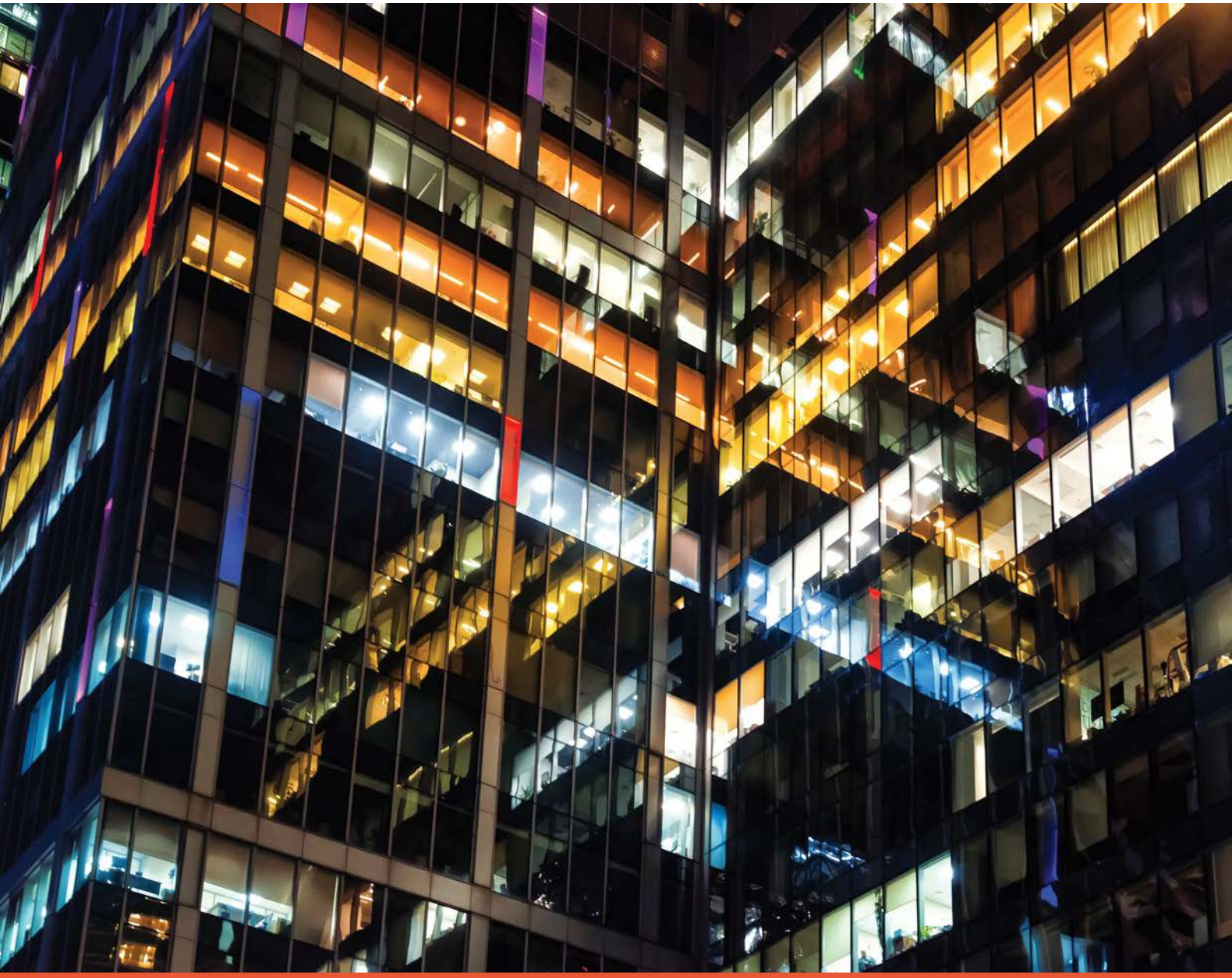

Central Bank Digital Currency

PwC Overview

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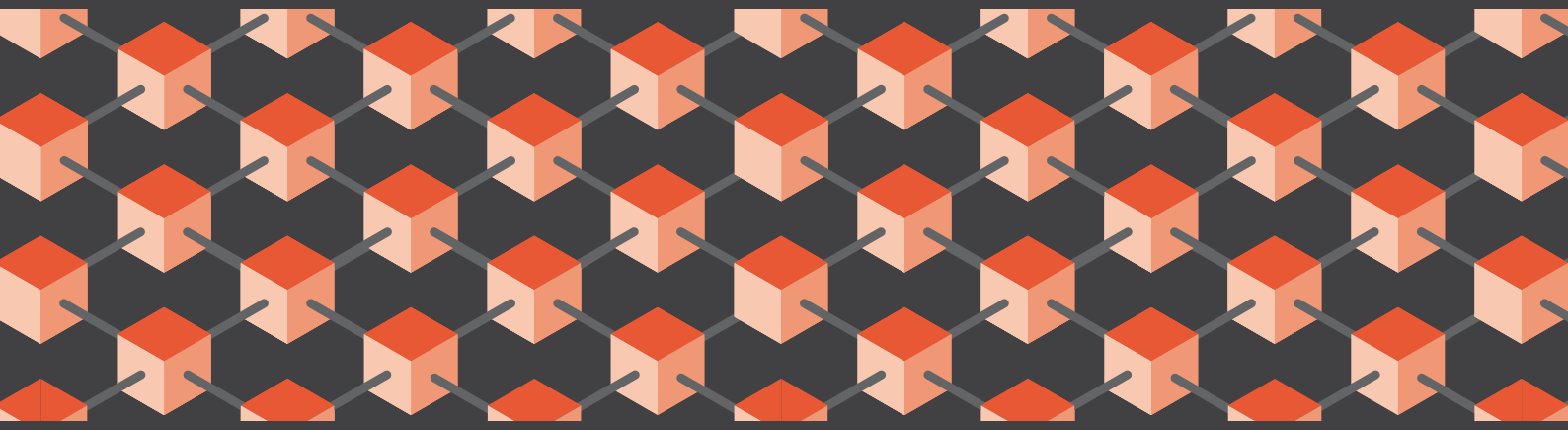


1. **Introduction**

In the last decade, the advent of new technologies and information systems has strongly shaken the banking and financial ecosystem. Our life and our payment habits have radically changed, and a new world of services and financial innovations gave birth to an unprecedented digital revolution.

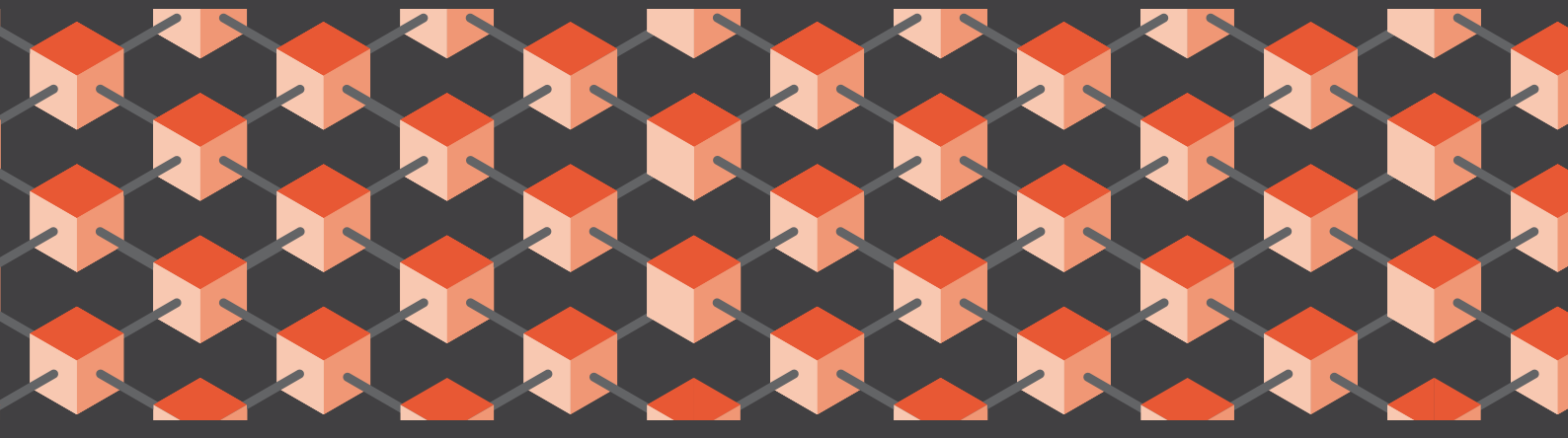
Now a **new technological era is taking place**, enabling the possibility to reduce the gap between the physical and digital world, thanks to the possibilities introduced by tokenization and programmability. Therefore, also the forms of money already change skin, as can happen with cash banknotes that can change and be redeemed in **Central Bank Digital Currency**.

