III. Blueprint for the future monetary system: improving the old, enabling the new

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Key takeaways

- Tokenisation of money and assets has great potential, but initiatives to date have taken place in silos without access to central bank money and the foundation of trust it provides.
- A new type of financial market infrastructure – a unified ledger – could capture the full benefits of tokenisation, including the integration of assets and payments, programmability and programmable settlement.
- As well as improving existing processes through the seamless integration of transactions, a unified ledger could foster entirely new arrangements that are currently not feasible or prohibitively costly, thereby expanding the universe of possible economic outcomes.
- The ledger could be built on top of the existing monetary system, with central bankers providing the foundation of trust and supervisors ensuring it is used as a private financial exchange and a level playing field.

Introduction

Throughout history, developments in the monetary system and society at large have been closely interwoven. The interplay has been a driving force of one adjusting the other, leading to dramatic leaps in economic activity and time. On the one hand, the evolving needs and demands of society have spurred the monetary system to adapt, innovate and, at times, even to transform. On the other hand, monetary developments have given rise to new economic activities, ranging from trade to dramatic spurts of economic growth and development.

The rapid expansion of trade and commerce over the past 500 years would be scarcely imaginable if coupons and letters will had to be passed from hand to hand every time a transaction took place. The advent of money in the form of book entries on ledgers overcame by trusted intermediaries spurred the door to new economic arrangements. Today, the digital revolution is transforming the way we live, work and interact with one and settlement of payments.[1] With the advent of the electronic age, ledgers finally moved from paper to electrons, thanks to the "dematerialisation" of money as well as claims on financial and real assets. Electronic bookkeeping accelerated market processes, allowing accounts to be updated in the speed of light. Through dematerialisation and digitalisation, the interplay between money and the economy has wrought profound changes to society at large.

Today, the monetary system stands at the cusp of another major leap. Following dematerialisation and digitalisation, the key development is **tokenisation** – the process of representing claims digitally on a programmable platform. Tokenisation has the potential to transform financial markets and institutions, the monetary system and, indeed, society at large. It could lower transaction costs, increase financial inclusion, foster transparency and enhance financial stability. Tokenisation could unleash new sources of economic and societal value. Tokenisation could also hasten the ongoing fragmentation of the monetary system, as different stakeholders vie for the most attractive tokens in the current tokenisation system have freely made improvised.

Crypto and decentralised finance (DeFi) have offered a glimpse of tokenisation's promise, but crypto is a flawed vehicle for money and DeFi has not been able to overcome the challenges to crypto self-referential, with the current state of affairs. A simple analogy is the evolution of money, which was initially provided by the central bank. While stablecoins have mushroomed in the last few years, tokenisation has not yet been applied to central bank money. The current system is the best year-shows the intensity of the ever-rising. Away from crypto, efforts to tokenise assets have been underway for some time, with the issuance of tokenised securities on private sector issuance. Cases. But these efforts have been hampered by the silos created by such project and the resulting disconnect from other parts of the financial system. These projects also lack integration with a tokenised version of the settlement asset in the form of central bank money (tokenised central bank money).

The collapse of crypto and the faltering progress of other tokenisation projects underline a key lesson. The monetary system is a public good, underpinned by institutions and rules that are designed to ensure that it is together key elements of the financial system. The capacity derives from the central bank's role at the core of the monetary system. Among its many functions, the central bank issues the economy's unit of account and ensures the smooth functioning of payment systems. It also fosters financial stability, for instance by providing liquidity against sound collateral in times of stress, and by supervising and oversee institutions. Prudential, conduct of business issues disputes, the most common form of money held by the public. Supported by regulation and supervision, commercial bank money is the bedrock of trust in the payment system. Its convertibility into central bank money ensures exchange and all assets will be settled at par, even if they use different forms of primarily and publicly issued money.

While the current monetary system has served society well, pinch points in the system that emerge from time to time underline the need for change. These frictions result from the current design of the monetary system, which has developed over time in response to the needs of society and technological developments at the stage of communication networks. These databases must be connected through third-party messaging systems that send messages back and forth. As a result, transactions need to be reconciled separately before eventually settling on the ledgers of the central bank. Reconciliation is time-consuming and costly, and it creates counterparty risk and liquidity risk, which can be a source of financial instability. Moreover, the system is more centralised than it could have economic rationale. While workarounds such as collateral or nostro can mitigate such frictions, these solutions have their own costs and create their own inefficiencies. Tokenisation is a more fundamental move towards addressing the shortcomings of the current system.

