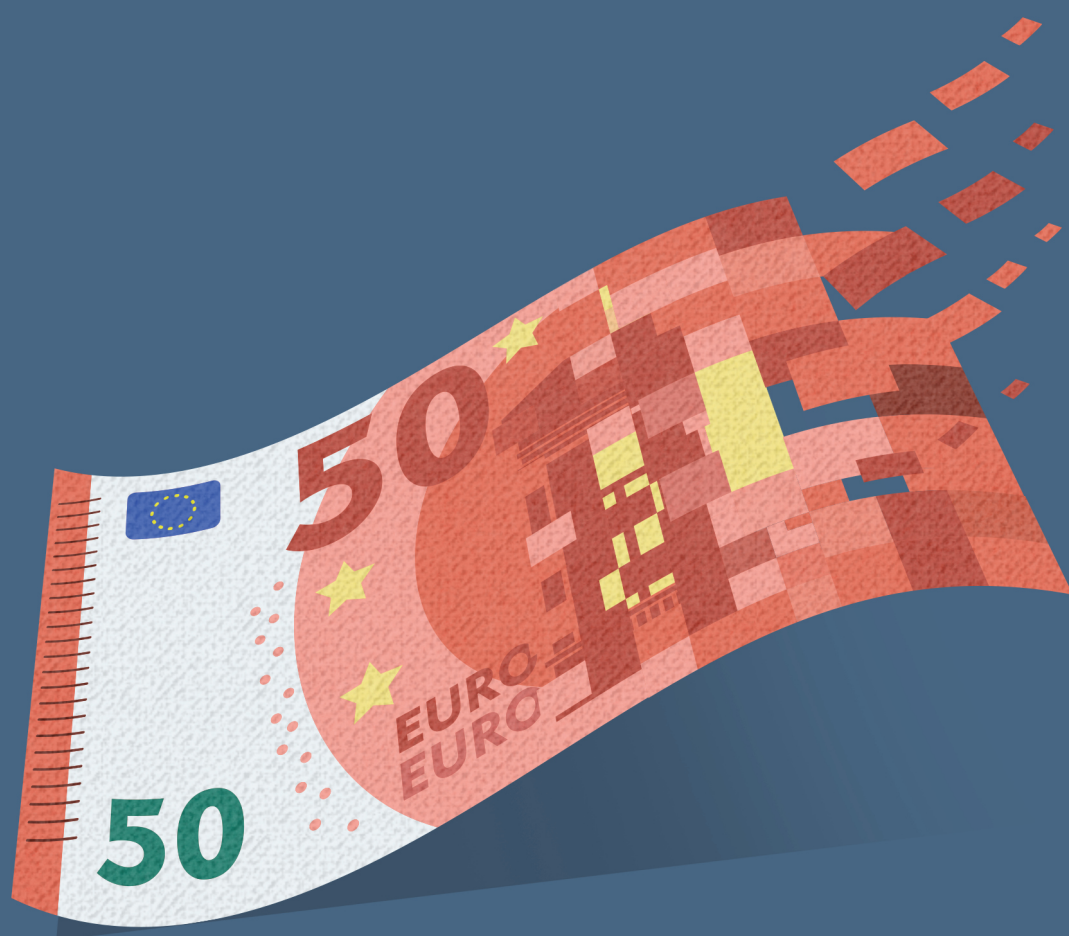


CBDC: Considerations for the Digital Euro



CBDC: Considerations for the Digital Euro

A review of a Central Bank Digital Currency in Europe

April 2020

dGen is a not-for-profit think tank based in Berlin, Germany. We focus on how blockchain technology can contribute to a decentralized future in Europe and what this might mean for people, society, private entities, and the public sector over the coming decades.

We're working with a team of researchers exploring how decentralisation will shape our future. Our insight reports focus on specific topics and industries to drive ideas for adoption in Europe. To find out more, please visit us at dgen.org.

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dGen, 2020

Foreword

At a moment in time when we see major upheaval in the world around us, we are reminded that technology, innovation, and progress are what characterise the modern economy. Whether for finding solutions to complex problems or improving outdated aspects of our lives and society, we are always looking at what is next to keep evolving and improving.

