banks have been required to provide

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also suggest that technology firms, payment institutions or banks could administer CBDC accounts and provide related payment services (including client registration and assistance), without taking ownership of CBDC funds along the process.

[65] Note that the use of *omnibus* accounts would be forbidden in this framework, in order to ensure the segregation of each non-bank participant's funds from the funds of the respective intermediary as well as those of other customers of the same intermediary.

[66] The EU Directive 2015/2366 aims to enhance consumer protection and convenience, to improve the security of payment services and to promote innovation and competition.

third parties with access to account data at the request of customers and to support both account information and payment initiation services provided by so-called 'Third Party Payment Service Providers'. This provision would reasonably apply also to UCBR accounts, avoiding any difference compared to 'standard' commercial bank deposit accounts.

In their quality of UCBR cash agents, monetary policy counterparties that decide to offer UCBR payment services to their customers would manage both operational activities and related administrative tasks and duties on behalf of their clients. This means that although the central bank would run the payment settlement system, it would not have any direct relation with non-banks: neither contractually nor in terms of controlling compliance with AML/KYC regulations, which would be the responsibility of UCBR service providers[67]. Such a setup would be similar to current practice in most securities settlement systems run by (international) central securities depositories ([I]CSDs), where participating custodian banks intervene at multiple levels between the (I)CSD and the final customers, who have no contact or legal relation with the (I)CSD.

This system would present some important advantages, both for the central bank and especially for the UCBR service providers. On one hand, the central bank would avoid all the administrative burden of establishing, managing and supervising millions of direct client relationships. Otherwise, the task would require a dramatic increase in central bank operational staff, adding personnel specialized in customer support and assistance, investigation, compliance etc. This would mean the central bank taking over a substantial part of the business linked to commercial banks' retail activities. In addition, any misdeed or illegal action accomplished via UCBR accounts would potentially expose the central bank to a significant reputational risk.

On the other hand, financial intermediaries offering UCBR payment and administrative services could be remunerated via the UCBR deposit fees mentioned above, which the central bank could almost entirely transfer to them as a compensation for their services. As such fees would be proportioned to the average volume of UCBR deposits, their total amount would be in principle relatively large, allowing banks to recover via this channel part of the interest revenues lost with the shift from commercial bank deposits to UCBR[68]. Another remarkable advantage for banks offering UCBR-related services would consist in the retention of all the benefits linked to the "know your customer" function. By maintaining the interface with clients on both sides of their balance-sheet, banks could continue discretely monitoring their borrowers' behaviour. Banks could also observe the risk attitude of net savers by comparing their allocation of funds to UCBR accounts vis-à-vis longer-term deposits and other risky assets. Thus, banks could better match their investment products to customer investor profiles.

[67] In the case of Third Party Payment Service Providers, the question of the responsibility for controlling AML/KYC compliance would have to be carefully studied and analyzed, also in light of relevant developments concerning PSD2's implementation.

[68] We are here in the least benign scenario (for the banks) in which alternative sources of financing (including the central bank) would be on average more expensive than retail sight deposits.

6.2. Legal issues (hints)

Although a full legal analysis is out of the scope of the present study, it is worth mentioning at least a couple of critical issues (among many possible others) that could deeply affect the characteristics and functioning of UCBR. The first question is whether UCBR would be legal tender. For example, in the euro area the 'legal tender' status is restricted to EU law-compliant euro-denominated banknotes and coins, with no exceptions. This means that UCBR would not qualify as legal tender without a formal change in the law[69]. A second, more general question would concern the legal framework: whether UCBR should be considered 'e-money' and – more broadly – what would be the legal basis for their issuance[70].