Governments and private bodies have been greatly interested in the token economy, in particular the one involving Stablecoins and Central Bank Digital Currencies, experimenting different use cases for the banking and financial world. This wave of innovation in the digital currency is still gaining momentum.

The question to ask is: what will the **role of Central Banks** be in this new context rich of innovation and to what extent will its fundamental values be put into practice?

The Central Bank Digital Currency is relatively a new concept, but the exploratory and experimental phase has already been forwarded, as well as the interest from the Banks that seek to understand how Blockchain technology can support them in creating a new form of money usable in both Retail and Wholesale cases.

As **PwC** we are investigating with great interest the evolution of this innovation, proposing ourselves as the **ideal technological partner** to provide a DLT-based solution for CBDCs, both from a functional and technical side.



2. Central Bank Digital Currency

The concept

2.1 From Cryptocurrencies to CBDC

Just a little over ten years ago, a very innovative and surely disruptive concept was born: **Bitcoin**. The latter aims at creating a system where value can be transferred without a central entity regulating the system mechanism. Bitcoin is a peer-to-peer digital currency system: it is able to work without trusted intermediary, relying on a protocol shared among all of the network participants. Bitcoin only preceded the establishment of an innovative ecosystem with new players and new business logics, i.e. the world of Cryptocurrencies.

Blockchain, the technology "under-the-hood" of Bitcoin, has evolved over time and and has radically changed the relationship between different users who do not trust each other.

These new features have made it possible to enable functions such as the tokenization of physical or monetary assets, by moving part of the physical economy to the Blockchain itself.

The concept of **Stablecoins** first arose from the root of these new ideas. Stablecoins are privately issued cryptocurrencies, generally collateralized with Fiat Money (EUR, USD), physical goods or financial assets. As their name suggests, the value of such cryptocurrencies is kept "stable" by the peg to the underlying collateralized assets. Tech giants were among the first players to express interest in the concept of Stablecoin, in particular about the creation of a private currency that could have a global purpose. Stablecoins market has grown significantly in the last year. Tether, the most relevant Stablecoin backed by dollar, now capitalizes more than 13 bln/$[1].

The idea of creation of multiple private currencies may put the actual world's monetary and financial dynamics at risk, by stripping Governments and Central Banks of their institutional role. Hence, the significant need for Central Banks to **explore** and **identify** opportunities within the innovative forge driven by the possibilities enabled by Blockchain technology.

At the end of this journey that lasted almost a decade, **the concept of Central Bank Digital Currency arose**, a new digital form of money issued by Central Banks, different from balances in traditional reserve accounts or settlement accounts. CBDCs are a response to decentralized phenomena such as cryptocurrencies, private tokens and declining of cash use addressing the need for regulatory oversight and financial stability while fostering innovation.

Figure 1: The path to Central Bank Digital Currency

From Crypto-assets…
First Digital Assets based on Blockchain technology **with their own monetary system**.

…to Stablecoins…
Stablecoins, or privately issued cryptocurrencies **pegged to a stable asset**.

…ending with CBDC
Central Bank Digital Currencies issued on Blockchain technology and **backed by Fiat Money**.

2.2 Tokenization as enabling factor

As defined in literature, **Tokenization** is the process of digitally representing an existing real asset on a distributed ledger[2]. The Financial Stability Board defines tokenization as the representation of traditional assets – e.g. financial instruments, a basket of collateral or real assets – on DLT[3]. Asset tokenization involves the representation of pre-existing real assets on the ledger by linking or embedding by convention the economic value and rights derived from these assets into digital tokens created on the Blockchain. The scenario that would arise is often indicated by the term “Tokenomics”, to indicate the possibility for companies to develop projects based on the exchange and enhancement of physical or immaterial tokens.

The Digital Assets traded on the network can be representative of goods of different nature, from a physical object to intangible assets, such as money, patents, copyrights, etc.

Tokenization can potentially leverage **the transformation of all circulating money in CBDC**, enabling the implementation of an infrastructure where the ownership of the digital token is certain, the digital token cannot be falsified and cannot be subject to double-spending. This differs from account-based electronic money, which uses a database-based reconciliation system to adjust entries in a ledger.

The journey to Central Bank Digital Currency has been long, from Bitcoin, to ICOs up to phenomena such as Cryptokitties. **Tokenization is here to stay**, and thanks to the advent of CBDCs, it may confirm itself as a disruptive phenomenon that is here to stay for the upcoming years.

1. Data Source: https://coinmarketcap.com/ (04/09/2020)
2. OECD,https://www.oecd.org/finance/The-Tokenisation-of-Assets-and-Potential-Implications-for-Financial-Markets.pdf
3. FSB,https://www.fsb.org/2019/06/decentralised-financial-technologies-report-on-financial-stability-regulatory-and-governance-implications/

2.3 Consumer needs and design choices

The design choices for a CBDC depend strongly on the real needs and requirements of consumers, and this is especially true in regards of the Retail sector. It's possible to define **four different dimensions** for a CBDC that must be taken under consideration in order to satisfy market needs this is especially true applied to the Retail sector. So, it is possible to define four different dimensions for a CBDC that must be weighed based on market needs:

- **Efficiency:** efficiency is closely linked to the convenience of the payment system and the similarity to cash-like payments (peer-to-peer payments). Hence the priority decision is to outline the infrastructure and roles for the Central Bank and the other financial intermediaries involved (e.g. Commercial Banks, PSP, etc.). The most relevant choice is to outline the operational role of Central Bank and Commercial Banks and to weigh the collaboration with the private sector to guarantee users an efficient payment service;

- **Accessibility:** from this first dimension originates the decision to create an account-based or token-based infrastructure, two different approaches that will be explained in depth in the following paragraphs. The design choice must be based primarily on the accessibility of the system so that it will be developed as inclusive as possible and, on any configurations, able to protect users' privacy, just as in today's cash transactions. The two possible accessibility models must be explored deeply, in order to understand which of the two fits best the optimal requirements set for the development of the CBDC;

- **Resiliency:** the resilience and robustness of network operations is a key dimension that must be taken in account for the creation of a CBDC. It must be decided whether to base the CBDC on traditional banking infrastructures or on Distributed Ledger Technology. Such choice deeply influences the structure and governance management of the infrastructure, which could either be centralized or decentralized;

- **Interoperability:** such dimension must be taken under consideration in order to guarantee the possibility of interaction between different CBDC systems, therefore it impacts a higher-level layer of decision for the CBDC design.

2.4 CBDC Value Case: Wholesale, Retail and Cross-border Payments

CBDCs can expand the functionalities of existing currency, making several payments use cases more efficient and working as a possible digital substitute for cash money. The degree to which CBDC can in fact offer these benefits will largely depend on its design.

