Reserve-backed tokens: A money for the future?

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ABSTRACT

Exactly what form the money of the future will take remains an open question. Central bank digital currencies (CBDCs), tokenised deposits and stablecoins have been discussed as potential candidates. This paper argues that reserve-backed tokens (RBTs) — backed solely and fully by central bank reserves — also represent a credible solution. RBTs pose a unique combination of benefits. Notably, they are safer than, and can crowd out, the unstable breeds of stablecoins. They can adopt a more flexible design than retail CBDCs and thus foster greater competition and innovation. Furthermore, compared with bank deposits, RBTs are immune to runs and are unencumbered by legacy features. Naturally, there are attendant risks and unknowns, but this paper argues that careful design and gradual rollout would help harness the benefits of RBT while mitigating the risks.

Keywords: CBDCs, stablecoins, tokenised deposits, crypto, central bank reserves, narrow banks

INTRODUCTION

Technological advances such as tokenisation, distributed ledgers and programmability are forcing a fundamental rethink about money among policymakers and financial service providers. Users' expectations regarding what constitutes an effective medium of exchange are also evolving. As a result, the search for a money for the future — one that is more suitable for increasingly digital economies — is underway. While much of the money currently in use is already in digital form (eg bank deposits and mobile money), the recent focus is on tokenised money. Central banks are studying central bank digital currencies (CBDCs) with some live rollouts already; commercial banks are exploring tokenised deposits; and FinTechs are issuing a wide variety of stablecoins. This paper examines a yet another tokenised money form: tokens issued by regulated private entities that are solely and fully backed by central bank reserves, ie reserve-backed tokens (RBTs).

The idea of an RBT is not entirely new. Some have argued in favour of stablecoins that are fully backed by central bank reserves.[1,2] Others have referred to an RBT-style arrangement as a synthetic or indirect CBDC.[3] The Bank of Korea has explored an RBT-style arrangement as a complement to retail CBDCs and tokenised deposits.[4] The Reserve Bank of Australia has noted that stablecoins backed fully by wholesale CBDCs could be part of the policy response to crypto and also facilitate a privately-led development of innovative payment instruments.[5] Meanwhile, the Bank of England's preferred model for systemic stablecoin issuers is to have the stablecoins fully backed by central bank reserves.[6] An RBT also has similarities with the monetary arrangement in Hong Kong, where commercial banks

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issue banknotes against holdings of certificates of indebtedness issued by the monetary authority.[7]

The contribution of this paper lies in providing an in-depth discussion of the pros and cons of alternative RBT design choices, comparing RBTs with other forms of tokenised money and discussing the potential implications for the financial system.

When designing an RBT, the overarching guiding principle is that it must add value relative to the other forms of tokenised money, while not posing additional risks. This raises several design trade-offs. A first issue is who should get access to the central bank balance sheet. Banks have the privilege of such access. In exchange for this privilege, however, they accept to be regulated to ensure they are sufficiently resilient, as otherwise their distress could damage the central bank's credibility. This means that RBT issuers, be it non-banks or FinTechs, should also be equally well regulated. A second design issue is whether RBTs must pay interest. As a means of payment like cash, RBTs should not pay interest. This can also help reduce the risk of disintermediating bank deposits and even moderate the impact on the central bank balance sheet. Meanwhile, to ensure that the RBT business model is a viable one, the central bank may need to pay interest on the RBT issuer's reserve balances. This may require the RBT reserve facility and the attendant interest rate policy to be distinct from the traditional setup. In terms of an RBT's transfer model and interoperability with other parts of the economy, giving issuers some design flexibility beyond a minimum criterion is likely to be beneficial. For example, while interoperability would have to be ensured via regulation, an RBT that is more compatible with public distributed ledgers may attract greater usage. In the end, issuers may self-select themselves into the type of RBT they would like to design depending on their target use case.

A well designed RBT would pose a unique combination of benefits relative to other tokenised forms of money (Table 1). Compared with retail CBDCs, RBTs may be operationally simpler for central banks to enable. In the case of CBDCs, central banks would need to assume a greater role in developing and managing the infrastructure. In the case of an RBT, their role would be more of an enabler while private players design and manage the front-end, even though the supervisory burden on the central bank may be higher. Meanwhile, retail CBDC is the liability of the central bank whereas RBT is the liability of the private issuer. RBT issuers would thus have a greater financial stake than retail CBDC wallet providers. RBT issuers may also earn interest on their reserve balances, unlike CBDC wallet providers, increasing their skin in the game. RBT issuers are likely to be able to design their respective RBTs more flexibly, something central banks seem unlikely to permit in the case of retail CBDCs. Greater design flexibility to issuers could foster greater competition and innovation in the RBT ecosystem. Indeed, innovation often flourishes when the public sector provides the hard infrastructure (eg monetary arrangement, regulatory framework) and a well-regulated and competitive private sector builds on top of it. This is not to say that RBTs and retail CBDCs are substitutes or that central banks should not pursue both RBTs and retail CBDCs in parallel. On the contrary, lessons from one engagement could inform the other.

Compared with fiat-backed stablecoins, RBTs could constitute a safer arrangement.[8] To be sure, stablecoins represent genuine innovations. In particular, tokenisation has enabled functionalities such as programmable payments that are novel for traditional finance. They are also more conducive to atomic settlements and composability (ie the ability to integrate various elements of the crypto and financial ecosystems to

Table 1: A comparison of RBTs, retail CBDCs, tokenised deposits and stablecoins

Attributes	RBTs	Retail CBDCs	Tokenised deposits	Fiat-backed stablecoins
Intended purpose	Means of payment	Means of payment	Means of payment and store of value	Means of payment
Issuer	Private	Central bank	Private (ie banks)	Private
Issuer regulatory status	Regulated	Regulated	Regulated	Lightly regulated (so far)
Complexity and intensity of regulation needed	Medium	Low	Very high	High
Primary revenue source for issuer*	Transaction fee + interest on reserves	Transaction fee (for wallet provider)	Transaction fee + interest on assets	Transaction fee + interest on assets
Issuer distress probability	Close to zero (but can fail due to fraud)	Zero (but intermediary fraud is possible)	Positive (eg due to insolvency)	Positive (but likely lower than banks once regulated)
Asset backing	Central bank reserves only	Retail CBDC is M0	Central bank reserves, bonds, and risky loans	Ostensibly low risk and highly liquid assets
Interest bearing?	No	No	Yes	No
Transfer model	Issuer can choose	Freely tradable	Burn-issue (ie liabilities burnt and created during a transfer)	Freely tradable
Crypto compatibility ie whether tradable on public ledgers	Issuer can choose	Unlikely	Unlikely	Yes
Support singleness of money?	Some versions may, some not	Yes	Yes	No

*Transaction fee may include platform fee. For example, a stablecoin issuer may earn additional revenue by selling value added services on its platform such as a 'money market fund sweep' functionality or insurance products

create new services). However, stablecoins have often broken their promise of so-called stability (convertibility at par) and violated the singleness of money.[9] They often lack transparency regarding the asset backing and may invest in riskier assets. Stablecoin sell-offs can trigger a fire-sale of the underlying assets, which can depress asset prices and have repercussions for entities in the traditional financial system. There is also the issue of dependence on custodians that safeguard the asset-backing. Moreover, so far, issuers are non-compliant or only lightly regulated and rely on complex contractual agreements (eg terms of redemption) that users may not fully appreciate.