One major implication is that in the absence of any change to the current laws and/or regulations – depending on domestic specificities – the central bank might need to satisfy all the requirements already applicable to private sector entities: both in terms of AML/KYC legislation and in other areas such as, for instance, consumer-related legislation. However, this would not necessarily be a terrible thing. First, outsourcing UCBR access management to the private sector would largely relieve the central bank from having to create in-house the entire administrative and operational infrastructure necessary to comply with these requirements. Indeed, it would allow the central bank to offer UCBR in a relatively short timeframe without changing the regulatory framework. Second, the fact that UCBR are not legal tender would limit the competitive threat both for commercial bank deposits, on one side, and for physical cash, on the other, as a means of payment (since holding and using UCBR would only be discretionary). This would avoid an abrupt change from the current retail payment environment and public's habits (e.g. no need to 'oblige' people to pay or accept payments in UCBRs). Ultimately, such an approach would be coherent with the underlying idea that UCBR would be essentially a new form of guaranteed deposits, in accordance with the original purpose of Tobin more than thirty years ago.

6.3. Summary view

To summarize our discussion, UCBR could be shortly described as

- An account-based CBDC;
- Fully integrated into the central bank's RTGS infrastructure;
- Non-interest-bearing, but with a variable (deposit) fee;
- Accessible by non-financial entities and private individuals via financial institutions (monetary policy counterparties) who already have direct access to the central bank RTGS system.

To minimize systemic risks, the introduction of UCBR should not be disruptive. Therefore, UCBR would coexist with physical cash (according to the media-of-payment neutrality principle) and any

[69] Cf art. 128(1) of the Treaty on the Functioning of the European Union (TFEU) for banknotes, and art. 128(2) of the TFEU and art. 11 of Council Regulation EC/974/98 for euro-denominated coins.
[70] In the euro area, e-money falls within the scope of application of the Second E-money Directive (EMD2).

other type of commercial bank deposit accounts. To smooth the transition, the maximum amount held in any UCBR account could be initially limited, with an overall cross-account individual limit. This could provide an adequate time buffer to commercial banks using deposits as a funding source to adapt their business models. Euro area banks could continue to benefit from the fixed-rate full-allotment tender procedure, in combination with a broad collateral framework, to compensate for the possible reduction in deposit funding. Moreover, those banks providing access to UCBR and offering the related payment and administrative services would enjoy three distinct advantages:

1. They could be remunerated via the UCBR deposit fees (that the central bank could almost entirely transfer to them);
2. They would retain all the benefits linked to the 'know your customer' function;
3. They would not need to contribute to the deposit insurance guarantee system any longer.

For the central bank, absent any major regulatory change (including the necessity to turn UCBR into legal tender), the impact would basically depend on the monetary policy toolkit that is already available. At the Eurosystem level, it would probably be unnecessary to introduce any new instruments, while policy principles would remain fundamentally unchanged. However, the modalities and the use of certain monetary policy tools should be adapted. The FRFA tender procedure and the broad collateral framework may need to formally become permanent features, in order to support banks facing a possible outflow of sight deposits, and to provide insurance against any unexpected shift between UCBR and commercial bank deposits. Such an approach would be consistent with the practice that the Eurosystem has developed over the years, and especially during the Great Financial Crisis[71]. In addition, reserve requirements could be revitalized and become an active monetary policy instrument, following policy rate normalization.

One major challenge for central banks would be the need to adjust their operational capacities to the new environment with UCBR. This would require adapting processing volume capacity especially in three areas: *i)* payment and settlement infrastructure; *ii)* collateral analysis and acceptance; and *iii)* counterparty monitoring. Concerning the latter function, central banks with an institutional role in financial supervision might benefit, as they could develop internal synergies with the supervisory level (while respecting any 'Chinese walls' between the two functional areas).