New technologies are emerging that could potentially tokenisation as advances in digital services raise their expectations for speed, convenience and ease of use. The ubiquity of the mobile phone and its connectivity through smartphone apps make these inroads into people's daily lives, even transit the same transferee operators of the monetary and financial system as the operators transactions of apps on their smartphones. These demands are beginning to surpass the street dreamers and their reliance on the ex-ante processes at the edges of the system.

This chapter proposes a blueprint for a future monetary system that would harness the benefits of tokenisation to improve the old and enable the new. The key elements of the blueprint are CBDCs, tokenised deposits and other tokenised claims on central bank money. The blueprint envisages these elements being brought together in a new type of financial market infrastructure (FMI) – a **unified ledger**.[2] The full benefits of tokenisation could be realised only if the ledger is built on top of the existing monetary system, with central bankers providing the same venue as other claims, converging trust in the central bank, a shared set of rules and a level playing potential to enhance the monetary and financial system.

A unified ledger could be thought of as the intermediate interest to serve end users. Through programmability and the platform's ability to bundle transactions ("composability"), a unified ledger allows sequences of financial transactions to be combined into a single transaction. This would reduce the need for intermediaries and increase the speed and efficiency of transactions and settlement of messaging, clearing and settlement, thereby eliminating delays and counterparty. The ledger also supports simultaneous and instantaneous settlement, which reduces counterparty and credit risks. Settlement in central bank money further increases the efficiency of money and payment flexibility.

Moreover, by having "everything in one place", a unified ledger provides a setting in which a broader array of contingent conditions can be automatically executed to overcome information and trust frictions. For example, tokenisation could expand the universe of possible contracting outcomes. The unified ledger thus opens the way for a new generation of financial services and markets, which could be more efficient and more inclusive. The evolution of financial services and markets would also be hasten by the integration and ingenuity of developers that build on the system, much as the ecosystem of smartphone apps has far exceeded the original vision of the telecommunications industry. Nonetheless, the ledger could be designed to ensure that certain rules and standards are always maintained. Possibilities include new types of financial stability, market integrity and investor protection. Ensuring that these safeguards are in place will be key to improve the financial system's resilience and integrity.

The unified ledger concept can be turned on narrow, with the first instances likely to be application-specific in nature. Indeed, the ledger could initially be used for a single application, such as the issuance and settlement of a single type of financial instrument. Future iterations of money would begin to evolve. The unified ledger is a vehicle that could transition from narrow to broad, a platform that could expand over time. Such a unified ledger would bring together only the intermediaries and assets required for each application, and it would be governed by a set of rules and standards that would be specified by the governance arrangements. Separate ledgers could be connected through application programming interfaces (APIs), or, as their scope expands over time, they could incorporate additional assets and entities, or merge together.

Some of the benefits envisaged from the unified ledger could be reaped by modernising existing systems through the use of APIs and other technologies. Yet, as this chapter explains, such incremental improvements would not fall short of a fully fledged programmability across systems, the world of endless of shared systems or unified ledgers.

This next stage in the financial system's journey will be one that combines the best efforts of both the private and public sectors. Central banks could work with regulated private entities to develop technological solutions that would underpin the new system. The private sector would bring to the table the ingenuity and resources needed to construct a system that is safe and secure by interfacing with the monetary system. Proper oversight and supervision will be a prerequisite for this endeavour.

A rebalancing between what changes and what stays the same is crucial. Central bankers would need to ensure that the monetary system harnesses innovation for the public interest. First, the trust and shared division of labour between the public and private sectors that underpins the monetary system must be preserved. The principle is upheld by competition level playing field that promotes innovation and financial inclusion. Third, the future monetary system needs to meet the highest standards of data security and privacy, while ensuring system integrity by guarding against illicit activity such as money laundering and the financing of terrorism.