RBTs, by contrast, would be fully backed by central bank reserves. Since inception, they would only be issued by well-regulated entities, ensuring transparency and compliance. RBTs are tokenised instruments, meaning that the beneficial aspects of stablecoins (such as programmability) would still be available to users, just in a safer and more stable manner. In fact, crypto-friendly and freely tradable RBTs may become a trusted and preferred means of payment within the crypto ecosystem, thus crowding out the unstable breeds of stablecoins. A safer crypto ecosystem would also mean fewer negative spillovers to the traditional financial system. In other words, RBTs may complement efforts to regulate crypto (stick-based approach) by ensuring that the traditional financial system offers the beneficial functionalities of crypto (carrot-based approach).[10]

Compared with tokenised deposits too, RBTs pose benefits. Deposits have multiple functions. They are used for both savings and payments, tend to come with various maturity and interest rate features, and are subject to deposit insurance. This can make the tokenisation of deposits rather complicated, and thus uniform tokenisation across banks more challenging. Moreover, tokenising is expected to result in additional use cases for deposits and expose banks to more shocks, making deposit funding more volatile and exacerbating bank runs. By contrast, RBTs have a clean slate advantage and a narrowly defined purpose, ie serve as a tokenised medium of exchange. Like tokenised deposits, RBTs would still be compatible with unified ledgers.[11] However, RBTs would not have interest payment or deposit insurance considerations, making them a simpler money form. Further, while issuing RBTs using their existing balance sheet would be an option, banks may prefer (or be required) to set up subsidiaries and issue RBTs using dedicated balance sheets. This could also give banks the ability to design RBTs more flexibly than tokenised deposits. For example, RBTs may be more widely accessible than tokenised deposits on the back of lower know-your-customer (KYC) requirements. In the end, it may be more attractive for commercial banks to issue RBTs than to issue tokenised deposits.

In the longer run, RBTs may even lead to a narrowing of banks, which has purported benefits. Enabling an RBT-specific reserve facility could lead to the rise of narrower institutions that specialise in offering a means of payment, namely RBTs, and banks that focus on savings and lending. These narrower and less complex institutions would likely be less risky. They would also be easier to regulate due to their simpler organisational structure. Further, while narrower banks may miss economies of scope that multi-purpose banks enjoy, robust data-sharing arrangement across institutions engaged in different activities (eg open finance) could help preserve synergies across activities.

Naturally, there are unknowns, and RBTs may pose undesirable consequences. One risk is that they could lead to a larger central bank balance sheet that is more difficult to manage. However, RBTs are unlikely to fundamentally shift the aggregate demand for money; they may only partially replace some of the other money forms like cash and bank deposits. As these monies also occupy central bank balance sheet space directly or indirectly (via fractional banking), the quantity of new central bank reserves needed ought to be less than the amount of RBTs minted. Another risk is that RBTs could disintermediate commercial banks during normal times and exacerbate bank runs during stress periods; concerns that apply in the case of retail CBDCs too. Once again, safety features in the design of RBTs (eg wallet limits) could help manage this risk. More generally, a gradual rollout would help test an RBT's benefits and deal with any undesirable consequences.

Amid a rapidly evolving economic landscape, it is unclear which form of money will be most suited for the future. However, given its potential as an effective medium of exchange, RBTs represent a worthwhile avenue for central banks and private players to consider. While it is possible that one money form emerges as the winner, it is more likely that retail CBDCs, tokenised deposits, RBTs and stablecoins co-exist, interoperate, and serve different purposes.

In what follows, this paper will discuss how an RBT could be designed. It then goes on to compare RBTs with fiat-backed stablecoins, tokenised deposits and retail CBDCs. This is followed by a discussion of the implications of an RBT for the central bank and for commercial banks. The final section provides concluding thoughts.

DESIGNING RESERVE-BACKED TOKENS

The objective of an RBT is clear: to serve as an effective medium of exchange in an increasingly digital economy. However, the optimal design of an RBT is not obvious. One of the first design questions relates to which entities should be allowed to issue RBTs.

Initially, the central bank may consider issuing RBT licences only to entities that already have access to its balance sheet, ie commercial banks. The advantage of this approach would be that banks are already inside the regulatory and supervisory perimeter, so oversight and compliance would be easier. Restricted access to RBT licences may, however, raise political economy issues. Those excluded (such as technology players) may challenge the unevenness of the playing field. This could hurt the RBT endeavour.

In the steady-state, the RBT licensing regime would thus have to be more competitive. The central bank may need to grant licences to any entity that satisfies the minimum eligibility criteria and is ready to comply with the necessary regulations. This could improve competition and innovation in the RBT ecosystem. That said, if many issuers seek and/or obtain RBT licences, operational burden on the central bank and related regulatory authorities would increase. Expanded access to the central bank reserve account may also require a change in law in some jurisdictions. In the end, a balance could be struck by adapting the stringency of the eligibility requirements or limiting the number of players that can have an RBT licence at a given point in time.

Relatedly, a comprehensive RBT-specific regulatory regime would have to be established. The regime would necessarily specify: (1) eligibility criteria (eg minimum capital endowment or governance track record); (2) the responsibility of RBT issuers to ensure KYC, customer due diligence and anti-money laundering/countering the financing of terrorism (AML/CFT) compliance, including when RBT tokens are transacted (eg travel rules); and (3) the regulatory and supervisory requirements applicable on a continuing basis (eg disclosures). In adopting a regulatory framework for RBTs, central banks are likely to draw elements from the framework for banks (and potentially from frameworks for other financial intermediaries that share similarities with RBTs such as exchange-traded funds and mutual funds). That said, the framework for RBT issuers is likely to be simpler than the framework for banks. This is because banks tend to have a more complex business model and engage in multiple activities such as payments, deposits and lending, whereas RBT issuers would focus only on payments (and thus also have a simpler balance sheet).

In fact, the framework for RBTs could be part of the broader framework for fiat-backed stablecoins (eg the Stablecoin Regulatory Framework in Singapore). A candidate issuer could then choose between an RBT or a stablecoin licence. Ideally, the RBT licence would be more demanding as it entails central bank balance sheet access. This would be analogous to the contrast between the more stringent and more privileged bank licence — one that allows central bank balance sheet access — as compared with a non-bank licence (eg mutual fund). Indeed, access to the central bank balance sheet comes with the added need to minimise the riskiness of the associated entity. The failure of an RBT issuer or a commercial bank — both of which are 'closer' to the central bank — is likely to be more damaging for the central bank's reputation as compared with the failure of a stablecoin or a mutual fund.

A second key design question is whether RBTs should be remunerated. RBTs are meant to serve primarily as a medium of exchange, like cash, and not as a store of value. This means that RBT issuers should be prohibited from paying any interest to

the holders. This is similar to central banks' preferred design in the case of retail CBDCs. This can also help limit disintermediation of savings deposits. Another rationale for keeping RBTs interest-free is the risk that RBT issuers might end up competing with each other on the interest paid to holders. Then, to pay higher interest, RBT issuers may undertake risky investments, which could jeopardise the very ethos of an RBT.

A follow-up question relates to the revenue model for RBT issuers. Obviously, RBT issuers are expected to offer payment services and generate revenues based on transaction fees. This would be similar to fees charged by payment services like Alipay and PayTM and even stablecoins. In addition, RBT issuers may generate a 'platform fee' by offering auxiliary services (such as purchase of movie tickets or investment products).

RBT issuers may also earn interest on the central bank reserves that back RBTs. Interest on traditional central bank reserves held by commercial banks is standard practice. From this perspective, interest on RBT reserves may be desirable from a consistency point of view. This would also make the business model for RBT issuers more viable, especially relative to retail CBDC wallet providers, who are unlikely to be paid such interest. However, this would have cost implications for the central bank. Furthermore, it would raise the issue of whether the interest rate on RBT reserves should be the same as the one on traditional reserves. A cautious way forward could be where the central bank initially offers a zero interest rate on RBT reserves and gauges whether private players find the RBT business model lucrative. If not, the central bank may then consider offering a positive rate, potentially linking the RBT reserve rate to the policy rate, although not necessarily one-to-one. In the end, the viability of the RBT model would hinge on whether the profit margin for RBT issuers is at par with that of peers in the payments business.[12]

Relatedly, the central banks would need to keep the RBT reserve facility distinct from the traditional one. This would obviously help decouple the interest rate policies on the two types of reserves. Moreover, traditional reserves are associated with monetary policy operations and central banks may prefer to keep the RBT reserve facility free from such considerations. The distinction could also be desirable from an accounting point of view.

Operationally, there are two potential models for the RBT reserve facility, especially in terms of handling transactions with and among the RBT issuers. Some central banks may initially prefer a centralised ledger, similar to typical real-time gross settlement (RTGS) systems. This may be operationally easier (eg during the pilot). In the longer run, a permissioned distributed ledger is likely to be desirable. This would involve RBT issuers as standard nodes and the central bank as a potentially more privileged node on the ledger. Such an approach may be better in terms of offering novel features such as programmable payments and atomic settlement among RBT issuers. A wholesale CBDC could also underpin RBTs, but this is not necessary.[13]

A third fundamental design aspect of an RBT is its transfer model, which is sometimes also referred to as the 'rails'. Broadly, there are two options. One is the burn-issue model where old liabilities are resolved and new ones are created during a transfer, similar to how deposits move across banks. Second is the bearer model where tokens are freely traded on a ledger.