In this report, we examine a potential next step for one of the pillars of our economy -- money itself. Central Bank Digital Currencies or CBDCs are a hot topic in reserve banks across the world. Around 80% of world banks are at least exploring the idea. A CBDC could be the next innovation in money and nobody wants to miss the boat.

Two events seem to have triggered much wider interest in the topic. The first being the announcement of Facebook's Libra and other private stablecoins, which could one day be seen as a rival to reserve currencies; these were met with disdain from regulators far and wide. The second event was the announcement of the DCEP, or digital Yuan, that the Chinese Government is working on. Both of these likely led to heightened interest in the topic, as Western governments try to avoid any encroachment from other currency contenders.

It is not all smooth sailing for CBDCs, however. There are many technological, societal, and budgetary factors to overcome before a CBDC will rival a major currency. But there does seem to be a desire to explore and find solutions to this set of problems.

At dGen, we have focused on a case for the 'Digital Euro'. Looking at the unique construct of the Eurozone, which presents its own nuanced challenges. We always try to think how this could impact EU citizens and not just the underlying economy. We are encouraged to see a lot of great work recently published by Banque du France and the Bank of England, and we hope our paper adds some elements to the overall discourse.

Jake Stott & Nick Dijkstra

Founding Board, dGen

Executive Summary

As digital payments become increasingly ubiquitous, the financial system must also evolve. Various steps have been taken to improve security, but these systems remain relatively slow and expensive, and often require large amounts of personal data.

Central Bank Digital Currencies (CBDCs) have gained interest for their potential to improve the financial services industry.

Central Bank Digital Currencies (CBDCs) have gained interest for their potential to improve the financial services industry. This is largely based on the development of cryptocurrencies and the underlying blockchain technology that has proved digital currencies can come with both privacy and security that is more akin to cash.

A digital Euro would be a unique undertaking, as the Euro spans 19 sovereign nations. The Euro was designed to sidestep issues of cross-border payments and provide for a stronger trading bloc and more stable currency. However, even though a shared currency has united this economic bloc, fragmented national payment systems continue to hinder trade.

Current solutions, such as the Single Euro Payment Agreement (SEPA) and companies like PayPal or Visa, provide workarounds. However, these solutions are either not widely available in the case of SEPA, or give large amounts of sensitive data about users to private companies.

A blockchain based CBDC has the potential to greatly improve speed, security, privacy, and efficiency. The decentralised nature of blockchain, while difficult to implement with a centralised financial system, provides enough new possibilities that it merits serious consideration.

The potential benefits a CBDC could offer are increased:

- Efficiency
- Security
- Privacy
- Adoption
- Consistent regulation and taxation
- Increased trading power.

However, creating a service that remains stable throughout the transition, and does not lock already marginalised groups out of the financial system is a delicate balance. The downsides that need to be accounted for are:

- Cost of implementing
- Technical considerations
- Potential interoperability issues
- Accessibility
- Financial stability.

Therefore, while fending off threats to the power of the Euro and the trading power of the Eurozone, a CBDC should not be designed merely as a reactionary measure. The merits of a CBDC need to outweigh the potential drawbacks.

Therefore, while fending off threats to the power of the Euro and the trading power of the Eurozone, a CBDC should not be designed merely as a reactionary measure. The merits of a CBDC need to outweigh the potential drawbacks. This is especially true for the Eurozone, which requires greater care to account for the size and diversity of economic regions.

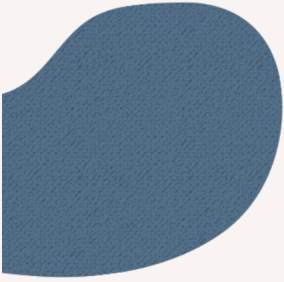
Furthermore, a wealth of technical considerations need to be appraised to find the right fit. The main technical considerations are permissioned vs. permissionless blockchain, token-based vs. account-based models and others around privacy, security, and wallets.