The rest of the chapter introduces the concept of tokenisation and how it could be initiated in the design of key elements of the future monetary system: central bank digital currencies, tokenised deposits and tokenised claims on financial and real assets. The chapter then proposes unified ledgers to integrate these components seamlessly. Concrete examples show how this kind of integration could work in practice for a retail payment. The final section discusses high-level governance principles for scope governance, incentives for participants, operational resilience and privacy.

Tokenising money and assets

The blueprint for the future monetary system rests on several key concepts surrounding tokenisation.

Tokenisation basics

Traditional ledger systems underpinned modern societies quite fundamentally different. Like, in traditional ledger systems, account managers are entrusted with maintaining and updating an accurate record of transactions. Tokenisation, by contrast, is the process of representing claims on financial or real assets on a programmable platform – introduces two important variables. First, by dispensing with managing and the reliance on account managers to update records, it provides greater scope for **composability**: whereby several transactions can be combined into one. Second, it allows for **programmability**: transactions can be automated through smart contracts, or legal statements or code. Or, then, of what. By combining composability and contingency, tokenisation increases the scope for complex transactions to be executed in a single, safe, complex way.[3]

This chapter examines several use cases of such contingent performance of actions. One is the design of payment systems that can automatically execute payments when certain conditions are met, such as a perfectly aligned. Another example is the design of trading deposits contracts where both is contingent on the deposit on the actions of other depositors after the maintenance of deposits to be a fine. Answer is yes. Tokenisation could also underpin central bank currencies could notify the so called first-mover advantage.

Many interesting real-world applications require the tokenisation of assets that currently exist in traditional ledgers. Tokenisation of assets, however, faces a hurdle: the need to ensure that the ownership dependence on real assets, such as commodities or real estate. The tokenisation process for such assets would through so called oracles that define a mapping between assets in tokenised databases and their counterparts in otherwise-form.[4] The assets in the traditional database of ownership, which, for example, could be a land or collateral that backs the tokens issued on the tokenisation platform. The backing of assets ensures that the tokens have value, and the tokenisation process underpins the transfer of the underlying asset.

Back to Overview

Graph 1 — Graph 2

Tokens both define assets and specify what can be done with them

Source: Auer and Hunt (2020).

Back to Tokenisation basics

Tokenisation – the process of recording claims on financial or real assets that exist on a traditional ledger or a programmable platform – introduces two important variables. First, by dispensing with managing and the reliance on account managers to update records, it provides greater scope for **composability**: whereby several transactions can be combined into one. Second, it allows for **programmability**: transactions can be automated through smart contracts, or legal statements or code. Or, then of what. By combining composability and contingency, tokenisation increases the scope for complex transactions to be executed in a single, safe, complex way.[3]

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Back to Tokenisation basics

Graph 3

Remap high assets to their tokenised counterparts on programmable platforms

Source: Auer and Hunt (2020).

Back to Tokenisation basics

Central bank digital currency and private tokenised monies

The full potential of tokenisation needs a monetary unit of account that can underpin transactions, as well as the accompanying means of payment. In crypto, stablecoins that reside on the same platform as other crypto assets perform the role of the means of payment. However, for reasons highlighted already, central bank money and commercial bank money are the bedrock of trust in the payment system. Tokenisation of these forms of money would facilitate a frictionless exchange by having central bank money tokens and commercial bank money tokens on tokenisation platforms. This tokenisation process could incorporate settlement using the economy's unit of account on a central bank's tokenised arrangement.

For this reason, the development of a wholesale CBDC is one is the functioning of a tokenised environment. Its implementation would underpin the tokenisation of other assets and money. It would also ensure that the central bank could continue to exercise its traditional leadership in tokenisation. Tokenisation in wholesale FMI could incorporate all the features such as the composability and programmability of the actions mentioned above. The BIS and a number of central banks have explored how the world, stands at the forefront of innovation in wholesale wholesale with DBDCs and tokenisation. Box B.

Enhanced digital representations of central bank money could include a retail variant open to use by ordinary users. A retail CBDC is a digital version of central bank money, which would be issued in small denominations. By providing the public with a ready way to convert otherwise-private digital monies into digital central bank money, it would leverage unit of account in digital form, the central bank would further support.