CBDCs could improve **trust**, **efficiency and payment functionality** among different use cases and players, such as:

- **Retail:** among the multitude of options payment already in use worldwide for the retail market (e.g. cash payment, credit, debit, etc.), CBDCs would offer a new choice for digital transactions, instant peer-to-peer payments and physical transactions. They could also potentially reduce costs e diversify payment channels;

- **Wholesale:** today, bulk payments are based on national payment systems, and transactions are typically conducted through compensation interbank using Central Bank's currency with real time gross settlement systems (RTGS). The CBDC concept could facilitate a broader and diversified access of institutions to high value payments and could leverage the birth of new wholesale financial infrastructure;

- **Cross-border:** once a CBDC's configuration and access mode are made clear, the question arises whether it can be used only domestically or also elsewhere. CBDCs could establish more direct monetary relationships at international level, reduce risk, improve the inefficiencies caused by today's international banking model, while strengthening competition in the international accounts, and fostering the integration and the inclusiveness of financial markets.

CBDCs can both reshape the **Wholesale Payments System**, still based on existing financial infrastructures, **Retail Payments System**, enabling new features and functionalities for end users, and **Cross-border System**, solving most of the current issues.

2.5 Private Sector Involvement

One of the possible choices for CBDC design foresees the role of the Bank as the entity that provides all CBDC related services. It should provide the entire core technology that keeps track of accounts and CBDC transactions. Furthermore, the Bank should also provide all retail services, including users onboarding through KYC procedures, user interface and funds custody, so that people can pay and transfer with CBDC in stores and online.

Such a model, however, could potentially heavily load the operational role of the Central Bank which becomes responsible for all the processes and risks, also damaging the development of the CBDC in an environment of competition and open innovation driven by private players.

For these reasons there are **several advantages in favor of private sector involvement** within a CBDC system:

- It allows a **broader range of service providers**. The presence of mature providers of financial services (e.g. major retail banks) would provide credibility and would ease their existing customers to use CBDC. In addition, the opportunity for newer or smaller service providers to participate could support innovation and competition, while improving the service available to the consumer and resilience of the whole system;
- The presence of a relatively larger number of service providers may improve the **resilience of the ecosystem** and reduces the dependence on a single key provider;
- Many providers within the private sector already have **great experience on customer service** for consumers and businesses, being also able to interact with them in a direct way.

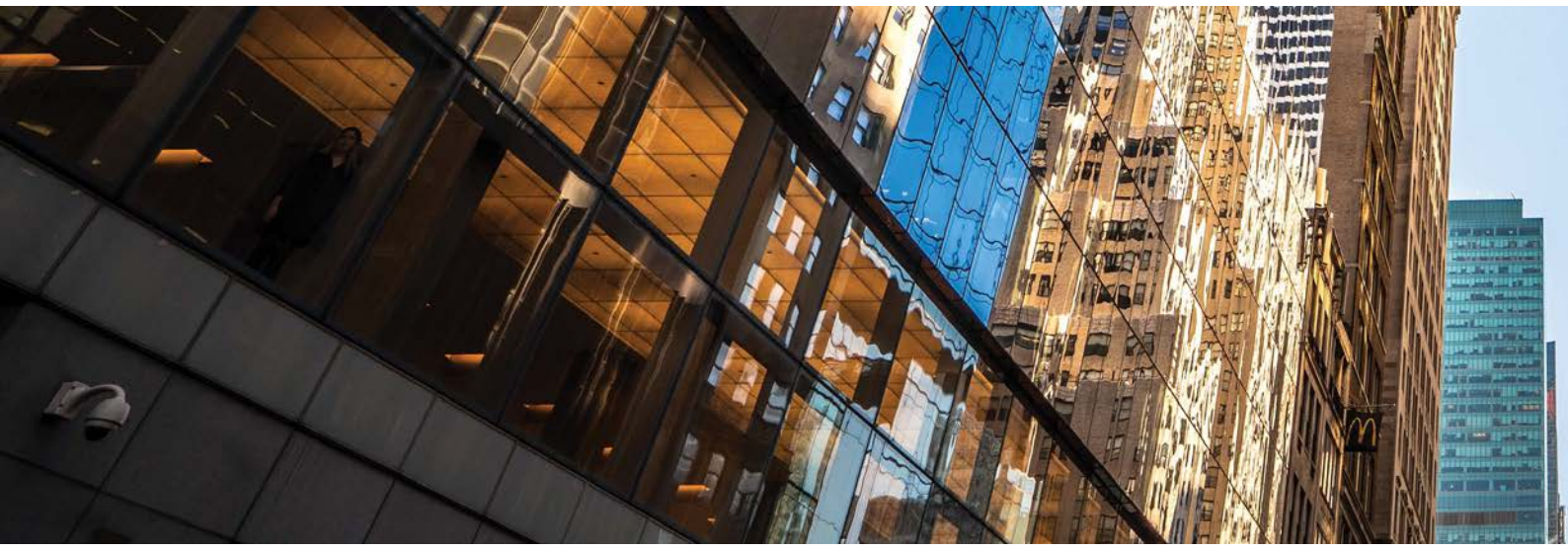
2.6 Coexistence with Private Stablecoins

Stablecoins certainly temporally preceded the rise of the CBDC, arousing great interest from the public and considerable doubts from Governments and Central Banks. For example, that's the case of the project of a private Stablecoin for a global purpose developed by Facebook, Libra Coin, that has in fact significantly reshaped its economic and architectural model in response to pressure from Governments and in particular from the SEC (U.S. Securities and Exchange Commission) in the United States.

In any case, the creation of a CBDC should assess in advance whether the potential benefits could alternatively be achieved by allowing the development of new innovative agreements in the private sector involving the world of Stablecoins.

This is a possibility, but there are different **potential downsides** that need to be weighed and valued:

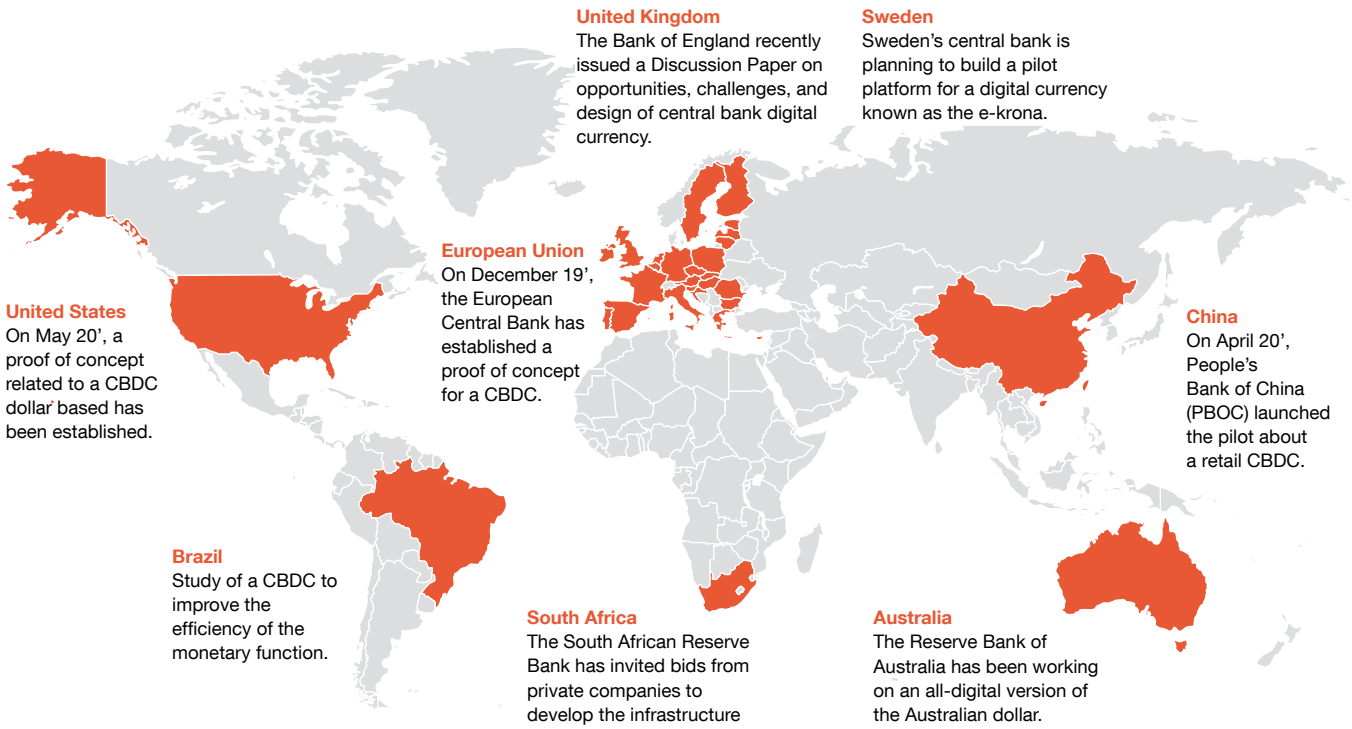
- Most Stablecoins are minted and **governed by private entities** that back their value with Fiat Money or other types of assets, held as collateral. Since there may be no complete guarantee on the reserves held by the private entity, liquidity risks may arise if 100% backing is not respected;
- There would be a **need to regulate Stablecoins**, which is not straightforward as it is not clear where such instruments could be positioned. In fact, while the CBDCs are issued by institutional players and therefore regulation occurs in advance, Stablecoins are managed by private entities that may not always move in accordance with the current regulatory framework;
- The **coexistence** framework between Stablecoins and CBDCs **is still unclear**, as well as the relationships and interconnections between these two types of assets, which are not defined;
- For government and financial institutions there is **the intrinsic risk** linked to the use of the Stablecoins instead of the official currencies.



2.7 How Central Banks are moving on

According to the Bank of International Settlements (BIS), **over 70% of Central Banks** are interested in the possibility of issuing a virtual currency. The most relevant global cases are described in the **map below**:

Figure 2: How Central Banks are moving on



United Kingdom
The Bank of England recently issued a Discussion Paper on opportunities, challenges, and design of central bank digital currency.

Sweden
Sweden's central bank is planning to build a pilot platform for a digital currency known as the e-krona.

European Union
On December 19', the European Central Bank has established a proof of concept for a CBDC.

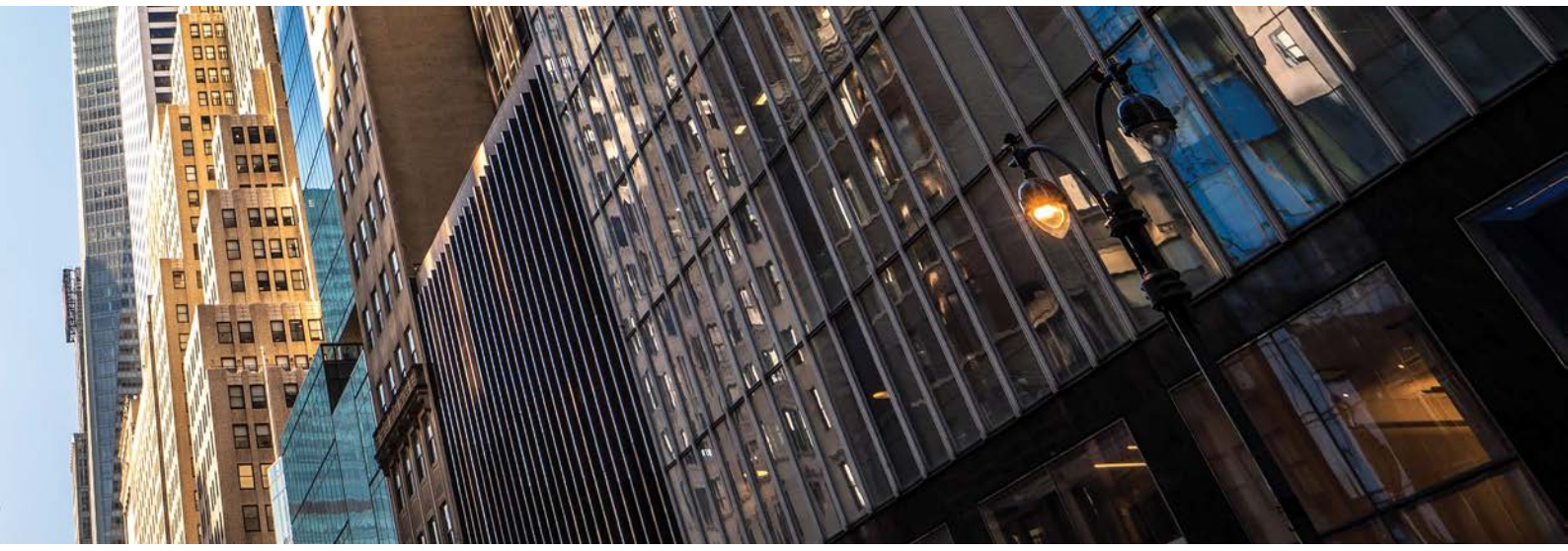
United States
On May 20', a proof of concept related to a CBDC dollar based has been established.

China
On April 20', People's Bank of China (PBOC) launched the pilot about a retail CBDC.

Brazil
Study of a CBDC to improve the efficiency of the monetary function.

South Africa
The South African Reserve Bank has invited bids from private companies to develop the infrastructure necessary for a CBDC.

Australia
The Reserve Bank of Australia has been working on an all-digital version of the Australian dollar.