7. Conclusion

CBDCs are quite a new topic. The advent of private digital "monies" represents a potential threat to official currencies and a challenge for many central bank activities (e.g. monetary policy conduct). This has first encouraged experts and public authorities to consider the possibility of issuing CBDCs as a means to preempt that threat and respond to that challenge. Almost in parallel, outstanding academics and socio-political movements have elaborated the CBDC concept and plugged it into pre-existing theoretical frameworks or models. The CBDC idea has then been envisaged as an

[71] Cf. Bindseil et al. (2017), as well as the *Banque de France* Working Papers mentioned above.

innovative tool to support the achievement of specific policy objectives ('deeply' negative interest rates, the elimination or abatement of inside money, reducing the role of banks/credit in the economy and so on), mostly in the context of a unilateral or partial analysis of its impact.

In this study, we have tried to re-assess the validity of different reasons for introducing a CBDC. By doing this, we have considered the broad implications of different alternatives for introducing a CBDC, in light of multiple central bank policy principles, goals and constraints. The three guiding principles in the evaluation of our results are *i)* the level of 'disruption' raised by each proposed solution, compared to the current situation, *ii)* the extent by which each solution could leverage or build on the current technical infrastructures, lowering the costs and risks of its implementation, and *iii)* the degree of integration of each specific option into a valuable and sensible proposal for CBDC users. This reality check has led us to caution against some of the most popular motivations that have been advanced to support the introduction of a CBDC. Such an approach has also allowed us to reformulate and update the original idea for establishing a UCBR system, and to clarify more in detail under which terms and conditions its implementation could now be feasible.

Our analysis shows that the decision to issue a CBDC is not a trivial one. In case a central bank decided to offer a CBDC, its design should be carefully pondered on the basis of a very comprehensive view. The chosen solution would have to fit different frameworks and multiple policy constraints. Such a solution would likely be a global compromise, the result of a mediation across different instances. This explains much of central banks' hesitance to take decisive steps into the CBDC-issuance direction.

Even more important, to explain the central banks' doubts, any solution to introduce a CBDC on a large scale might bring along a non-trivial impact on the architecture of the financial system. As we have seen, the most radical solutions envisage a diminished role for banks, mainly based on the two 'strong' hypotheses of (almost) perfect markets and a high degree of synchronization between monetary policy and fiscal policy. In a less disruptive scenario, which minimizes the impact on the current two-tier intermediation model, non-interest bearing UCBRs could represent a more viable option, assuming that the central bank would be ready to commit long-term to a FRFA tender procedure, a broad collateral framework, and an active use of reserve requirements. But this cannot be taken for granted. Even where such instruments already exist and have been used (as in the Eurosystem), there might be other reasons suggesting a more cautious approach. A central bank that formally commits to provide any residual funding, at a fixed price, as a substitute for bank deposits, might be subject to much stronger political pressure, and a much higher level of visibility and accountability. Such a role would make its lender-of-last-resort function more explicit (Niepelt, 2018). Depending on its use of the collateral framework tool, the central bank could directly influence banks' lending/borrowing volumes as well as the related terms and conditions, even sector by sector. The two-tier intermediation system would survive, as far as private banks – not the central bank – would still perform credit allocation for the rest of the economy. However, bank monitoring would be carried out *in primis* by the central bank, rather than depositors. Especially in those jurisdictions where the central bank is in charge of bank supervision, or is associated with the bank supervisor, this

may make sense from an economic point of view, provided that it does not come at the cost of the central bank's independence.

Further research seems warranted, both at an empirical and a theoretical level: first of all, to derive a precise estimation of the macroeconomic impact and the related implications for systemic risk and financial stability, on one side, and to assess the needed central bank operational capacity, on the other. Note that, from the point of view of the academic research, very few theoretical models have been produced on this topic, most of these being based on quite restrictive hypotheses. Legal aspects also need to be carefully investigated. If – after all – a central bank did decide to issue an account-based CBDC, adequate preparation would be required, along with a careful and gradual implementation to minimize the risks mentioned above.

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Appendix A:

Strict narrow banking – Vollgeld

Differently from the Chicago Plan, in a Vollgeld framework the government would not directly back up bank balance-sheets with treasury credit to replace deposits. Instead, in the short-term at least, the central bank would stay available to refinance the banking system "substantially" – not just at the margin – and even at a zero rate. Especially during the transition phase – immediately after the switch to Sovereign Money – the role of the central bank would be critical.