Each model has pros and cons. The burn-issue model supports the singleness of money,[14] which is compelling, while the bearer model can feature deviations from par, as seen in the case of stablecoins. That said, such deviations are expected to be fewer and smaller in case of RBTs.

Stablecoins are backed by a wide range of assets with varying liquidity profiles and are issued by weakly-compliant entities. This can, at times, make users doubtful about the feasibility of a stablecoin's promise of full backing, lead to sell-offs and drop in valuation below par, thus violating singleness. By contrast, RBTs would be compliant and regulation would help ensure full asset-backing at all times. Moreover, sole backing with central bank money — which is the safest asset and the ultimate unit of account — would mitigate the risk of deviations away from par. Meanwhile, free transferability of RBTs — which may beget added functionalities — could be more appealing to users and thus make it a more viable ecosystem. Free tradability may even be necessary if RBTs were to compete effectively with stablecoins that also follow the bearer model. In the end, given that the case is not clear-cut either way, a flexible design where the central bank allows RBT issuers to choose their preferred transfer model could be the way forward.

In this case, issuers could self-select. Commercial banks may prefer RBTs based on the burn-issue model, which is also the model that tokenised deposits are most likely to adopt (eg Regulated Liability Network). By contrast, technology players may prefer to issue bearer RBTs. In the end, it would be up to the users to decide which model they prefer, or in other words, how much they care about singleness versus a potentially wider set of RBT use cases. In fact, unless one version turns out to be unacceptably risky and is outlawed by the central bank, both types of RBTs may co-exist.

An issue that is particularly relevant in the case of bearer RBTs is who should be responsible for KYC-AML-CFT compliance during the various stages of a transaction; the RBT issuer *or* the service provider (in whose wallet/network the tokens reside/travel)? This would be crucial as bearer RBTs could end up being transferred to and held by non-KYC users that are not a customer of the RBT issuer *per se*. While rules to ensure end-to-end compliance in such cases are not yet in place, it is increasingly clear that the KYC-AML-CFT and travel rules that apply in the case of cross-border payments can serve as a basis for a compliance framework for digital assets, including RBTs.[15]

The fourth major RBT design aspect is its interoperability with other parts of the financial system. There are three dimensions to this.

First is interoperability across RBT tokens issued by different private players. In theory, this may be straightforward as all issuers would need a minimum degree of technical compatibility to participate in the RBT ecosystem, and settlement would be achieved using central bank reserves. In reality, however, direct convertibility between RBTs designed for different ledgers may be technically challenging in some cases. Issuers may even purposely hinder interoperability (for example, by introducing transaction fees). To address these risks, regulation may be needed to avoid the creation of walled gardens and ensure a competitive RBT ecosystem.

Second is interoperability with the traditional financial system, including bank deposits and mobile payment services. This is likely to be natural as both RBTs and bank deposits are backed by central bank reserves. As Figure 1 shows, conversion from bank deposits to RBT implies that new RBT tokens are minted. Subsequently, settlement between the bank and the RBT issuer takes place on the central bank balance sheet with reserves being shifted from the bank's balance sheet to that of the RBT issuer. Meanwhile, the central bank's balance sheet expands. Conversely, conversion from RBT to bank deposits would mean that existing RBT tokens are extinguished. Interoperability with mobile and other payment services in the economy may involve additional steps but is expected to follow a similar process.

Nonetheless, the onus would once again be on regulation to ensure that there are no interoperability bottlenecks.

Third is compatibility with the crypto ecosystem. Technically, this is unlikely to be an issue. A promising precedence is that multiple stablecoins can be issued on the Ethereum blockchain and maintain interoperability if they satisfy a set of properties (known as ERC-20). From a policy perspective, however, whether RBTs should be crypto compatible is less obvious. This would be desirable if RBTs are supposed to be a credible alternative to stablecoins. However, certain risks call for a balanced approach. For one, the crypto ecosystem may trigger much demand for RBTs, for example, in search of a safe haven or a nominal anchor. This can substantially increase the size of the central bank balance sheet, which can be more difficult to manage (as this paper will discuss). In addition, given the proximity of RBT issuers and the central bank, any financial losses or frauds that originate in the crypto ecosystem and affect the RBT arrangement could damage the central bank's reputation.

Given these trade-offs, crypto compatibility may not be a binomial choice but a matter of degree. Beyond ensuring that each RBT issuer satisfies minimum eligibility and regulatory requirements that ensure a high degree of safety and reliability, the central bank may consider allowing RBT issuers the choice of how crypto-friendly they wish to be. This includes, for instance, the degree to which an RBT is compatible with a public ledger. The central bank may even consider a staggered licensing regime to incentivise specific outcomes (for example, stricter AML rules for more crypto-compatible RBTs). This may be similar to capital requirements that are an increasing function of banks' crypto exposures.[16] In the end, technology players may wish to specialise in crypto-friendly RBTs, while banks prefer non-crypto RBTs. Banks may even be prohibited from offering crypto compatible RBTs due to third-party risk management laws in some jurisdictions.

Overall, giving issuers some flexibility in terms of designing their RBTs, while necessarily ensuring a minimum degree of compliance and interoperability could help

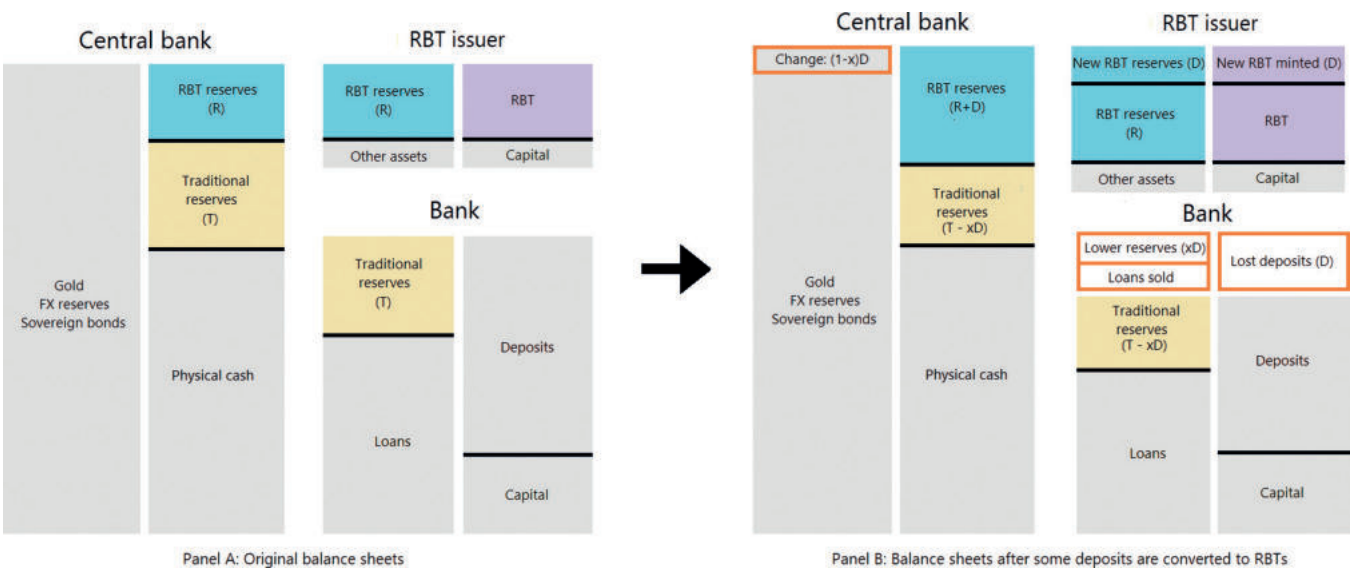

Figure 1: An illustration of how bank deposits could be converted to RBTs and attendant balance sheet adjustments

ensure the viability of the RBT ecosystem. This could also go a long way in supporting competition and innovation.