While permissionless blockchains are the backbone of decentralised payments, the lack of centralised control makes them unfeasible for a CBDC. In order to design a system in which the central bank can retain control over the currency, a permissioned or hybrid blockchain is necessary.

One idea to protect user privacy, but still retain the authority to perform anti-money laundering (AML) and know-your-customer (KYC) checks, is anonymity vouchers. These would be granted at regular intervals and would enable users to protect a cumulative amount of money from oversight, rather than screening all transactions over a certain benchmark. The voucher-shielded transactions should operate with the anonymity of cash.

However, under the right circumstances, a well planned digital currency could improve financial services and invigorate trade.

Additional care needs to be taken so that people in an economic zone are not blocked from participating due to age, homelessness, residency and citizenship, socioeconomic status, or disabilities. However, under the right circumstances, a well planned digital currency could improve financial services and invigorate trade.



While the development of a digital Euro will likely take extensive planning, the potential merits further exploration. This report explores the various technical choices and their benefits or deterrents. Overall, further discussion and pilot projects are necessary to determine if a digital Euro in the wild will actually benefit the Eurozone. We are encouraged by recent activity from *Banque du France* and the *Bank of England* around potential CBDC implementations.



Glossary

Central Bank Digital Currency (CBDC): A currency stored solely on digital ledgers and controlled by the central bank similarly to a fiat currency.

Wholesale Currency: a currency used to clear settlements between financial institutions.

Retail Currency: a currency used by all participants in an economic zone - individuals, businesses, and financial institutions.

Wallet: storage for digital assets, hot wallets allow assets to be accessed and used, while cold wallets are secure as they are not connected to the internet.

Fiat Currency: a legal tender that is required to be accepted within a current jurisdiction and controlled by the central bank to regulate fluctuations.

Permissionless Blockchain: a fully decentralised blockchain, where anyone can participate and validate transactions.

Permissioned Blockchain: blockchains that require private access to participate, and can have allowances to give certain nodes more control over the network.

Hybrid Blockchain: a blockchain that has the ability to take the benefits of a private, permissioned blockchain, but also allow it to access the network of a permissionless blockchain, without losing control.



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01

Introduction to the Digital Euro



Introduction to the Digital Euro

Cryptocurrencies have been speculated about as the future of payments. However, as with many new technologies, they have both outpaced and under performed expectations.

Cryptocurrencies are presented as a democratisation of payments. While in many regards they do cut out intermediaries, at present, the largest cryptocurrencies are both not widely accepted and deeply volatile, blocking them from gaining currency status. Rather they act more as investments.


However, the technology behind cryptocurrencies - blockchain - presents interesting solutions, namely in security, speed, and trustless transactions. The variety of tokens that have been created after the first, Bitcoin, reveal some of the issues in creating a scalable, secure, and decentralised solution.

The potential and benefits of this technology have been enough to generate interest from private providers, such as Facebook with Libra, and central banks. These initiatives have the potential to see greater adoption, and provide a new currency, even if not as democratic as cryptos initially envisioned. Rather, these currencies seek to utilize the security and peer-to-peer nature of blockchain to facilitate faster cross-border transactions and enable a digital currency that, at least partially, replicates the privacy of cash.

Implementing a new form of currency rightfully sparks concern over financial stability, though, and should not be done lightly. This is especially true when targeting multiple economic zones. While Libra is a deep cause of concern for precisely this reason, a Eurozone Central Bank Digital Currency (CBDC) must also work through similar issues.

This report seeks to understand the unique difficulties that a digital Euro will encounter, as well as to explore some of the different approaches that have been proposed for CBDCs.

Fiat Currency/Euro Overview



Fiat currencies, also called legal tender, are mediums of exchange issued by governments. Merchants who operate in a specific jurisdiction are required by law to accept that jurisdiction's fiat currency in exchange for their goods and services.

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The central bank controls this money supply to keep prices stable. Following Monetarist theory, most central banks find it desirable to have a slight inflation rate to drive economic activity.¹ Retaining governmental control over the currency is generally seen as essential to stabilise and grow national economies.