"*On the switchover day all current accounts (sight deposits making up M1) become sovereign money and will be transferred off the bank's balance sheet into custody accounts (in the same way many banks hold stocks and shares in custody accounts on behalf of their customers). This is only possible if the banks receive loans from the Swiss National Bank for the same amount. Thus banks have liabilities to the Swiss National Bank resulting from the introduction of sovereign money. All "current-account" money (M1) will become legal tender (or sovereign money) which is guaranteed by the Swiss National Bank. The existing commitments of banks to pay the balance of the current-account holders on request, convert to obligations to the SNB. From the banks' point of view they merely change creditors (from customers to the Swiss National Bank), and they now have the advantage that overnight customer liabilities are converted into longer-term Swiss National Bank liabilities. [...] Through this loan from the Swiss National Bank in the order of M1, the Swiss National Bank will become the banks' largest creditor. The Swiss National Bank must make these loans in most cases without collateral, or only with poor collateral, as banks won't be able to provide the usual collateral in the form of securities for such large amounts*" (Dawney, 2017). Thus, the Vollgeld proposal deviates from Bagehot's rule (1873) that central banks should lend only against good collateral (as in current standard operations) and at penalty rates (as in Emergency Liquidity Assistance operations).

In the long term, however, the end-state scenario would be one in which commercial banks should not depend on central bank financing. "*Reducing the size of these loans created at the switchover is necessary to reduce the risk of the Swiss National Bank and also to prevent banks becoming hostages to the state. A reduction in these loans is also in keeping with the liberal orientation of Switzerland [...] Therefore, banks should be as independent as possible from the Swiss National Bank and mainly financed with depositors, insurance companies and other banks*" (ibid.). Again, the last statement evokes a situation where Modigliani-Miller conditions and hypotheses are valid. Were this not to be the case, Vollgeld proponents assume that the central bank may want to target directly the monetary aggregate. "*The Swiss National Bank is given a legal mandate to enact the reduction and eradication of the loans created at the switchover over a long enough time period to avoid any transitional problems for the banks or the economy. As loans are repaid to the Swiss National Bank the money supply will sink (as with any loan repayment). To keep the money supply constant and to avoid possible deflationary problems, the Swiss National Bank must give out new debt-free sovereign money, which it can do by giving it to the Federal government, the cantons or directly to the Swiss citizens. This is how billions of Swiss Francs of public revenues can be created*" (ibid.).

In practice, the implementation of Vollgeld would imply a return to monetary targeting via direct monetary injections (including helicopter money), in order to compensate a possible reduction of the money supply, generated by a shrinking of bank lending activity (credit crunch). In turn, this would imply two problems.

1. First, a drastic change from the modalities pursued for monetary policy implementation over the last decades. Interest rate targeting is generally considered superior to monetary targeting by current central bank policy makers. In addition, it is not clear how monetary targeting could face the necessity of withdrawing liquidity in a sovereign money framework, and how forex interventions could take place (Jordan, 2018b). Actually, these concerns for monetary policy implementation seem to underestimate the capacity of the central bank, in a Vollgeld framework, to control money aggregates as well as to influence bank lending volumes and interest rates. Thus, the central bank may not necessarily decide to target the quantity of outside money, but may passively accommodate this quantity to public demand for sight deposits, which would be critically influenced by lending/borrowing conditions (e.g. interest rates), on which the central bank could still exert a certain influence, depending on its monetary policy instruments. As for volumes control, in a Sovereign Money scenario, monetary targeting would present many advantages, due to the coincidence between broad money and narrow money: for example, liquidity traps would no longer exist, as the policymaker could directly increase the aggregate quantity of money held by private agents (as in Benes and Kumhof, 2012). Nonetheless, an extension of the monetary policy toolkit might be necessary and the central bank role in financing the economy would certainly become more prominent, with political consequences that could ultimately undermine its independence.
2. Much more important, in our view, is the impact that Sovereign Money would have on the general functioning of the economy, especially with regard to the mechanism of credit allocation, as well as its distributional effects. A number of unknowns would have to be clarified, and a number of political issues resolved, in order to consider the practical viability of the Vollgeld option. For example, an efficient mechanism would have to be found to determine how such "debt-free" monetary injections could be properly converted into credit channeled to those economic sectors with the highest productivity. Another issue would be whether local administrations and political authorities could manage such important flows of "public revenues" more efficiently than financial markets and the banking sector. A further question would concern the outcome of such a large bank disintermediation in an advanced economy characterized by many small/medium enterprises. Finally, a more "political" issue would refer to the redistributional effects of monetary targeting via helicopter money versus other alternatives. Again, taken together with point 1 above, this is very likely to irremediably compromise the independence of the central bank. In the context of the euro area, this scenario seems thoroughly unrealistic from a political point of view.