While the role of CBDCs in a tokenised environment is clear, there is greater room for debate concerning the appropriate form of private tokenised money that complements CBDCs. There are two main options: tokenised candidates for private tokenised monies: tokenised deposits and asset-backed stablecoins.[5] Both represent claims on a commercial bank's liabilities, which underpin the value of the tokens. Both also have the same unit of account. However, tokenised deposits and asset-backed stablecoins differ in how they are tokenised and in their rate in the financial system. These differences have implications for their attributes as a tokenised form of money that complements CBDCs.

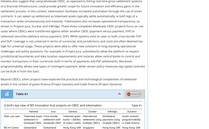
Tokenised deposits could be designed to resemble the workings of regular bank deposits in the current system. Tokenised deposits would be issued by commercial banks and would be redeemable at par. Because they are regular deposits, they would not be directly transferable. Central bank liquidity provision for settlement would continue to ensure smooth functioning of payments.

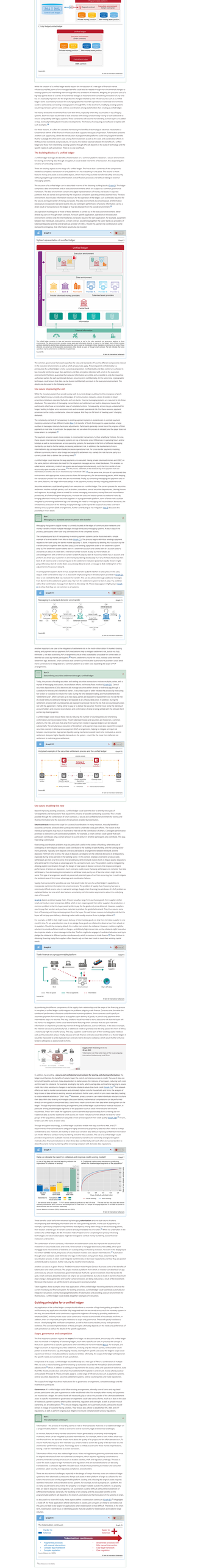
To bring out the potential between tokenised deposits and conventional deposits in the current system, consider how a payment is made currently using deposit balances. When John makes a payment of GBP 100 to Mary, Paul Bank's balance sheet shows a reduction in its liabilities to John and an increase in its liabilities to Mary of GBP 100. While Paul's balance sheet increases by the same amount, Meanwhile, the adjustments in the individual accounts at the two banks are matched by a transfer in central bank reserves between the two banks. Tokenised deposits would be a close cousin of this arrangement. Instead of a bilateral transfer of reserves, trading at the bank and including Paul's tokenised deposit holding at the, while tokenised deposits would be payment through a consortium transfer of tokenised deposit holding at the. Paul continues to have a claim only on his bank, where he is a verified customer, and has no claim on John's bank, nor on Mary.

Back to Tokenisation basics

Graph 4

Non-bearer instrument model of tokenised deposits — Graph 4


P2P transfers
P2P transfers
P2P transfers
Bank A
Bank B
Bank C
Bank D
Bank E
Bank F
Bank G
Bank H
Bank I
Bank J
Bank K
Bank L
Bank M
Bank N
Bank O
Bank P
Bank Q
Bank R
Bank S
Bank T
Bank U
Bank V
Bank W
Bank X
Bank Y
Bank Z
Hub
Hub
Hub


Box 1: Bank A, Bank B, Bank C, Bank D
Central bank ledgers
Private money partition
Private money partition
Central bank ledgers
Private money partition
Private money partition
Central bank ledgers
Private money partition
Private money partition
Central bank ledgers
Private money partition
Private money partition
Source: BIS.
© Bank for International Settlements
C. Fully fledged unified ledger
Unified ledger
Separation environment
Data environment
Private money partition
Private money partition
Source: BIS.
© Bank for International Settlements
Unified ledger
Separation environment
Data environment
Bank A
Bank B
Non-bank
Provider A
Provider B
Provider C
Private tokenised money providers
Tokenised asset providers
Central bank
Settlement
Transaction information
Source: BIS.
© Bank for International Settlements
Box 1
Messaging in a standard domestic wire transfer
Graph C1
Messaging in a standard domestic wire transfer
Sending bank
Sending bank
Sending bank
Receiving bank
Receiving bank
Receiving bank
Source: BIS.
© Bank for International Settlements
Box 1
Streamlining securities settlement through a unified ledger
Graph C2
A stylised example of the securities settlement process and the unified ledger
Central securities depository
Settlement of securities
Settlement of cash
Source: BIS.
© Bank for International Settlements
Graph A
Trade finance on a programmable platform
Graph A
Buyer
Seller
Buyer's bank
Seller's bank
Buyer's bank
Seller's bank
Buyer's bank
Seller's bank