The Euro is a unique fiat currency as it spans over multiple sovereign countries. These include 19 members of the European Union, as well as several states with monetary agreements and unilateral adopters, all of which make up the Eurozone.

The Eurozone was designed as a:

'single currency offers many advantages: it makes it easier for companies to conduct cross-border trade, the economy becomes more stable, and consumers have more choice and opportunities'.²

To adopt a single currency, the political goals and economic systems of all participating nations had to be aligned - an extremely difficult task.²

To adopt a single currency, the political goals and economic systems of all participating nations had to be aligned - an extremely difficult task.² Extreme care and planning was necessary to introduce a new currency without leading to large scale financial disruption.

Creation and introduction of the Euro, then, required a long and well-planned strategy. While interest in a unified currency began in the 1960s, preparation for economic unification did not begin until 1990.² Preparation carried on until 1999, following the three-stage preparatory period proposed by the Delors Report.²

Introducing a digital Euro (CBDC) on top of this system requires similar careful implementation to ensure the stability of all economic regions and the agreement of all countries.

The Euro was launched on 1 January 1999, but only operated as an "invisible" currency for the first three years, used only for accounting and electronic payments. It was made available for retail use in 12 countries on 1 January 2002.² This created a functional Eurozone, which now represents the largest trading bloc in the world.

Operating as a unified area means that countries within the Eurozone are not sovereign in their monetary policy and must adhere to the European Central Bank's (ECB) monetary policy decisions to maintain financial security across the entire region. However, states maintain their sovereignty over fiscal policies, which can lead to conflicting monetary policy preferences. This made the introduction of the Euro a controversial step, one that remains so to this day. Introducing a digital Euro (CBDC) on top of this system requires similar careful implementation to ensure the stability of all economic regions and the agreement

The introduction of a CBDC is risky, but there is also great opportunity to further strengthen both the economic power of the Eurozone and the economic cohesion of its member states.

To be clear, digital currencies already exist, however, there are several key differences enabled by the development of cryptocurrencies and blockchain technology.

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What is a CBDC?

A Central Bank Digital Currency (CBDC) is a digital currency issued by a national bank with legal tender status. Similarly to a fiat currency, a CBDC would be controlled by a central bank in order to regulate fluctuations and maintain stability.

Governmental control of the digital currency differentiates it from private stablecoins, which attempt to temper the volatility of cryptocurrencies by pegging them to other currencies. However, they have not yet seen widespread adoption. Control by the central bank solves this as merchants would be required to accept a digital fiat currency. CBDCs would also be subject to the same level of fiscal manipulation, if not more, that central banks already have over traditional fiat currencies.

To be clear, digital currencies already exist, however, there are several key differences enabled by the development of cryptocurrencies and blockchain technology. These new developments could make a compelling case for releasing a new type of digital currency.

How is a CBDC different from other digital currencies?

Digital currencies are any currency kept on digital ledgers, as opposed to physical cash. Currently, the vast majority of Euro units in circulation are already digitised and available for cashless transactions. In November 2019, the ECB reported a total money supply (M3) of 13 trillion euros,³ of which only 1.3 trillion were available in cash.⁴

This digital money operates as account-based funds, versus the token-based currency that cash presents. In account-based monetary systems, the accounts are under bank control and payees must prove their identity to access the funds credited to them (i.e. prove that they own this account). However, in a token-based currency, the payee must only prove that they own currency units (for example by handing cash to the receiver). Therefore, the current operation of digital funds comes with many stipulations that break down privacy.



Cryptocurrencies, on the other hand, use blockchain technology to create a digital token-based currency. This is possible as these digital tokens cannot be replicated or reproduced, and therefore operate in a manner that is much closer to cash. Users merely have to prove that they own the currency by holding a private key to access the wallet the tokens are stored in.

Government Solutions

To use digitally stored Euros, member states and their commercial banks typically use a national system for cashless payments. For instance, the German Girocard or the Belgian Bancontact system enable country-wide access to digital funds with lower fees and instant payment options. However, limited infrastructure and legal guidelines make these systems available only at the country level.

As a result, international payments have high latency and costs.