RBTs VERSUS STABLECOINS, TOKENISED DEPOSITS AND CBDCs

In terms of their riskiness, RBTs, retail CBDCs, tokenised deposits and fiat-backed stablecoins are part of a continuum. As Figure 2 shows, the continuum can be described by two dimensions: the riskiness of the backing (x-axis) and the riskiness of the issuer (y-axis), wherein I assume that the latter dimension subsumes the effect of regulation. By design, money forms that lie towards the upper right-hand corner of this continuum are riskier.

In this continuum, RBTs lie somewhere in between. As regards asset backing, RBTs are fully backed by central bank reserves while retail CBDCs are a direct liability of the central bank, making them equally safe. At the same time, an RBT's backing is safer than that for bank deposits (ie a variety of low- and high-risk assets), fiat-backed stablecoins (ie ostensibly low risk and highly liquid assets) and other stablecoins (ie those backed by commodities or algorithms). In terms of issuer riskiness, an RBT issuer (ie a private player) is obviously riskier than the retail CBDC issuer (ie the central bank). That said, an RBT issuer would be equally well regulated as, and thus comparable to, a deposit issuer (ie a commercial bank). An RBT issuer would also be safer than the current breed of stablecoin issuers, although this difference would likely shrink over time as jurisdictions adopt regulatory frameworks for tokenised money issuers based on the 'same risk, same regulation' principle (eg the Markets in Crypto Assets Regulation in Europe).

All in all, the two dimensions of riskiness taken together indicate that while retail CBDCs are the safest form of tokenised money, RBTs would be safer than tokenised deposits and stablecoins. That said, risk is only one aspect of an RBT. The following subsections provide a more rounded

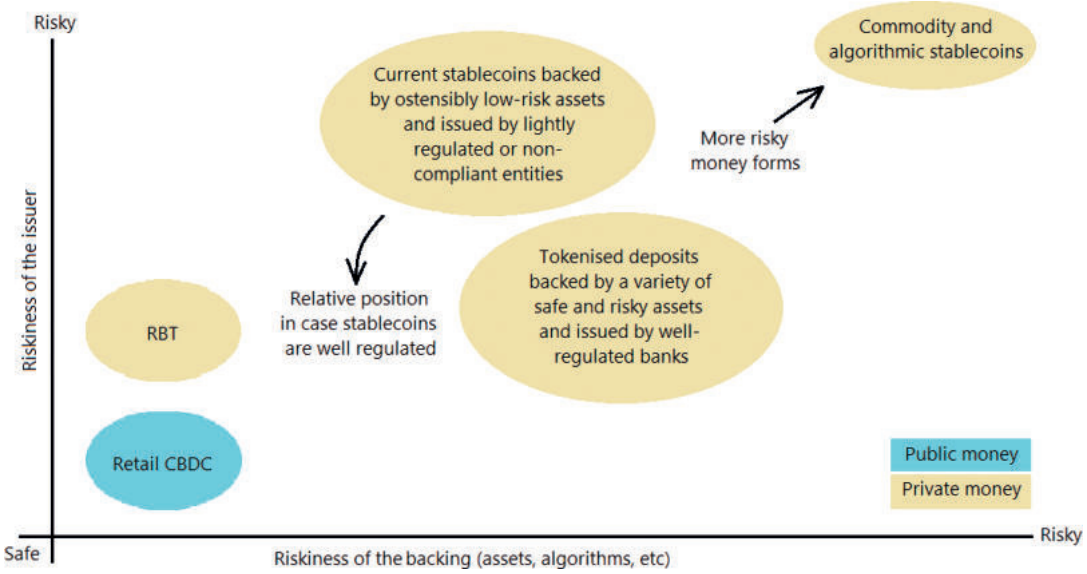

Figure 2: A schematic representation of the relative riskiness of various tokenised money forms (note that this representation abstracts away from the transfer model, which is another important determinant of the overall riskiness of a monetary arrangement)

comparison of the various tokenised money forms and argue that RBTs pose a unique combination of benefits.

RBTs versus retail CBDCs

Retail CBDC is public money; a central bank liability issued to the public in digital form, akin to digital cash. By comparison, RBT is private money, ie the liability of private issuers but fully backed by central bank money. This makes RBTs and retail CBDCs closely related, but also leaves important differences.

For one, compared with retail CBDCs, RBTs may be simpler for central banks to enable from an operational standpoint. While central banks need to take the lead in creating the end-to-end CBDC infrastructure, an RBT would have the central bank as the 'enabler' and let private players design the front-end. Thus, an RBT engagement may be less demanding than pursuing a major financial and strategic undertaking in the form of a retail CBDC, even though the supervisory burden may be higher in case of an RBT.[17] Relatedly, the central bank could easily begin an RBT pilot with a few banks that already have access to its reserve facility, while a CBDC is likely to require new infrastructure.

In addition, compared with retail CBDCs, RBTs may be designed more flexibly, and in particular, embrace programmable money features more easily. Programmable money in the case of retail CBDCs can go against the philosophy of 'neutrality of public money' and raise political economy concerns. In fact, some central banks (eg Bank of England, European Central Bank) do not foresee offering programmable money features in their proposed digital currencies but remain open to programmable payments.[18] These concerns would not apply in the case of an RBT as it is not a central bank liability. The private sector — including non-financial businesses — could thus have greater freedom in incorporating novel features and optimising the RBT according to the needs of the sector and its supply chains (eg trade finance, automobiles).[19]

Moreover, incentives for private players to undertake innovation could be higher in the case of RBTs. To be sure, even in the case of retail CBDCs, central banks are gravitating towards a two-tier model where private players remain in the front-end.[20] However, compared with being a retail CBDC wallet provider, a player issuing RBTs would have greater financial stake in the product it offers. The renumeration of RBT reserves (unlike CBDC wallet balances) further strengthens the stake. This could lead to greater competition and incentives to innovate.

The risk of low adoption or lack of demand in the case of RBTs would also be less problematic for the central bank as compared with the same risk in the case of CBDCs. Adoption of retail CBDCs in both pilots and live rollouts remains weak.[21] Some central banks are not even sure about pursuing retail CBDCs in the near future, in part due to uncertainty around their value-add. This concern may also arise in the case of RBTs. A failed RBT initiative, however, would not be the failure of the central bank *per se*, while a failed CBDC initiative is likely to dent central bank reputation.

That said, RBTs and CBDCs do pose some very similar risks because of an RBT's full central bank backing. These include disintermediation of bank deposits, a run towards RBTs during financial turmoil, and currency substitution in recipient economies. Some of these risks, however, can be managed via careful design and implementation, as also noted in the context of retail CBDCs.[22]

In the end, it is worth stressing that an RBT is not a substitute for a CBDC. They can complement each other, and lessons from an RBT engagement (eg use cases, risk management) could be used to inform the design of a retail CBDC and vice versa.

RBTs versus tokenised deposits

RBTs and tokenised deposits have several features in common. Both are backed by central bank reserves (fully in one case and fractionally in the other). Both are issued by entities that require adequate regulation and supervision: banks because they engage in maturity transformation and are inherently risky, while RBT issuers because they may have incentives to deviate from full backing. Both also subscribe to a two-tier arrangement wherein the central bank provides the backing and the infrastructure while the private entity deals with the customers and engages in product innovation. The difference between RBTs and tokenised deposits, therefore, may come across as blurry. That said, there are crucial differences.

Bank deposits are a legacy product with specific properties that can render tokenisation more complicated. For one, deposits are subject to deposit insurance. They also have variants; some deposits are demandable, others have a duration attached, and some pay interest. This means that banks must decide which types of deposits and which accompanying features to tokenise. Further, as traditional deposits are interoperable, a minimum degree of interoperability and uniformity across different tokenised deposits would be expected, otherwise the ecosystem could end up being fragmented and not user-friendly. Bank deposits also already serve multiple functions (eg means to payment and save) making them prone to shocks in the relative demand for these functions. Tokenising would endow deposits with *additional* demand factors and thus expose banks to more shocks. Relatedly, banks may also have to compete in terms of the add-on features that their respective tokenised deposits offer. All of this could make tokenised deposits flightier and thus bank deposit funding more volatile.