Appendix B:
CBDC/UCBR paying no interest

According to Meaning et al. (2018), in case CBDC/UCBR paid no interest, the dynamics of the public's demand for them would always oppose the central bank's interest rate policy actions. Formally, we can explain this as follows. Define R^C as the CBDC/UCBR rate, $\bar{\phi}^C$ as the non-pecuniary transactional expected utility of CBDC/UCBR, and R as the theoretical risk-free rate (policy rate). As for Meaning et al.:

$$R^C = R - \bar{\phi}^C$$

or

$$R = R^C + \bar{\phi}^C$$

With CBDC/UCBR paying no interest, $R^C = 0$, in equilibrium the risk-free rate should be

$$R^* = \bar{\phi}^C > 0$$

Define the bank deposit rate as

$$R^D = R + \bar{\phi}^D$$

where $\bar{\phi}^D$, the expected risk premium on deposits, is a function of the probability of loss given bank default, the non-pecuniary transactional expected utility of deposits, and the term premium (if any).

In accordance with Meaning et al., let's assume that the demand of bank deposits (i.e., the public's supply of funds to the banking sector) is a function of the differential between the bank deposit rate and the CBDC/UCBR rate:

$$D \equiv D(R^D - R^C) \equiv D(R)$$

with

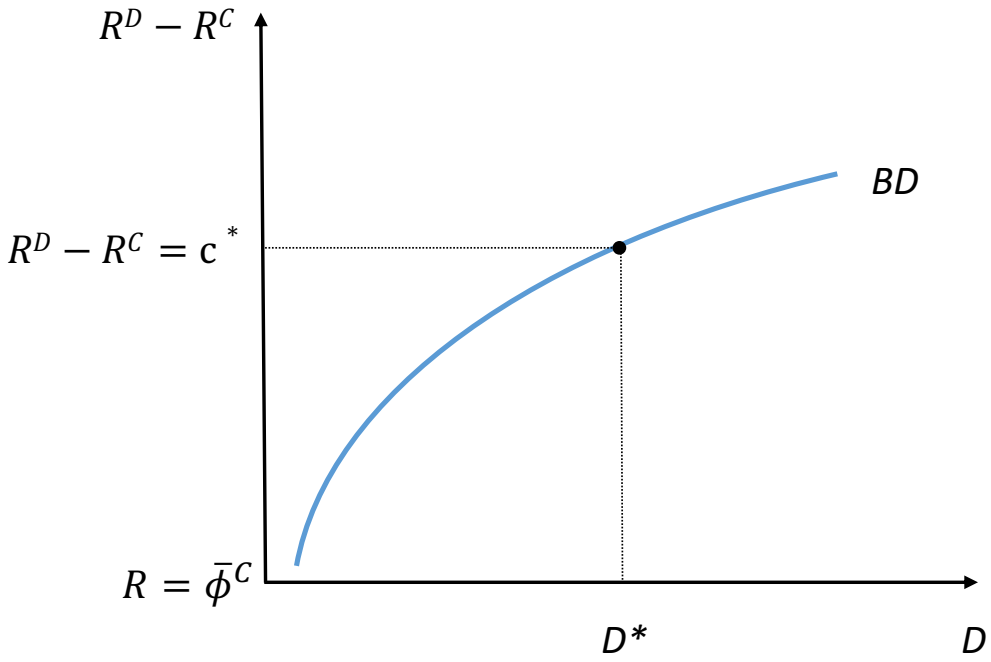
$$D'(R^D - R^C) > 0$$

implying

$$D'(R) > 0$$

An increase of the policy rates by the central bank would imply a larger availability of funds for bank lending, so loosening credit conditions (all else equal) against the intentions of the policy-maker. By the same token, a reduction of the policy rates would shrink the availability of funds for bank lending, again opposite to the central bank's underlying purpose. It is on this ground that Meaning et al. suggest that the CBDC/UCBR rate could be synchronized with other relevant policy rates. This would warrant a steady-state impact on banks' balance-sheets without causing sudden inflows/outflows between bank deposits and UCBR when the policy rates are changed. In this manner, the differential between the rate paid to banks and non-banks would be set as a positive fixed spread with the two rates always moving together: both would be part of the same system of main policy rates.