As a result, international payments have high latency and costs. To solve this, in 2014, wire transfers were unified with the Single Euro Payments Area (SEPA), providing allowances for multi-country payments. The SEPA package includes instant payments, which arrive at the recipient within 10 seconds. However, both SEPA member states and their commercial banks have been slow to adopt this due to its high performance requirements and costs, with only 51% participation as of 2019.⁵

SEPA was adopted to reinvigorate trade in the Eurozone, by reducing redundancies, delays, and fees, alleviating strains on both businesses and individuals.⁶ While the instant payments have the ability to solve many issues, lack of adoption has stalled this effort.

Businesses Providing Solutions

Meanwhile, credit cards and online payment services, such as PayPal, have become the primary vector for transnational payments due to their more consistent fees and delivery time. As a result, the market for cross-border payments is dominated by a few companies, who track all payments, and thus collect large amounts of data about their customers. There is a history of hacking and subpoenas, which are cause for concern for users of these services.

In addition to external threats to privacy, the companies themselves have proven to be less than impartial. Recently, the magazine *Jewish Currents* reported that several PayPal transactions to their staff members were held for including the

As a result, the market for cross-border payments is dominated by a few companies, who track all payments, and thus collect large amounts of data about their customers.

word “Iran” in their reference.⁷ A further analysis by *Slate* revealed that words like ISIS, North Korea, and Cubano Sandwich led to blocked transactions, whereas the words Bomb, Hitman, and Cocaine did not.⁸ This points to potential bias in their services.

Possibilities of Cryptocurrencies

Blockchain, and the underlying Distributed Ledger Technology (DLT), are promoted for democratising payments by cutting out intermediaries and gatekeepers. By removing a single authority, they seek to solve issues of bias, as well as increase transaction speed and security.

The DLT that underlies blockchain improves security by removing single points of failure. However, these decentralised systems operate in several ways that are incompatible with the control, anti-money laundering (AML), and know-your-customer (KYC) oversight that are necessary for governments. To benefit from the improvements that blockchain has made possible, this technology needs to be heavily tempered to fit into current legal and financial systems.

Despite this, token-based cryptocurrencies revealed that digital currencies can be transferred and managed in a manner that is much closer to the privacy and immediacy provided by cash. While creating a system with limited oversight, both from corporations and to some extent governments, is necessary if cash is to be replaced, increased use of digital payments call for this step even concurrently with cash.

Benefits

According to the Banque du France, the ‘primary reason for issuing a CBDC would be to offer a perfectly liquid and safe payment instrument that is adopted to technological changes’.³⁰ However, combining the highly centralised system of a governmentally issued currency with a technology that seeks to be decentralised at its core is a daunting task.

The benefits a CBDC seeks to offer are:

- Efficiency
- Security
- Privacy
- Widespread adoption

Despite this, token-based cryptocurrencies revealed that digital currencies can be transferred and managed in a manner that is much closer to the privacy and immediacy provided by cash.

According to the Banque du France, the ‘primary reason for issuing a CBDC would be to offer a perfectly liquid and safe payment instrument that is adopted to technological changes’.³⁰

These combined solutions are increasingly viewed as necessary, with the impending implementation of private stablecoins, such as Facebook's Libra, or other governments' CBDCs, which are seen as a threat to the power of the Euro.

- Consistent regulation and taxation
- Increased trading power.

These combined solutions are increasingly viewed as necessary, with the impending implementation of private stablecoins, such as Facebook's Libra, or other governments' CBDCs, which are seen as a threat to the power of the Euro.

Additionally, where the SEPA plan failed to bring widely available instant payments, a CBDC would succeed, as legal tender status would require adoption by all banks and countries within the Eurozone. Therefore, a CBDC is generally seen as bringing a revitalised economic system.

Downsides

For all of the hype and interest, CBDCs appear to already fail to achieve the level of democratisation that they were initially touted as. There are a myriad of issues to make sure that the same, or even greater, numbers than the 40 million EU citizens who are currently unbanked do not also get locked out of a new system.⁹

The greatest downsides to a CBDC are:

- Cost of implementation
- Technical considerations
- Potential interoperability issues
- Accessibility
- Financial stability.