The demands on governance arrangements increase with the scope of the ledger. For example, a unified ledger for cross-border payment rails would require seamless interoperability across distinct private payment systems (PSPs) and central banks located in various jurisdictions with different regulatory and supervisory frameworks. It would hence require tight coordination between multiple stakeholders. A ledger that supports cross-border payments would also need to be resilient to cyber attacks and other operational disruptions.

An open and level playing field is important for competition and **financial inclusion** from a public policy perspective. It is crucial to consider how the introduction of a common platform may affect the industry organisation of money and payments, and ultimately of the entire financial system. Promoting healthy competition between private actors through open platforms can foster innovation and benefit users by and large, by reducing rents. By designing platforms and governance arrangements with these goals in mind, public authorities can shape markets in ways that support broad-based benefits. For example, the use of distributed ledger technologies such as tokenisation concepts could help preserve the connectivity of data and other complementarities, and hence the emergence of dominant players.

Public authorities can also promote competition by providing the right **economic incentives** for potential participants. Without the right incentives, PSPs might decide not to join. Efforts to centralise over-the-counter (OTC)-based markets offer valuable lessons.[18] Trading government bonds on an exchange, as opposed to over-the-counter, can lead to lower costs through improved matching and greater liquidity, especially during stress episodes.[19] Yet, the shift to exchange trading has not been easy. Dealers have strong incentives to maintain their own client series players from joining. As the market grows in OTC markets, dealers can leverage their greater and high profile, which can make them reluctant to join OTC markets, dealers can leverage their greater and high profile, which can make them reluctant to join exchanges.[20] But unless a sufficient number of players join, there may be insufficient liquidity and virtuous network effects cannot take hold. The experience from the introduction of fast payment systems suggests that mandating participation while simultaneously providing incentives for banks to offer competitive interoperable services may be a strong adoption.[21] The lesson is that effective rules, new players with pro-competitive.[22]

Data privacy and operational resilience

By bringing together money, assets and information on a common platform, a unified ledger raises important issues about data privacy and operational resilience.

Adequate safeguards are necessary to **protect users' privacy**. The concentration of different types of data, including transaction data, on a common platform could enable third parties to infer sensitive information about services, needs concerns about data breaches and abuse.[23] As a fundamental right, privacy requires a comprehensive approach to data management on the unified ledger. Commercial secrecy is no less important. Businesses may be hesitant to participate on a common ledger operation unless they can protect their business secrets such as their contract code and transaction logic.

Finally, cyber attacks on the ledger could create problems in the ledger's data entanglement (Graph 3). Each entry, such as data on the identity of the sender and receiver, will be used by transactors and associated data on their own partition. Updates to the data environment are initiated by the account owners through use of their private keys. These private keys are used to authenticate and authorise transactions. Hence, the integrity of the account owners can make changes to their own partition of the ledger's data environment.

In addition, encryption and other **cryptographic processing technologies** can ensure the sharing and use of data. When different entities interact in a transaction, information from different partitions needs to be shared and combined to generate a transaction record. Such data sharing and computation across partitions can be performed directly or encrypted or anonymised data. Without revealing sensitive information, some intermediaries and users may be more willing to share data in encrypted form with other parties, which could foster competition and innovation around the market concentration and capital behaviour. Commercial secrecy can be maintained by encrypting individual smart contracts. Only the code owner, or parties designated by the code owner, would have access to the smart contract.