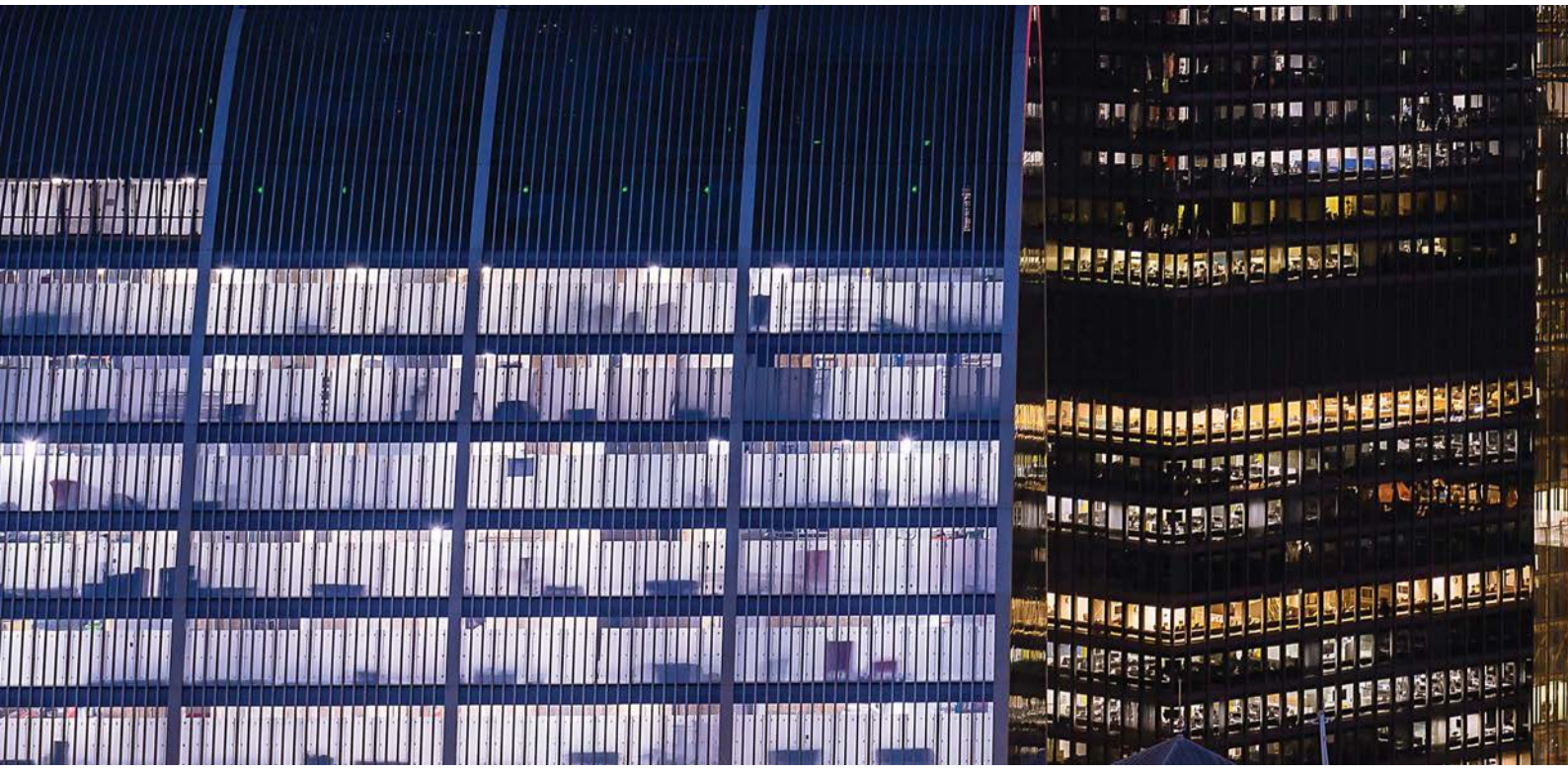
3. Economic design and impacts on monetary and financial stability

3.1 The impact on monetary and financial stability objectives

CBDCs constitute a **new form of money**, which would allow individuals and businesses to make electronic payments using **virtual currency** minted by a **Central Bank**. This paradigm shift could potentially affect the structure of the banking system and the ways through which the Bank achieves its primary objectives to maintain monetary and financial stability.

The introduction of CBDCs could support a **more effective transmission of monetary policy** through certain channels, but these benefits should be weighed against the **risks**, such as the potential effects of **banking disintermediation on the credit supply**. If families and businesses held and used CBDCs only for making payments, they would have to convert some of their funds from bank deposits into Central Bank money in the form of CBDC, so some disintermediation would be inevitable. But a much larger or faster transition from deposits to CBDC could have significant implications for the amount and the cost of credit that the banking sector provides to the economy and on how the Bank achieves its goals.

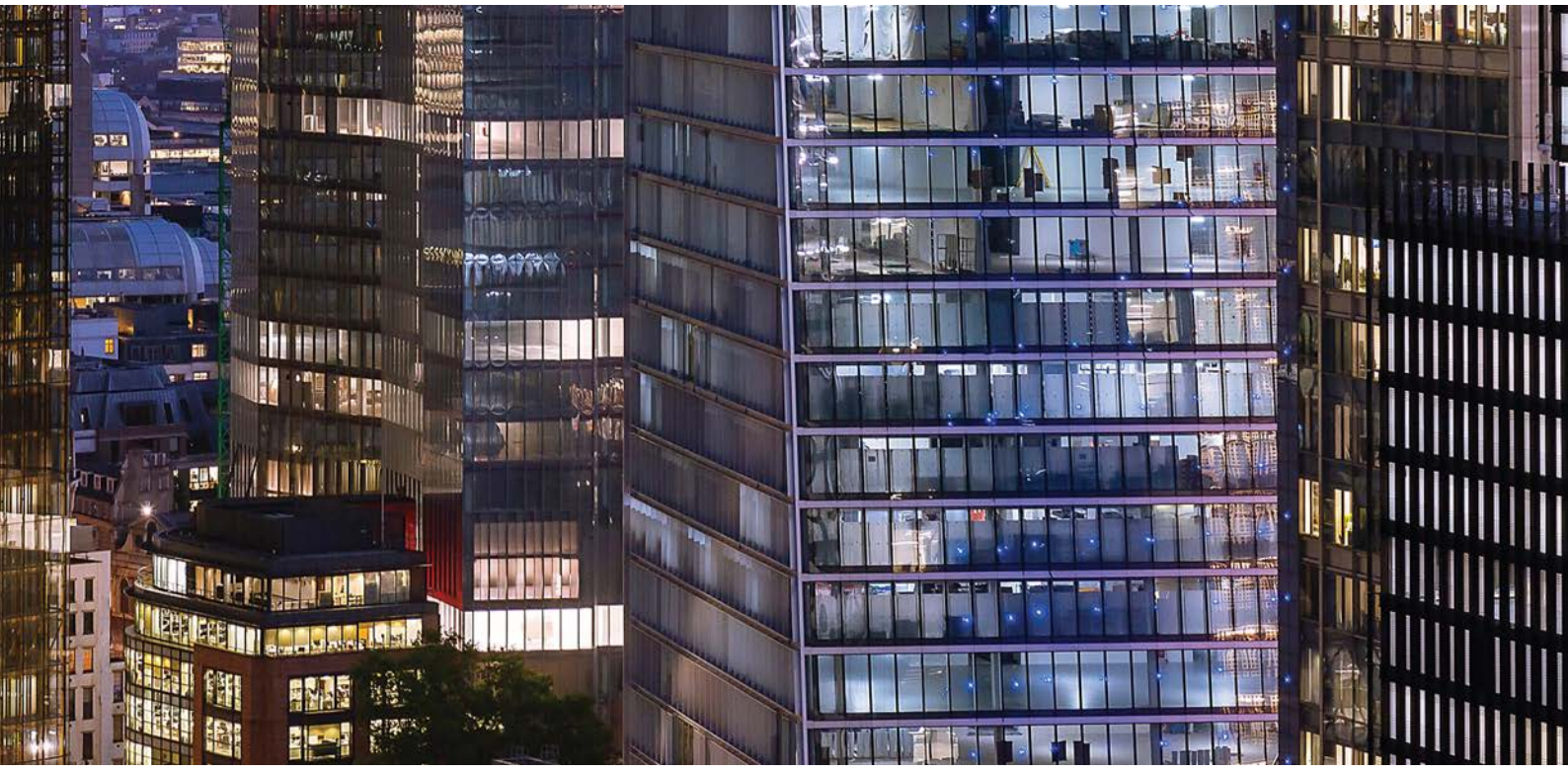
For example, the introduction of CBDCs could force banks to react by raising interest rates on customers deposits, now sometimes even negative. In fact, although the potential configurations of CBDCs represent commercial banks as distribution channels that interface directly with users, the possibility of implementing usual banking models which, for example, are based on fractional reserve and which until today have been the banking system pillars, may no longer be allowed. From this perspective, the biggest risk is that the contraction of banks' balance sheets could affect the availability of credit, with possible repercussions on financial stability. For all these reasons it is therefore important to evaluate all the opportunities and risks and to use the macroeconomic tools available to offset the potential systemic risks that could occur.