By contrast, RBTs capture all the tokenisation related benefits of tokenised deposits. Yet, they do not have the burden of precedence. They have a narrowly defined purpose, which is to serve as a medium of exchange, and would be designed precisely to satisfy that purpose. Banks may be able to design their RBTs more flexibly compared with tokenised deposits. For instance, KYC requirements for RBTs could be lower relative to opening a bank account. Unlike tokenised deposits, RBTs would not have interest payment or deposit insurance considerations. Also, in the case of tokenised deposits, commercial banks must adopt the burn-issue model to support the singleness of money. By contrast, depending on the rules in the jurisdiction, bank may be able to issue RBTs that are more freely tradable and crypto-compatible (even if only via a subsidiary, as this paper will discuss). As a result, banks may prefer RBTs over tokenised deposits.

RBTs versus stablecoins

Stablecoins represent genuine innovations. For instance, due to their tokenised nature, it is easier to offer programmability using stablecoins compared with using traditional payment methods such as a fast payment system. Relatedly, stablecoins and tokenised financial or real assets on the same ledger can support atomic settlements between a wide range of assets. Moreover, their 24/7 availability means that they can also improve cross-border payments.[23] Stablecoins have thus demonstrated the potential for improving efficiency of traditional payments.

They have also emerged as the primary means of payment in the crypto ecosystem.[24] In part, this is due to their more stable valuation relative to alternatives like Bitcoin. Fiat-backed stablecoins also straddle the traditional and the crypto ecosystems, thus serving as a convenient bridge between them. For instance, conversion costs are lower when converting stablecoins to/from fiat as compared with conversions involving other crypto assets.

That said, stablecoins (at least the current breed) have several flaws. First, they violate singleness. Several stablecoins broke their peg by large margins around the collapse of Silicon Valley Bank.[25,26] Violations of singleness can debilitate monetary exchange as even small departures from par can get amplified as they reverberate through economic transactions. Second is the lack of transparency about the liquidity and 100 per cent cover of the asset backing.[27] In part, this is because stablecoin issuers tend to be lightly regulated and non-compliant with disclosure requirements that generally apply in the case of banks. Issuers may also have incentives to invest in riskier assets and earn higher returns.[28] Third, a wave of stablecoin redemptions can trigger a fire-sale of the underlying assets. This can depress the price of those assets and lead to repercussions for entities in the traditional financial system that have direct or indirect exposure to those assets; similar to redemption risks in the case of mutual funds.[29] The fire-sale issue may get exacerbated because holdings of some stablecoins are highly concentrated.[30] Redemption constraints — wherein some issuers offer redemption into fiat infrequently — can also add to the panic among stablecoin holders.

RBTs have the potential to capture the benefits of stablecoins while addressing many of the flaws. For one, RBTs lower redemption related risks. In the case of a large RBT redemption, the issuer could simply reduce its reserve balance at the central bank without any asset price impact *per se*. This may force the central bank to adjust. However, the quantum of impact is likely to be small as funds obtained by users via RBT redemptions would typically end up in another part of the economy (such as bank deposits) and buffer any impact on the central bank balance sheet. Secondly, unlike stablecoin issuers, RBTs would not need to depend on custodians. Thirdly, a 100 per cent backing by the safest asset makes RBTs a trustable anchor. In particular, backing by central bank reserves — the ultimate unit of account — is likely to make any violations of singleness in case of an RBT smaller and infrequent compared with stablecoins. Fourth, RBT issuers would have a simpler balance sheet structure (backed by just one instead of many assets) and thus be easier and more effective to regulate than stablecoins. This would also make RBTs more transparent. All in all, RBTs have the potential be an attractive means of payment in both traditional and crypto ecosystems and thus organically crowd out the unstable breeds of stablecoins. In the process, RBT could impart stability to the crypto ecosystem and also mitigate spillovers to the traditional financial system.

IMPLICATIONS FOR THE FINANCIAL SYSTEM

An RBT would impact various aspects of the financial system: the central bank's balance sheet, the operational model of commercial banks that wish to issue RBTs, and the organisation of the banking sector as a whole.

Implications for the central bank

As an alternative payment method, an RBT is expected to reduce the market share of other means of payment, such as cash and bank deposits. This is likely to expand the central bank balance sheet, but by less than one-to-one compared with the amount of RBTs issued.[31] When RBTs replace cash, the central bank balance sheet impact would be null as both these instruments occupy the same balance sheet space. When RBTs replace bank deposits, the impact is rather non-trivial. As shown in Figure 1, let D be the quantity of deposits converted to RBTs and x be the bank reserve ratio requirement. Assume that the bank responds by reducing its reserves proportionally, ie by xD and selling $(1 - x)D$ loans.[32] Meanwhile, the RBT issuer increases its liabilities by D while increasing its reserves by the same amount.

The net increase in the central bank balance sheet is $D - xD = (1 - x)D$, which is less than the amount D of new RBTs created.

That said, if the public perceives RBTs as a safe asset due to its full reserve backing and want to use it as a savings vehicle, the balance sheet impact can be large. Despite being a non-interest-bearing instrument, RBTs may experience heightened demand, which could lead to a considerable volume of savings deposits at banks being converted to RBTs.

The safe asset perception of RBT could also make the central bank balance sheet more volatile. During normal times the public's incentive to hold RBT balances beyond what is needed for day-to-day transactions may be low. This is because deposits (which tend to be insured up to a limit) are reasonably safe. During stress times, however, concerns around banks' health could lead to sudden spikes in RBT demand. The failure of Silicon Valley Bank in March 2023 highlights the speed of digital bank runs.

Overall, RBTs could expose the central bank's balance sheet to fluctuations in money demand, which could weaken the central bank's grip on its balance sheet. A larger and/or more volatile balance sheet could pose several challenges.

For one, as the balance sheet becomes more leveraged, asset price volatility would have a larger impact on the central bank's capital. If asset prices fall sharply, capital can deplete quickly and raise credibility issues.[33] Low capital may also inhibit the central bank from paying dividends to the treasury. In fact, the central bank may need to get capital replenishment from the ministry of finance, which could hamper its independence.[34]

A larger central bank balance sheet may also lead to higher inflation and/or financial stability risks. This is because an expanded balance sheet, such as following quantitative easing (QE), tends to increase money supply. This can add to retail price pressures, fuel asset prices and lead to credit booms. That said, an RBT-driven increase in central bank balance sheet size is unlikely to have such repercussions. This is because unlike QE, an RBT would not necessarily ease liquidity and increase money supply; instead it would largely lead users to switch from one means of payment to another.

A larger central bank balance sheet may even have some benefits.[35] These benefits do not serve as motivations for introducing an RBT. Nonetheless, they are notable considerations. For one, a larger balance sheet could support financial stability as it could enable the central bank to satisfy more effectively the private sector's demand for safe and liquid assets. In addition, a larger balance sheet could help deepen the engagement with banks and non-banks, say via an expanded repo programme. This can strengthen the transmission of monetary policy, especially to money markets, which play an increasingly important role in financial markets.[36] In addition, some have advocated the benefits of a larger balance sheet for credit easing policies.[37] Moreover, the ability to pay interest on a larger volume of reserves can serve as a potent monetary policy tool for central banks.[38]

Past increases in balance sheet size, such as those in the USA after the great financial crisis of 2008 or the COVID-19 crisis, are not unprecedented. A gradually rolled-out RBT would help ensure that any increase in balance sheet size is smooth. Meanwhile, RBT design elements such as limits on wallet balances (like in the case of retail CBDCs) would ensure that RBTs are not used as a savings instrument and thus help limit RBT demand. Further, while one user could open multiple RBT wallets from different issuers to circumvent wallet specific limits, KYC rules could help prohibit such behaviour.

Implications for banks considering issuing an RBT

It may be relatively easy for banks to issue RBTs as they already issue retail deposits

that are (fractionally) backed by central bank reserves. In particular, they have experience in dealing with the central bank balance sheet and have the necessary systems in place. Banks are also already used to financial regulation. All of this can facilitate RBT issuance by banks, including operational aspects such as the reconciliation of changes in RBT liabilities and the required reserves. Issuing RBTs is therefore likely to be a smaller step for banks as compared with non-banks.