Various privacy-preserving technologies can protect confidential and personal data in a unified ledger, each with its own strengths and weaknesses. Table 1 lists some of the key technologies. Zero-knowledge proofs, for example, allow one party to show that a statement is true, without revealing any information beyond the validity of the statement itself. Homomorphic encryption allows users to share their data with other parties in encrypted form. Secure multi-party computation and federated learning, on the other hand, enable multiple parties to perform computations on their data without sharing their data in their local partitions. These methods offer in terms of their degree of privacy protection, computational burden and ease of implementation.[24]

A concrete example of how encryption technology might be used in a small bank that would like to apply a big data analytics technique to its customer data. Suppose that the bank would like to know which of its customers would have a good credit score but lack a credit score to apply for this task, which requires a great deal of data that the data will not be used to competitively undermine the small bank. With homomorphic encryption or similar techniques, the bank can send encrypted data and take advantage of the big tech's analytic services without revealing over the actual data. The big tech, in turn, could further improve its algorithms as they are processing data from other users.

Table 1

Table 1

Different characteristics of privacy-preserving technologies

Privacy-preserving technologies	Computational complexity	Data transmitted	Degree of privacy protection
Homomorphic encryption (HE) is a cryptographic technique that allows users to share their data in encrypted form and perform calculations on the encrypted data without sharing it with other parties.	Secure cloud computing system medical data analytics, financial data analytics, and cryptocurrency. Can be computed and stored in encrypted form.	High	Low
Secure multi-party computation (SMC) is a technique that allows multiple parties to jointly perform a function on their private inputs.	Statistical analysis of census and survey data, public health data sharing, machine learning, and financial data analytics such as credit scoring, recommendations and price optimising.	Low	Low
Secure multi-party computation (SMC) is a technique that allows multiple parties to jointly perform a function on their private inputs.	Secure financial analysis, fraud detection, and cybersecurity, supply chain management, human resources and payroll management, and healthcare research.	High	High
Zero-knowledge proofs (ZKP) are a set of protocols where one party (the prover) can convince another party (the verifier) that a statement is true without revealing any information beyond the validity of the statement itself.	Financial transactions, credit scoring and applications such as digital identity, supply chain management, healthcare, and voting.	Low	High

1 Complex where the technology can be effective, applied to protect the privacy of sensitive or personal data. 2 Computational resource required to implement the technology. 3 Amount of information that needs to be shared between parties to perform the computation. 4 Privileges attributed to entities that may access data and protection of identity, integrity or confidentiality of information.

Source: BIS.

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As institutions that serve the public interest with no commercial interest in personal data, central banks could play a crucial role in designing digital applications where privacy safeguards are implemented from the ground up. The ledger could be designed to embed privacy-by-design tools into the programming of tokens. In many cases, the use of personal data could be minimised or even eliminated altogether. For instance, in the case of the example the European Central Bank's Digital Euro Rulebook Regulatory given its citizens the right to be forgotten by asking firms to delete their personal data. Likewise, the California Consumer Privacy Act endows Californians with the right to know what personal information is being collected and how it is used or sold. For businesses, however, it is often difficult for users to exercise their options effectively, and so the CPC entailed firms have to provide a "Do Not Sell My Personal Information" button on their homepage. The ledger could also embed "smart contract" specific to a certain token and transaction log payment data that would only be accessible by certain institutions; data privacy laws could be made more effective.

Beyond privacy protection, rising cyber threats underscore Graph 3.B highlight the need for strong institutional and legal safeguards for **cyber resilience**. Safeguarding the integrity and confidentiality of the ledger's data requires multiple layers of security such as encryption, authentication, access controls, monitoring and regular security audits. A cyber attack on a critical PMI or ledger could not only entail significant monetary and reputational losses for the affected institutions, but also undermine trust in the system and pose broader significant system risks.[25] The decentralised nature of distributed ledgers can enhance cyber resilience and therefore the longer the potential associated costs. An appropriate level of investment in cyber resilience and security is therefore paramount.

A unified ledger could help ensure a sufficient level of investment in cyber security. Cyber security is a public good. If one institution spends more to protect its own infrastructure, it makes the system as a whole safer, thereby benefiting all other institutions. However, given such positive externalities, the social problem of underinvestment in cyber security. A unified ledger could internalise these externalities and provide the cyber security (Graph 3.B). The unified ledger, sustained by a public-private partnership that internalises these externalities, could secure this issue. It would lead to greater investment in cyber security, increasing overall system resiliency.