While other digital currencies are a threat, and the ECB will have to take steps to mitigate this, a digital Euro should not be implemented solely as a reactionary step. A CBDC should be adopted for its own benefits, with a mind to all of the potential issues.

When considering whether or not to implement a CBDC, Eurozone countries have to consider if a new system would truly be a benefit. While other digital currencies are a threat, and the ECB will have to take steps to mitigate this, a digital Euro should not be implemented solely as a reactionary step. A CBDC should be adopted for its own benefits, with a mind to all of the potential issues.

Interest in CBDCs

So far, around 80% of central banks worldwide are exploring a CBDC, according to the Bank for International Settlements.¹⁰ 40% of the polled central banks have moved from basic

research towards experimentation, and 10% of the respondents have already started pilot projects and are imminently close to launching their CBDC.

With lower transaction fees and faster processing, CBDCs could facilitate payments both within a country's borders and across borders and, by proxy, international trade.

Those countries have the potential to significantly strengthen their economic position. With lower transaction fees and faster processing, CBDCs could facilitate payments both within a country's borders and across borders and, by proxy, international trade.

Such a borderless payment system would promote the use of a country's CBDC to increase the efficiency of trade payments. Due to competition between financial markets, countries that forgo the introduction of a CBDC could suffer from a weakened international trade position. If other countries adopt faster and cheaper payment methods, those that do not will likely see declining trade, and potentially even risk the power of their currency. Reversely, those that are early adopters could see the greatest benefits.

At present, there is widespread concern that some countries might introduce a CBDC as a reserve currency at the expense of other reserve currencies. For instance, it is feared that with the digital Yuan might challenge or even replace the US-Dollar as the world's dominant reserve currency.¹¹

For this reason, national banks are not only fending off the threats from cryptocurrencies and private stablecoins, but are also in a race to market with other central banks.

For this reason, national banks are not only fending off the threats from cryptocurrencies and private stablecoins, but are also in a race to market with other central banks. Tunisia became the world's first country to issue a CBDC in November 2019 with the e-Dinar. While this is representative of a much larger interest among emerging economies in CBDCs, China will likely become the first superpower to launch one. China's CBDC is generally seen as the greatest threat to other global economic powers.

Recently, the ECB joined research efforts with the central banks of Canada, England, Japan, Sweden, and Switzerland, as well as the Bank for International Settlements.¹² This group plans to share knowledge on emerging technologies, CBDC use cases, as well as economical, functional, and technical design choices. While there is pressure for many central banks to act rapidly, there are also concerns about implementing secure, scalable, and affordable CBDCs. There are a variety of other issues to take into account, which has slowed the Eurozone and many other countries in CBDC development.

Meanwhile, some member states of the Eurozone have already begun to explore their own CBDC. Earlier in 2018, the ECB

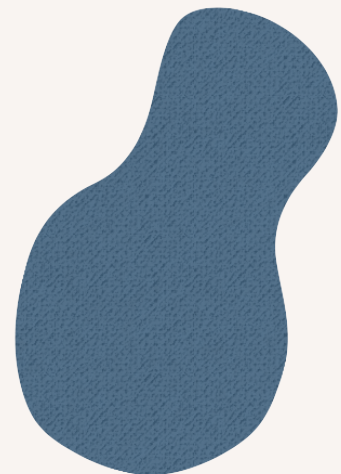
halted Estonia's plans to create a CBDC, citing that no Eurozone member has the right to introduce a new national currency in competition with the Euro.

France's central bank has also made moves to outpace the ECB in releasing a CBDC. According to the French central bank, a limited wholesale CBDC pilot will take place in Q2 and Q3 2020.¹³ In contrast to a retail CBDC, which would target private persons, wholesale CBDCs are meant only for financial institutions to facilitate settlements with each other. As the ability for this to rival the Euro is diminished, it has yet to be halted by the ECB.

On the flipside, CBDCs may give rise to a renewed fragmentation of the Eurozone, if individual countries should decide to release their own digital currency.