3.2 Economic Design Choices

To counterbalance and limit as much as possible the potential risks discussed in the previous paragraph, there will be a **few factors** which determine the extent of these risks, as follows:

- **Whether the CBDC is interest-bearing:** A non-interest bearing CBDC is less attractive for consumers deposits and thus it may be less prone to become mass adopted. An unremunerated CBDC will have less effect on the disintermediation of the banking system, as households and businesses will have less incentive to shift their value from bank deposits to the CBDC. Meanwhile a remunerated CBDC could provide Central Banks with new instruments that could lead to faster and fuller transmission of monetary policy to deposit rates. On the other hand, remuneration may increase the potential for greater disintermediation of the banking system, by increasing the incentive for households and businesses to hold larger amounts of their capital into CBDC;
- **The value of CBDC to insured depositors:** Deposits of less than €100,000 are protected by the FITD (in Italy). Also, across Europe, consumer deposits are covered by specific insurance policies. However, some savers below such insurance thresholds may still be concerned about delays in getting access to their savings in the event of a bank failure or may not be fully aware (or trusting) of the protection offered by the FCCS. A remunerated CBDC, in completely removing any credit risk, could offer an attractive alternative saving vehicle for such depositors;
- **The convenience of CBDC for making transactions:** a large part of the stock of deposits held with commercial banks are what could be called 'transactions' balances, that is held to allow households and businesses to make transactions. For these accounts, which will tend to have higher turnover of funds but lower average balances, the ease of doing transactions could actually be more important than the interest rate.



4. Technological Design

Technology

4.1 CBDC Architectures

The definition of the **right architecture** at the basis of the CBDC strongly depends on the choice of the operational role that must be assumed by the Central Bank and by the other financial intermediaries involved.

What differentiate the possible architectures mainly regard the structure of the claims and records held by the Central Bank and the operational responsibilities of the players within the network. There are **three different types of architecture**, as outlined in the figure below:

Each of the architectures can easily implement both accessibility, account-based and token-based mechanisms. Although the choice of technological architecture mostly influences the operational roles of the actors that allow network operations and guarantee infrastructure resilience, households and businesses that adopt CBDC are also heavily impacted by these choices both on the functional side and user utility features.

1.

The model based on **Direct Issuance** is the simplest and most centralized one, as it may potentially take out all the other private institutions involved. In this model, it is the Central Bank that keeps track of all financial statements and all retail transactions and issues the CBDC directly to end users. On the other hand, private institutions are expected to participate in the other two architectural models, but their roles differ mainly in the fact that in the Indirect Issuance model the claim is against the intermediary and not against the Central Bank as in the Hybrid model. The Direct Model could seem like the most appealing at first sight because it is simpler to implement, as it eliminates dependency on intermediaries, but it has issues which are not easy to solve and this may pose threats in terms of reliability, speed and efficiency of the payment system. Firstly, the private sector might have better capabilities to build and operate technical capacity at this scale, as seen in today's credit card networks. Furthermore, retail KYC and customer due diligence could be very difficult to carry out by the Central Bank since it would require a massive expansion of operations and it would be difficult to provide this kind of services. One compromise to the model outlined above could be the Direct Issuance model architecture, but with KYC and customer due diligence that could be handled by the private sector. This way, the Central Bank can focus on executing simple transactions and, when required, control the issuing of more of the currency, while the burden of providing complex functionalities is left to private institutions. This model could be better than the basic Direct Model, but in any case, the Central Bank would be the only institution handling payment services;

Figure 3: Direct Issuance Architecture

Direct issuance
(claim against the central bank, just as banknotes do)

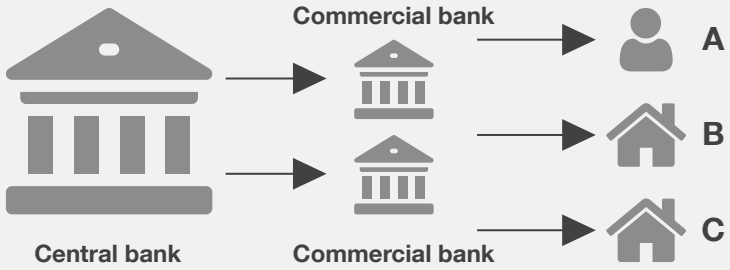
- Central bank issues CBDC to public.
- Central bank onboard (KYC).
- Central bank handles retail payments.
- No anonymity

2.

The **Two-tiered Issuance** model is the one that best reflects the state of the current financial system, where private intermediaries are a complete part of the system. First, the great advantage of this model is that all interfacing operations with retail consumers are not the responsibility of the Central Bank. The great weakness lies in the fact that the CBDC would no longer be a claim towards the Central Bank, but towards the Private Institution. This means that the model would not be able to solve current trust issues towards private institutions, while offering financial services to retail. So, in conditions of financial stress or insolvency by the Private Sector, the Central Bank could not in the first instance honor the claims of consumers, because it does not own them. For this reason, the Indirect Issuance model poses regulatory problems and should provide for insurance policies towards deposits;

Figure 4: Two-tiered Architecture

Two-tiered issuance
(claim against the intermediary, just as digital payments do)



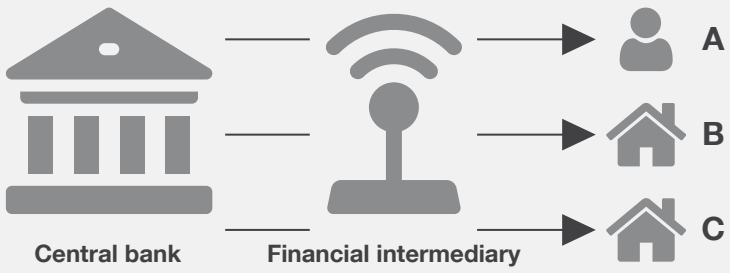
- Central bank issues CBDC to Commercial Banks.
- Commercial banks onboard (KYC) and handle retail payments.
- Central bank handles wholesale payments.
- Possible privacy for retail transactions.

3.

The **Hybrid model** combines, as the name suggests, the key elements of the previously presented models. In fact, in this model the claim remains against the Central Bank, but there is the participation of Private Institutions to support system operations. The key element is that the claims are kept by the Central Bank separately from the retail register of the Payment Providers. In this way, if the private institution were to fail, the system would guarantee the portability of the digital assets and the Central Bank would be able to manage the transfer of the customer's relationship to a healthy Provider that allows him to operate again. It is therefore necessary that the Central Bank is able to restore the retail balance, keeping an updated copy of all the retail balance. The Hybrid model may be able to guarantee greater resilience compared to the Indirect model, while benefiting from the participation of the Private Institutions which make network's operations more efficient and discharge the responsibilities of the Central Bank to interface with retail.

Figure 5: Hybrid Architecture

Hybrid CBDC



- CBDC is a claim against Central bank.
- Intermediary onboard (KYC) and handle retail payments.
- Central bank periodically records retail balance.
- Possible privacy for retail transactions.

4.2 The right infrastructure: legacy technology or DLT-based?

The CBDC concept can undoubtedly also be deployed on conventional centralized technological infrastructures, but **DLT's** individual component innovations may be useful and an impressive technological infrastructure such as that underlying the CBDC should have different characteristics compared to the usual financial infrastructures.

The main distribution and decentralization pillars common to all **DLTs can significantly improve system's resilience**, a**ccessibility and service continuity**, but at the same time the use of DLT poses important challenges in terms of scalability, privacy and security. Furthermore, the choice of infrastructure must also be weighed on the basis of the architectural models explained in the previous paragraph. Indeed, such a choice places a different workload on the system that the Central Bank must build and needs to keep running.

The **main difference** between an approach based on conventional technologies or on DLT **lies in the way of storage**, **updating and sharing of data**. In the conventional approach, data storage and sharing are centralized and based on physical nodes held only by the network owner, while data updating doesn't require distributed consensus, exposing the infrastructure to systemic risks, such as those connected to the Single point of Failure risk. On the other hand, DLTs enable decentralized infrastructure governance by revolutionizing the dynamics of data management and network operations. In fact, the nature of DLTs is to be decentralized and distributed, in such a way that data storage takes place on different nodes dislocated logically and geographically, while the updating and data processes are based on algorithms that make it possible to achieve the consensus between all the nodes that make up the network. This consensus system makes the network much more resilient and robust, but at the same time it affects the throughput and the scalability of the system, even though within permissioned environments these issues have already been addressed.