Banks may also have a strong interest in issuing RBTs. For one, their existing clients could become potential RBT users. Banks are also well regulated and thus trusted entities. These factors could help banks generate demand for the RBTs issued by them. Moreover, should RBTs gain popularity as a medium of exchange, being an RBT provider would allow banks to benefit directly from transactional revenues and also remain relevant in an increasingly digital financial ecosystem. In particular, greater customer engagement could help improve banks' market share in various financial services due to cross-product synergies.

Issuing RBTs may also help banks reduce the impact on their own balance sheet. This is because if a bank's existing customers simply shift their demand deposits into that bank's RBTs (as opposed to withdrawing the deposits to buy RBTs from another issuer), the bank's overall balance sheet size would not need to change (although the composition would change and likely result in more reserves and fewer loans).

Operationally, banks could issue RBTs either by using their existing balance sheet or via a subsidiary with a separate balance sheet.

The former model (Figure 3, panel B) may be simpler from the bank's point of a view. However, ensuring that banks have the minimum required reserves vis-à-vis deposits as well as RBTs may be trickier. The difficulty stems from the fact that reserve assets on the bank's balance sheet may not be earmarked for the two types of liabilities. In other words, the distinction between (tokenised) deposits and RBTs may get blurred in this case. To avoid this fungibility issue, the central bank may need to keep RBT reserves distinct from traditional reserves.

In case banks use a subsidiary model (Figure 3, panel C), the fungibility issue does not arise. This also helps keep the bank's traditional operations separate from its RBT business, thus reducing scope for negative spillovers from one to the other. The subsidiary model may also help the central bank adopt an activity-based regulation for RBT issuers, which tends to be simpler than entity-based-regulation.[39] Such a model may also facilitate a more flexible design of RBTs as any extant bank-specific regulations would not have to apply to the subsidiary. In fact, these advantages may even lead the central bank to make it mandatory for RBT issuers (be it a bank, non-bank, or technology player) to issue RBTs from a dedicated balance sheet only.

Implications for the banking sector

In the short run, RBTs could disintermediate bank deposits at two levels. First, as a non-interest-bearing medium of exchange, RBTs could chip away banks' demandable deposits, ie deposits that households and businesses hold primarily for transactional purposes. A key driver of such disintermediation would be any novel features like programmability or atomic settlement that RBTs offer relative to deposit-based payments. Secondly, if depositors perceive RBTs as a quasi-direct claim on the central bank — and thus a *safe* asset — RBTs could also disintermediate interest-bearing deposits due to flight-to-safety motivations. This could either affect individual banks that are deemed to be vulnerable at a given point in time or affect the banking sector more broadly during a crisis (and potentially even magnify the same). These risks also apply in the case of retail CBDCs, but certain design

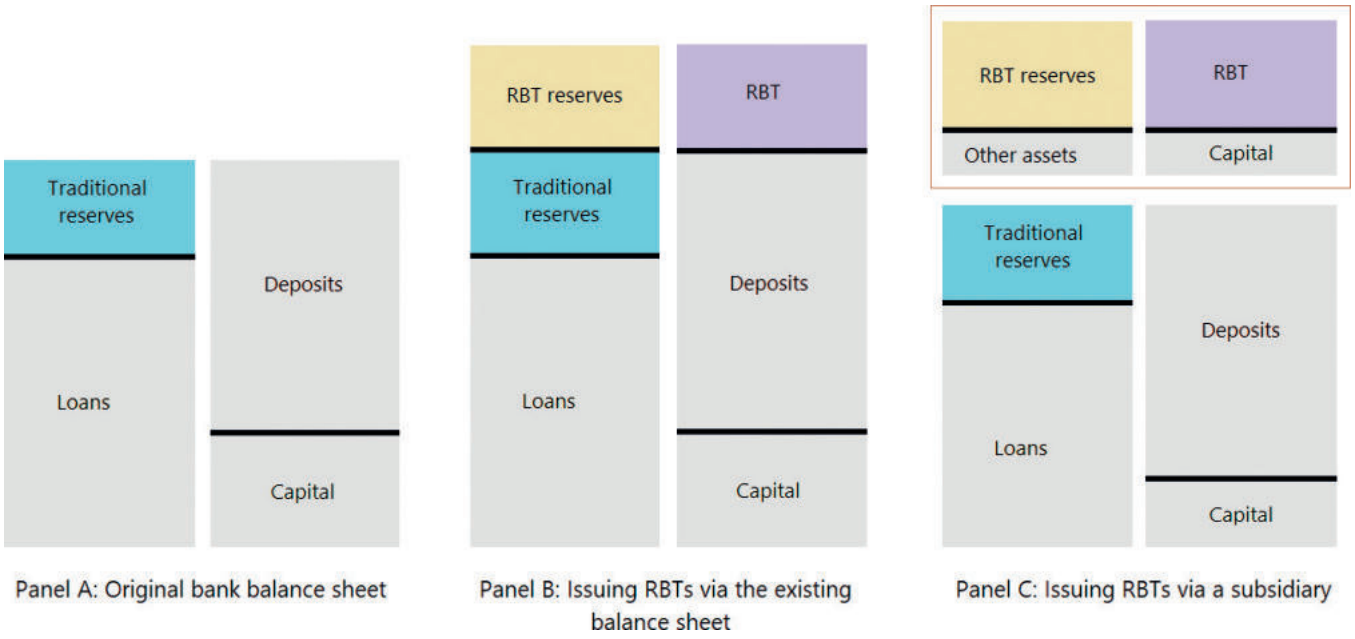

Figure 3: There are two potential ways in which a bank may issue RBTs: via its existing balance sheet (panel B) or via a subsidiary (panel C); in the latter case, the bank uses some of its existing capital to set up a subsidiary that has its own balance sheet with RBT liabilities, reserves to back the RBTs, and potentially some other assets depending on what the regulatory regime permits

choices such as wallet limits and gradual rollout could help mitigate these risks. Banks could further alleviate balance sheet impact by being active RBT issuers.

In the longer run, RBTs could impact the banking sector structurally. Today's multi-purpose commercial banks perform several functions, from creating demandable liabilities to transforming maturities and monitoring loans. By chipping demandable deposits away, RBTs may lead financial intermediaries to self-select into more specialised or 'narrower' business models: (1) payment-focused institutions that issue RBTs as a means of payment to earn transaction and other platform fee; and (2) financial intermediaries that accept savings/term deposits and lend to borrowers while earning an interest margin.

An RBT-led narrowing of banks would be related to the monetary reform proposal that was advanced in the wake of the Great Depression, popularly known as the Chicago Plan.[40] It advocated separating the monetary and credit functions of banks and envisaged a 100 per cent reserve bank that issued demandable deposits that were fully backed by central bank reserves. At the same time, the plan suggested eliminating fractional reserve banking and instead proposed that lending be undertaken by equity-financed banks only.[41]

Any RBT-led narrowing of banks would differ from the Chicago Plan in two ways. First is the revenue model. As per the Chicago Plan, the narrow bank would earn the difference between interest received on reserves and the one paid to depositors.[42] By contrast, RBT issuers would be payment-focused institutions that could earn interest on reserves but would not pay any interest to the RBT holders and would likely charge a transaction fee. Secondly, while the Chicago Plan advocated for equity financed lending

institutions, an RBT-led narrowing would naturally accommodate lending-focused banks that accept savings or term deposits.

Various studies have supported the narrow bank vision.[43–45] Less complex institutions tend to be less vulnerable. In particular, RBT issuers would be largely immune to bank runs because even if all holders choose to redeem their tokens simultaneously, the issuer could simply dissolve the reserve backing to cover the liabilities with no fire-sale costs or asset price impact. Meanwhile, lending-focused banks could still engage in maturity transformation by funding longer term (eg one-year) loans with shorter term (eg three-month) deposits. Yet, they would be less fragile compared with traditional banks as term depositors would not be able withdraw their deposits prematurely without a penalty. This may, however, weaken the disciplining effect of bank runs.[46] Overall, the need for reserve requirements in the case of such lending-focused banks is likely to be lower. Narrower financial institutions would also be easier to regulate.[47]

That said, narrower financial institutions can have downsides. They may be less resilient due to their focus on a single activity (ie loss of diversification benefits). Specialisation can also lead to a loss of the efficiencies that multi-purpose banks generate based on economies of scale and scope.[48] However, if the various activities are offered by a competitive set of institutions, it could help restore many of the efficiencies. Permissioned and fairly compensated data-sharing arrangements (eg open finance) that allow user data from one activity (eg payments) at one service provider to be available to other service providers engaged in other activities (eg lending) could also help retain the benefits of multi-purpose banking.