This idea is illustrated in Fig A.1. below, where *BD* represents the demand of bank deposits by the public.



Appendix C:

CBDC/UCBR rate synchronized with policy rate(s) – Upper boundary problem

(Proofs of Propositions 1 and 2)

Based on the notation introduced in Appendix B, we can here prove the following.

Proposition 1: Assuming that the non-pecuniary transactional expected utility of UCBR is greater than that of cash/e-cash, both supposed constant, in equilibrium the UCBR nominal rate of return should be negative and equal to the difference between the two: $R^C = \bar{\phi}^B - \bar{\phi}^C < 0$.

Proposition 2: When the UCBR nominal rate of return is positively linked to the main policy rate, then any upward (downward) move of the policy rate would imply a higher (lower) total expected return for UCBR over cash.

Proof. In equilibrium, by no arbitrage arguments, the total expected returns of the riskless asset, of UCBR and of cash/e-cash should be the same:

$$R^* = R^{C*} + \bar{\phi}^C = R^{B*} + \bar{\phi}^B$$

where R^B is the cash/e-cash rate, $\bar{\phi}^B$ is the non-pecuniary transactional expected utility of cash/e-cash, while R^C, $\bar{\phi}^C$ and R are defined as above.

Assuming that

i) The nominal value of physical cash and e-cash is constant, i.e., cash/e-cash do not bear any interest:

$$R^{B*} = 0$$

ii) The non-pecuniary transactional expected utilities of cash/e-cash and UCBR are constant and positive:

$$\bar{\phi}^B, \bar{\phi}^C > 0$$

iii) UCBR have a higher non-pecuniary transactional expected utility than cash/e-cash:

$$\bar{\phi}^C > \bar{\phi}^B$$

then the following relationship must hold:

$$R^{C*} = \bar{\phi}^B - \bar{\phi}^C < R^{B*} = 0 < R^* = \bar{\phi}^B \qquad \text{Q.E.D. (Proposition 1)}$$

Moreover, in case $R^C \equiv R^C(R)$ and $\frac{\partial R^C}{\partial R} > 0$, then it is trivial to show that:

$$\frac{\partial(R^C - R^{C*})}{\partial R} = \frac{\partial[R^C - (\bar{\phi}^B - \bar{\phi}^C)]}{\partial R} > 0 \qquad \text{Q.E.D. (Proposition 2)}$$

BANQUE CENTRALE DU LUXEMBOURG

EUROSYSTÈME

2, boulevard Royal
L-2983 Luxembourg

Tél.: +352 4774-1
Fax: +352 4774 4910

www.bcl.lu • info@bcl.lu