Another key element of the DLTs is the **use of the Cryptography**, in order to increase security and which can potentially allow the end user to make use of tamper-proof cryptographic systems, also assuming special accessibility and operating schemes that combined with a token-based approach could guarantee considerable privacy similar to that for the use of banknotes.

The use of DLTs could also include the opportunity to exploit the features made possible by **Smart Contracts** that enable the concept of Programmable Money, that is, the possibility of coding real business logic within the DLT infrastructure itself. This function opens up the exploitation of many use cases for both the wholesale and retail world, significantly increasing the possibility of developing a large number of services on the CBDC infrastructure.

These are trade-offs between different design principles, so it would have to strike the right balance in order to achieve the Bank's policy objectives.

4.3 Core Ledger Requirements

For a distributed approach to CBDC, there are **different characteristics** that must be taken under consideration, such as:

- **Control:** can the Central Bank control who joins the network and can retain full control over minting of digital currency?
- **Resilience:** is there a Single Point of Failure in the System?
- **Transparency:** is there read-only access for every actor involved? is the system fully transparent?
- **Scalability:** is the system scalable enough to allow the creation of a real and mass-adopted CBDC infrastructure?

Such requirements must be addressed when choosing the right technological stack, especially when deep-diving into the choice of the use of a permissioned or permissionless ledger.

4.4 Token-based or Account-based

Accessibility to a CBDC is one of the key characteristics of a virtual currency. The two main differences lie in the underlying data structure and in the authentication and funds transfer process.

There c**an be two different** ways a consumer can access its Central Bank digital tokens:

- **Account-based model:** within this approach, ownership is linked to an identity, so anyone can verify the owner of the account and this type of accessibility resembles the systems we use today for sending digital payments. This scheme assumes that the asset claim is strictly connected to a certified identity, as in today's bank accounts. To make a transaction you must prove your identity as it happens today through a personal password and an OTP code. When a transaction or transfer of funds occurs, the record is updated by increasing or decreasing the position of the account on its database.

- **Token-based model:** within this approach, ownership is linked to a proof. This is achieved through the use of PKI (Public Key Cryptography Infrastructure). Token-model accessibility can provide better anonymity for end users and resembles the possession of digital cash very much. Simply with a digital signature, an individual is able to demonstrate possession of its CBDC. The token-based model aims to ensure wider and less complex accessibility than the account-based model, also being able to ensure better privacy features for the user and eliminate problems with regards to funds restore. On the other hand, this approach may present severe issues, especially related to cryptographic Key Management by users. In fact, in the case of a non-custodial solution (where the user is the only responsible for Key Management), if the user loses his private keys, he would no longer have access to his funds, without a third party who can run to help him restore the funds. This problem can be limited by building Key protection schemes. Another major problem is that given the peculiarity of this model, there is a need to create new AML compliant frameworks to the regulations and therefore find the right compromise between privacy and regulation.

Table 1: Account-based approach vs Token-based approach

	Account-based	Token-based
Access	KYC/AML practices	Universal
Anonymity	Not anonymous	Different levels of anonymity can be established
Transfer	Centralised	Decentralised
Cash-like	Not	Yes
Custody	Custodian approach	Non-custodian approach

4.5 Programmable Money

One of the possibilities enabled by the **union between DLT and Smart Contract** within the CBDC concept, is to create a "programmable money" model. All this mainly thanks to the use of Smart Contracts, which are able to transform business logics into pieces of code that self-execute on the basis of the external events. The simplest example would be "On X date, transfer 100 € in programmable tokens from Y account to Z account".

A programmable CBDC enables the development and implementation of numerous use cases, especially in the financial sector. For the honor of understanding, a very important use case at financial level that can be enabled thanks to DLT and Smart Contracts will be briefly explained: **Delivery versus Payment (DvP)** without the necessary presence of financial intermediaries.

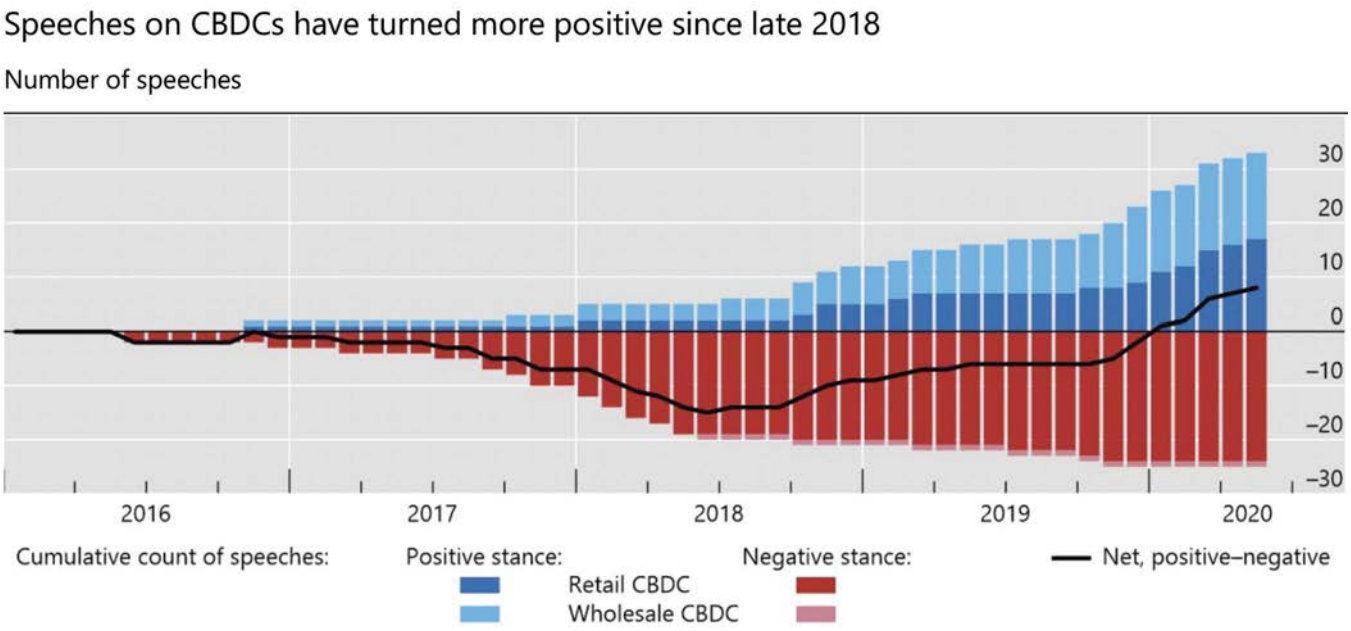
Delivery versus payment is already implemented nowadays in the world of finance through trusted intermediaries. These are for instance banks, clearing houses or central securities depositories.

Since most of today's trades occur digitally, DvP is achieved by the intermediary simultaneously updating several records in their database and/or transmitting instructions to other institutions. Nonetheless, the cash and underlying security, (or cash), will sit in a different platform, and legal entity. This may cause significant delays and counterparty risk. In this context, the use of Blockchain technology and smart contracts allows a way for two parties to interact in a transaction without counterparty risk. DvP offers the possibility of carrying out **an atomic transaction** where two generic users can exchange two different asset classes without the need for a third party to act as guarantor (escrow). The atomicity of the transaction enables true delivery versus payment on a shared ledger, without needing a trusted intermediary to manage the process. The digital DvP can only work **thanks to a Smart Contract** that operates in a decentralized context (DLT): the regulation between the two asset classes (shares Vs CBDC) is enforced by the Smart Contract itself in which rules are wired that cannot be changed or altered without the participants not being aware of them.