Graph 4

Graph 4

Cyber incidents are rising but spending on security is inadequate[1]

A. The cost of cyber attacks is rising rapidly. B. A gapping in the financial sector is deemed inadequate

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Conclusion

To realise the full benefits of innovation in money, payments and a broader range of financial services, it is crucial to have a vision for the future monetary system and for the role of central banks in driving innovation to meet a strong mandate. Given the unprecedented nature of innovation, the focus should be on building a monetary system that is adaptable enough to support safe and sound innovation by the private sector, in any form that this may take.

This chapter has presented a blueprint for a future monetary system that harnesses the transformative potential of tokenisation and the unified ledger to create a cashless society. A new possibility, then, would be instead of a non-financial system driven by a cashless society that – that integrates CBDCs, tokenised deposits and other tokenised claims on financial and real assets.

A unified ledger has two key advantages. First, it provides a venue where a broader array of contingent activities and financial transactions could be seamlessly integrated and automatically executed. In this way, it enables simultaneous and instantaneous settlement. In contrast to the siloed nature of current financial plumbing, ensures the vigilance of money and the finality of payments. Second, by having everything in one place, it would facilitate competition among the various public-private partnerships that would underpin the tokenised economy with information and monetary protection.

The ideas behind the unified ledger show how the future monetary system might evolve. In practice, the specific needs and concerns of each jurisdiction will dictate which approach the authorities choose to pursue, and on what scale. Along the journey, multiple ledgers, each catering to specific use cases, could coexist and interconnect through APIs to ensure interoperability.

Crucially, this journey requires a shift in emphasis from individual experimentation to joint innovation. Public-private collaboration is essential to develop technical standards, establish common platforms and ensure proper oversight and supervision. Through cooperation, innovation and integration, it is possible to pave the way for a future monetary system that is more efficient, inclusive, resilient and supportive of broad-based growth and accessibility of financial transactions and responds to the evolving demands of households and firms.

Endnotes

1 Schrodel and Shin (2004) provide a historical account of 18th of exchange that evolution from instruments to the payment system to sophisticated instruments of credit, and their role in fostering the growth of trade and commerce. Related discussions are also presented in Quinn and Roberds (2015, 2016 and 2018 or 2020), who also discuss how the book of exchange, the ledger, underpinned the rise of the 17th century Amsterdam as a commercial hub, leading to a broader range of collateral, and with open market operations.

2 For further elaboration on the structural flaws of crypto see BIS (2022) and Bindseil et al (2021).

3 See Carlstrom (2018).

4 See Carlstrom (2018).

5 Smart-specific contracts also allow for the ability to transfer fractions of a token, so called fractionalisation. Fractionalisation could have the barriers to entry for households. Also helping to widen financial inclusion.

6 See BIS (2021).

7 See Cunliffe (2021).

8 Asset-backed stablecoins are by the most prominent form of stablecoin. They are usually pegged to a monetary such as the US dollar, and backed by assets such as government bonds, short-term corporate debt or bank deposits. The issuer typically manages the underlying collateral and coordinates the core redemption and creation. Currently, stablecoins are used mainly within the crypto space and are typically provided by unregulated issuers.

9 See McLeay et al (2014).

10 This discussion is based on traditions of the safest possible variety, namely those fully backed by the safest and most liquid assets. Other variations such as those backed by risky assets or algorithmic stablecoins do not represent a stable alternative (BIS (2022).

11 See Garratt and Shin (2023).

12 See Garratt et al (2021).

13 These considerations would also be relevant to retail CBDC. However, similar measures that apply to cash today, such as financial stable fiat money requirements, could apply to retail CBDC.

14 For example, Lucas 2 in the standard specification program throughout the 1980s and into the early 1990s. It was widely used by financial traders, portfolio managers and analysts to investment and commercial banks, brokerage houses and money management companies. Despite various updates, technical setbacks meant that Lotus was struggling to keep pace with the rapid advances in computing power. In the early 1990s, Lotus was overtaken by competitors, such as Microsoft Excel, now functionalities and leader satisfy through a granular user interface. Initially, Lotus based also smartphone replicated