CONCLUSION

Technological advancements are forcing a rethink about monetary arrangements globally. The search for the ideal tokenised form of money for the future is underway. Candidates include CBDCs, tokenised deposits and stablecoins. This paper examines the pros and cons of RBTs: tokens that are fully and solely backed by central bank reserves. RBTs would enable well-regulated private entities (not just banks) to access a new central bank reserve facility to flexibly develop tokens that are ideal for their purposes. As such, RBTs embrace the view that the central bank balance sheet is a policy tool that can facilitate a novel medium of exchange that is better suited for increasingly digital economies. Indeed, RBTs offer a unique combination of benefits.

First, compared with retail CBDCs, private players are likely to have a bigger financial stake in RBTs, especially if RBT reserves are remunerated. This would foster greater competition and innovation in the RBT ecosystem. In addition, RBTs could adopt a more flexible design relative to retail CBDCs. They may also deepen public–private partnership, that is, a setting where private players tend to excel in serving end users and innovating, while central banks provide the public goods such as the base infrastructure and the regulatory framework.

Secondly, compared with stablecoins, RBTs would be a safer and more credible alternative, and may help crowd out the unstable variants. This may lend stability to the crypto ecosystem and also reduce spillovers to traditional finance. RBTs may thus serve as a carrot-based policy (ie make traditional finance more attractive) and complement efforts to regulate crypto, a stick-based policy.

Thirdly, commercial banks may prefer issuing RBTs over tokenised deposits. This is because deposits are a legacy form of money with multiple functions; means to save and means to pay. They are prone to bank runs and tokenising deposits could also make banks' deposit funding more volatile. By contrast, RBTs begin with a clean slate and

are a simpler money form with a narrower purpose. RBTs could also be made more widely accessible than tokenised deposits. In the longer run, enabling RBTs may lead to payment-focused RBT issuers and lending-focused banks that offer longer-term savings deposits. These narrower financial institutions are likely to be safer and easier to regulate. More generally, RBTs, RBT issuers and the RBT reserve facility — ie the RBT ecosystem — could evolve in a manner that is similar to how the fractional reserve banking ecosystem has successfully evolved in the past decades.

Enabling an RBT-specific reserve facility and widening access to the central bank balance sheet are somewhat unchartered territories for the central bank, but so are CBDCs. Nonetheless, central banks are engaging in CBDC projects in controlled settings to better understand the balance of benefits and risks. A similar approach is worth pursuing in the case of RBTs. In fact, RBTs may be operationally less demanding for central banks than CBDCs. Moreover, lessons learned from an RBT engagement could inform CBDC engagements, and vice versa. Meanwhile, to minimise risks, central banks could initially ration RBT licences and provide them only to select entities that are already inside the oversight perimeter, while also imposing constraints on the design of an RBT, such as wallet limits.

The form of money best suited for an increasingly digital future remains unclear. This underscores the need for a multi-pronged and experimentative approach today. This paper has shown that RBTs have the potential to serve as a safe and effective medium of exchange. As such, pursuing RBTs is a worthwhile avenue to consider. In the end, a single money form may emerge as the winner. However, it is more likely that multiple tokenised money forms including retail CBDCs, tokenised deposits, RBTs and regulated stablecoins co-exist, interoperate and serve different use cases.

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References and Notes

(1) Kahn, C. and Singh, M. (2021) 'If stablecoins are money, they should be backed by reserves', Risk.net, available at: https://www.risk.net/comment/7744611/if-stablecoins-are-money-they-should-be-backed-by-reserves (accessed 29th March, 2024).

(2) Bank for International Settlements Innovation Hub (October 2022) 'Project Aurum: A prototype for two-tier central bank digital currency (CBDC)', Project Report, available at: https://www.bis.org/publ/othp57.htm (accessed 29th March, 2024).

(3) Adrian, T. and Mancini-Griffoli, T. (2021) 'The rise of digital money', *Annual Review of Financial Economics*, Vol. 13, pp. 57–77.

(4) Bank of Korea and Bank for International Settlements (October 2023) 'A step toward new financial market infrastructure: Bank of Korea's initiative', available at: https://www.bis.org/publ/othp77.pdf (accessed 29th March, 2024).

(5) Reserve Bank of Australia (2023) 'Australian CBDC Pilot for Digital Finance Innovation', available at: https://www.rba.gov.au/payments-and-infrastructure/central-bank-digital-currency/pdf/australian-cbdc-pilot-for-digital-finance-

innovation-project-report.pdf (accessed 29th March, 2024).

(6) Bank of England (November 2023) 'Regulatory regime for systemic payment systems using stablecoins and related service providers', Discussion Paper, available at: https://www.bankofengland.co.uk/paper/2023/dp/regulatory-regime-for-systemic-payment-systems-using-stablecoins-and-related-service-providers (accessed 29th March, 2024).

(7) Alipay wallet balances are also fully backed by central bank reserves, which makes them comparable with RBTs except for tokenisation. In the USA, Custodia Bank has proposed a business model called Avits that is similar to RBTs. However, Custodia's application to access the Federal Reserve's master account was rejected due to concerns relating to KYC/AML compliance and the concentration of its proposed activities in the crypto sector.

(8) This paper compares RBTs with fiat-backed stablecoins which are backed by ostensibly liquid financial assets such as commercial bank deposits, government bonds and money market funds. Stablecoins backed by commodities, crypto assets or algorithms are much riskier monetary arrangements and are beyond the scope of this paper.

(9) Garratt, R. and Shin, H. S. (2023) 'Stablecoins versus tokenised deposits: Implications for the singleness of money', *BIS Bulletin*, No. 73, available at: https://www.bis.org/publ/bisbull73.pdf (accessed 1st April, 2024).

(10) Aquilina, M., Frost, J. and Schrimpf, A. (2023) 'Addressing the risks in crypto, laying out the options', *BIS Bulletin*, No. 66, available at: https://www.bis.org/publ/bisbull66.htm (accessed 1st April, 2024).

(11) Bank for International Settlements (2023) 'Blueprint for the future monetary system: Improving the old, enabling the new', BIS Annual Economic Report, Ch. 3, available at: https://www.bis.org/publ/arpdf/ar2023e3.htm (accessed 29th March, 2024).

(12) A case in point is payment banks in India that are somewhat related to RBTs. Payment banks cannot lend but need to pay interest on deposits. Profitability among these banks has been an issue, especially due to the rise of the digital payment revolution. This has led to industry calls that payment banks must be allowed to lend. By contrast, RBTs do not pay interest and thus issuers need not compete along that margin.

(13) Durfee J., Maniff, J. L. and Slattery, P. (September 2023) 'Examining CBDC and wholesale payments', FEDS Notes, The Federal Reserve, available at: https://www.federalreserve.gov/econres/notes/feds-notes/examining-cbdc-and-wholesale-payments-20230908.html (accessed 29th March, 2024).

(14) Note that even the burn-issue model cannot *guarantee* singleness. For instance, when deposits are transferred, the payer bank's liabilities are extinguished and new liabilities are issued on the recipient bank's balance sheet. Settlement occurs in central bank money. This ensures singleness *during* the transaction. However, when banks fail and depositors cannot redeem their deposits in full, deposits can violate the singleness of money. In other words, while retail CBDCs and physical cash satisfy the singleness of money by construction because they serve as the ultimate unit of account, private monies (ie liabilities of private issuers) remain prone to violations of the singleness of money.

(15) Bains, P., Ismail, A., Melo, F. and Sugimoto, N. (2022) 'Regulating the crypto ecosystem: The case of stablecoins and arrangements', IMF Working Paper, available at: https://www.imf.org/en/Publications/fintech-notes/Issues/2022/09/26/Regulating-the-Crypto-Ecosystem-The-Case-of-Stablecoins-and-Arrangements-523724 (accessed 1st April, 2024).

(16) Basel Committee on Banking Supervision (December 2022) 'Prudential treatment of crypto asset exposures', BCBS Standards, available at: https://www.bis.org/bcbs/publ/d545.htm (accessed 29th March, 2024).