5. **PwC Italy's Point of View and Conclusion**

Central Bank Digital Currencies **are coming**. As outlined by recent research from the *Bank for International Settlements* (BIS), **a growing number of central bank governors and board members have made public speeches about CBDCs**. In 2017 and 2018, many of these had a negative or dismissive stance, particularly toward retail CBDCs. Since late 2018, the number of positive mentions of retail and wholesale CBDCs in speeches has risen, and in fact there have now been more speeches with a positive than a negative stance (figure 6). Experiments and studies will lead in a short time to concretize the concept of money issued by the Central Banks and to define a regulatory and economic framework that fully embraces this innovation by counterbalancing the possible risks.

Figure 6: BIS Working Papers, NO 880 - Rise of the central bank digital currencies: drivers, approaches and technologies



It is therefore important to be ready, designating the right technological solution that optimally spreads the functionality of the CBDC.

From now on, CBDCs could represent a **disruptive phenomenon for the current payment system** and for the banking sector, bringing real benefits in terms of efficiency and cost cutting. The CBDC approach would lead to a **frictionless user experience with a frictionless and near-free backend processing**:

- **Settlement** between Banks could be **instant and independent** from any payment processor, clearing/settlement house or third-party payment network;
- Payment transactions (P2P, B2C and G2C) could **be free of charge**;
- There is **no need of netting services** since in cross-currency transactions there's not an impact on correspondent banking accounts, driving down reconciliation costs and other back office costs.

Moreover, CBDCs could represent the definitive solution regarding the necessary transformation of physical cash into digital currency given the decline in the use of cash. In the long term, Central banks will benefit from **the cost cutting and simplification of cash handling operations** (print, stock, distribution). On the shorter term, Central Banks may find benefits in the **impossibility to counterfeit CBDC tokens**, reducing the counterfeit rate for banknotes and coins

As **PwC Italy Blockchain Competence Center**, we have long experience and strong expertise on Blockchain technology. We strongly believe in the potential of this new innovative form of money made possible thanks to the use of DLT and Blockchain technology. That's the reason why we have been among the first European players within our industry to **explore** the concept of CBDC and to implement a technological solution with clear assumptions at the base.

Our take is that the key to success in obtaining a correct implementation and exploding the fundamental functionalities of a CBDC, is above all a **technological theme** related to the design of the infrastructure and logical architecture of the Blockchain solution.

For this reason, we have defined a high-level model that can be leveraged in order to implement a Central Bank Digital Currency and we use it to discuss with clients and introduce them to the enormous potential of CBDC solutions.

The technological **framework** underlying our CBDC model is based on the following **pillars**:

- high **interoperability** and easy **integrability** with the financial infrastructures currently in use;
- **resemblance** with current **Central Banking** and **digital cash** systems, with many of the benefits of the existing account-based payment mechanisms;
- **hybrid architecture** that is able to guarantee the presence of commercial banks and financial intermediaries that act as a distribution vehicle;
- **proven and solid technology stack** deployed in a secure and permissioned environment.

The model is adaptable with both an Account-based and **Token-based approach.** Our take on this is that the second approach could be **more impactful** and could bring **greater benefits** than processes currently in use.

By following an **Account-based approach**, users would gain **limited advantages** over the current payment system since they are able to send money to other EU (SEPA) users already, using their mobile phone and without any friction (even instantly). Furthermore, unlike cash, every transaction is monitored, just like eMoney or SEPA transfer and this could be a barrier for the adoption, especially if the end goal is the replacement of cash.

On the other side, a **Token-based approach could deliver more benefits** mainly driven by financial inclusion: un-banked citizens could start to use digital payments and gain access to online services, remittance and P2P payments. This approach also solves many concerns related to privacy. In fact, the tradeoff of this approach is that will bear the same risks of money laundering, terrorism financing and other misuse of the currency as it is for cash. A Token-based approach may also be desirable even for players and private institutions that may see their business playing field reduced. Commercial Banks

and PSP (Payment Service Providers) could be able to implement **Value-Added-Services** such as Custodian Services, mechanisms to convert Cash banknotes in CBDC or provide advanced transaction processing schemes.

Financial Institutions and major players in the payments sector must be ready for the change that will take place and be ready to scale up or to play a concrete role in case of insurgence of business opportunities. As PwC Blockchain Competence Center Italy, we have a clear vision on the topic of CBDCs, both from a technological and a business point of view. We are able to accompany our customers along a path based on a own strategic framework (figure 7) which aims to understand the matter in depth, predict what will happen in the short and long term trying to anticipate the market and have an operative machine ready to go if needed.

Figure 7: PwC Strategic Framework

Understanding

- **Deepen how CBDCs can be game changers**, especially due to the possibility of taking full advantage of the features introduced by the DLT.
- **More studies**, **experiments and analysis of the results can be conducted** to get a clearer and in-depth view on CBDC and the associated risks.

Analyse and Forecast

- **Continuous** analysis of the ecosystem, ongoing and upcoming projects promoted by other financial institutions.
- **Understand how CBDC mass adoption could impact consumers**, studying changes in the payment market and the evolution of end user habits.
- Analyze how ready the financial institution is for an impact of this type and **investigate what technological and business gaps** exist in the transformation process.

Ready to act quickly

- **Be ready** to scale up or to play concrete role in case of insurgence of business opportunities in line with our strategic guidelines (avoidance of reputational, regulatory, compliance and operational risk).

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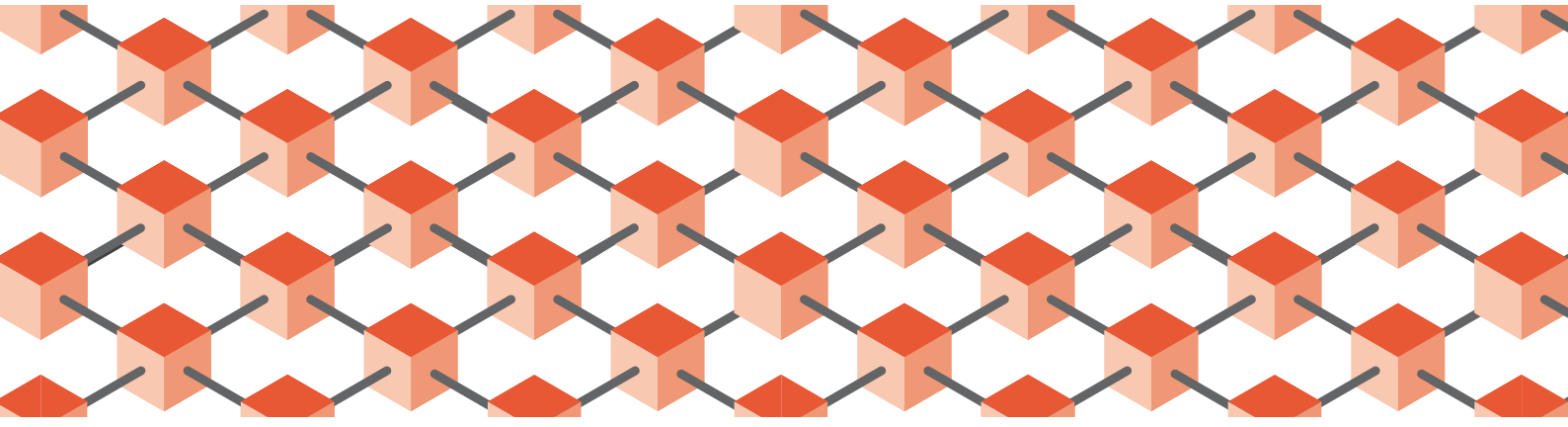

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