(17) Auer, R. and Boehme, R. (2021) 'Central bank digital currency: The quest for minimally invasive technology', BIS Working Paper No. 948, available at: https://www.bis.org/publ/work948.htm (accessed 1st April, 2024).

(18) Programmable payments (or smart contracts) are payments that are automatically executed when certain conditions are satisfied (eg a journalist getting paid with every download of their article). By comparison, programmable money (or purpose-bound money) is a token with an embedded condition that governs its transferability (eg tokens that may only be used in a specific shop).

(19) Tenner, T. and Wallraf, A. (2023) 'Position paper on a digital euro – the next step in the evolution of money', German Banking Association Working Paper, available at: https://bankenverband.de/en/digital-euro/position-paper-digital-euro-next-step-evolution-money/ (accessed 29th March, 2024).

(20) Bank for International Settlements Innovation Hub (September 2023) 'Project Sela: An accessible and secure retail CBDC ecosystem', Project Report, available at: https://www.bis.org/about/bisih/topics/cbdc/sela.htm (accessed 29th March, 2024). This project studied retail CBDC architectures that help maximise private-sector engagement.

(21) Chen, S., Goel, T. and Qiu, H. (2023) 'Beyond technology: Considerations for retail central bank digital currency adoption in Asia-Pacific',

Journal of Payments Strategy and Systems, Vol. 17, No. 4, pp. 408–421.

(22) Chen, S., Goel, T., Qiu, H. and Shim, I. (2022) 'CBDCs in emerging market economies', BIS Paper No. 123, available at: https://www.bis.org/publ/bppdf/bispap123.htm (accessed 1st April, 2024).

(23) The existing cross-border payment landscape remains inefficient, marred by high transaction costs and delayed settlement. Stablecoins can cross borders relatively easily. They also help get around the lack of synchronised operating hours of payment systems across jurisdictions.

(24) Aramonte, S., Huang, W. and Schrimpf, A. (December 2021) 'DeFi risks and the decentralisation illusion', *BIS Quarterly Review*, available at: https://www.bis.org/publ/qtrpdf/r_qt2112b.htm (accessed 1st April, 2024).

(25) Bank for International Settlements (July 2023) 'The crypto ecosystem: Key elements and risks', Report to the G20, available at: https://www.bis.org/publ/othp72.pdf (accessed 29th March, 2024).

(26) Glowka M., Kosse, A., Mattei, I. and Rice, T. (2023) 'Will the real stablecoin please stand up?', BIS Paper No. 141, available at: https://www.bis.org/publ/bppdf/bispap141.htm (accessed 1st April, 2024).

(27) Existing stablecoin issuers such as USDC and Tether regularly disclose that they have more than a 100 per cent asset backing of their liabilities. However, there is less clarity on the liquidity profile of the asset mix and whether it can cover large redemption shocks.

(28) Arner, D., Auer, R. and Frost, J. (November 2020) 'Stablecoins: risks, potential and regulation', Bank of Spain Financial Stability Review, available at: https://www.bis.org/publ/work905.pdf (accessed 29th March, 2024).

(29) Financial Stability Board (February 2022) 'Assessment of risks to financial stability from crypto-assets', available at: https://www.fsb.org/2022/02/assessment-of-risks-to-financial-stability-from-crypto-assets/ (accessed 29th March, 2024).

(30) Adachi, M., Da Silva, P. B. P., Born, A., Cappuccio, M., Czák-Ludwig, S., Gschossmann, I. and Philipps, S. M. (2022) 'Stablecoins' role in crypto and beyond: Functions, risks and policy', *ECB Macroprudential Bulletin*, No. 18, available at: https://www.ecb.europa.eu/press/financial-stability-publications/macroprudential-bulletin/html/ecb.mpbu202207_2~836f682ed7.en.html (accessed 1st April, 2024).

(31) Armas, A. and Singh, M. (2022) 'Digital money and central banks balance sheet', IMF Working Paper, available at: https://www.imf.org/en/Publications/WP/Issues/2022/10/28/Digital-Money-and-Central-Banks-Balance-Sheet-524987 (accessed 1st April, 2024).

(32) In case the bank chooses to reduce its reserves by 'less' and thus hold excess reserves, the central bank balance sheet impact can be greater. However, this is something central banks could manage by adjusting the interest rate on excess reserves.

(33) This is like the risk that higher leverage poses in the case of in case of commercial banks. However, central banks can operate with negative equity, which makes them different from a typical commercial bank.

(34) Bank for International Settlements (2012) 'Are central bank balance sheets in Asia too large?', BIS Paper No. 66, available at: https://www.bis.org/publ/bppdf/bispap66.pdf (accessed 1st April, 2024).

(35) Bernanke, B. (September 2016) 'Should the Fed keep its balance sheet large?', Brookings Commentary, available at: https://www.brookings.edu/articles/should-the-fed-keep-its-balance-sheet-large/ (accessed 29th March, 2024).

(36) Duffie, D. and Krishnamurthy, A. (August 2016) 'Passthrough efficiency in the Fed's new monetary policy setting', Proceedings of the Jackson Hole Symposium, pp. 1815–1847, Federal Reserve Bank of Kansas City, available at: https://www.kansascityfed.org/Jackson%20Hole/documents/7030/Duffie_JH2016.pdf (accessed 29th March, 2024).

(37) Curdia, V. and Woodford, M. (2011) 'The central-bank balance sheet as an instrument of monetary policy', *Journal of Monetary Economics*, Vol. 58, No. 1, pp. 54–79.

(38) Greenwood, R., Hanson, S. G. and Stein, J. C. (2016) 'The Federal Reserve's balance sheet as a financial-stability tool', Harvard Working Paper, available at: https://scholar.harvard.edu/files/stein/files/jackson_hole_ghs_20160907_final.pdf (accessed 1st April, 2024); Reis, R. (2017) 'QE in the future: The central bank's balance sheet in a fiscal crisis' *IMF Economic Review*, Vol. 65, No. 1, pp. 71–112.

(39) Borio C., Claessens, S. and Tarashev, N. (2022) 'Entity-based vs activity-based regulation: A framework and applications to traditional financial firms and big techs', FSI Paper No. 19, available at: https://www.bis.org/fsi/fsipapers19.htm (accessed 1st April, 2024).

(40) Simons, H. C. (1934) *A Positive Program for Laissez Faire: Some Proposals for a Liberal Economic Policy*, Chicago University Press, Chicago, IL.

(41) A broader definition of a narrow bank is one where the financial institution issues demandable liabilities and invests in assets that have little or no nominal interest rate and credit risk. This definition subsumes the notion of a 100 per cent reserve bank as per the Chicago Plan but also treats a mutual fund that only invests in government bonds as a narrow bank.

(42) The Narrow Bank proposal in the USA was based on this idea, although the proposal was turned down by the Fed.

(43) Fisher, I. (1936) '100% Money and the Public Debt', Adelphi Company, New York, NY, available at: https://cdn.mises.org/100%20Percent%20Money_Fisher.pdf (accessed 1st April, 2024). This paper lays the foundations of narrow banking.
(44) Friedman, M. (1960) *A Program for Monetary Stability*, Fordham University Press, New York, NY. This paper provides several arguments in favour of narrow banking.
(45) Benes, M. J. and Kumhof, M. (2012) 'The Chicago plan revisited', IMF Working Paper, available at: https://www.imf.org/external/pubs/ft/wp/2012/wp12202.PDF (accessed 1st April, 2024). This paper provides empirical support for many of the advantages of narrow banks using a calibrated DSGE model of a modern banking system.
(46) Calomiris, C. W. and Kahn, C. M. (1991) 'The role of demandable debt in structuring optimal banking arrangements', *American Economic Review*, Vol. 81, No. 3, pp. 497–513.
(47) Pennacchi, G. (2012) 'Narrow banking', *Annual Review of Financial Economics*, Vol. 4, No. 1, pp. 141–159.
(48) Bossone, B. (2001) 'Should banks be narrowed?', IMF Working Paper, available at: https://www.imf.org/en/Publications/WP/Issues/2016/12/30/Should-Banks-Be-Narrowed-15415 (accessed 1st April, 2024).