Due to the unified nature of the Euro's monetary system, a digital Euro could quickly gain widespread adoption. On the flipside, CBDCs may give rise to a renewed fragmentation of the Eurozone, if individual countries should decide to release their own digital currency.

In the context of CBDCs, the Bank for International Settlements has identified three possible options: a wholesale CBDC, which is token-based, or a retail CBDC which can be either token-based or account-based.¹⁴ Under their framework, a token-based retail CBDC comes closest to the notion of "digital cash".



02

Technical Considerations

Technical Considerations

The most important considerations come down to which technologies should be used and how these should be implemented, as this will determine the extent of centralisation, security, and accessibility.

Combining a centralised banking system with a decentralised technology, like distributed ledgers, is difficult to imagine and demands significant compromises. Several variables and limited real-life implementation further complicate this. The most important considerations come down to which technologies should be used and how these should be implemented, as this will determine the extent of centralisation, security, and accessibility.


A CBDC must eventually scale up to host most of a country's finances. This is even more important for a digital Euro, as the currency of a much larger and diversified bloc. Due to the difficulty of implementing new technologies on such a large scale, some countries are looking into outsourcing this. The result is referred to as a synthetic CBDC, which is created through a government's partnership with private firms. Those external companies would manage the customer facing technology and customer service, while central banks would provide regulation, authority, and security.

There are several other considerations to account for as well. The difficulty in melding these two systems has even spurred arguments to keep a CBDC on an entirely centralised private database controlled by the central bank - completely avoiding a blockchain. The result would be a simple, centralised digital currency. This solution would, however, sacrifice some of the benefits provided by a distributed ledger, like transparency, immutability, and the avoidance of single points of failure. The benefits of such a currency compared to current digital currencies are unclear.

Permissioned vs. Permissionless Blockchains

Permissionless (public) blockchains are the technology that provide many of the benefits cryptocurrencies purport - specifically the democratisation. On a permissionless blockchain, also called public blockchain, anyone can participate in the validation of transactions. A game-theoretical incentive system, called a consensus algorithm, aligns the interests of validators to make attempts to fraudulently change the blockchain an unprofitable endeavour.

Permissionless blockchains are fully decentralised, and therefore have no single points of failure, as the ledger of transactions exists on every connected node. This makes public blockchains highly resilient against external force majeure



(superior force) events, such as direct attacks to hardware, wars, governmental crises, or power outages.

However, they remain susceptible to internal attacks, and cannot effectively be placed under the control of a single entity; this is a primary concern in a CBDC, as the central bank must retain control. The open access of a public blockchain would expose a country to a new form of cyber-warfare via their digital currency.

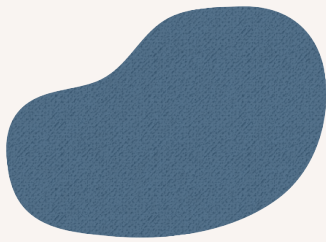
Furthermore, while it is theoretically possible to give certain nodes a higher level of authority, this is difficult to implement and counterintuitive to the idea of a public blockchain. This severely limits the control a central bank would have over its CBDC, such as the possibility to control the money supply or to freeze accounts for investigative purposes.

For these reasons, permissioned (private) blockchains, sometimes referred to as private blockchains, are a far more realistic potential for CBDCs. In contrast to a public blockchain, where everyone can participate in transaction validation, a private blockchain only has a limited number of selected and trusted validators. In the context of CBDCs, these validators could be the central bank itself and a few trusted institutions, such as authorised commercial banks.

Under this model, the central bank retains authority over the issuance and destruction of currency units, while maintaining security against information being retroactively corrupted by a single centralised node.

Under this model, the central bank retains authority over the issuance and destruction of currency units, while maintaining security against information being retroactively corrupted by a single centralised node. However, this provides some serious concerns about personal privacy, as multiple parties have to validate transactions and therefore have access to large amounts of sensitive data.

Hybrid solutions have also been suggested, which would be a private blockchain working combined with a public blockchain. This grants greater levels of privacy and oversight through the private blockchain. Interoperability with the public blockchain gives access to all the fundamental features of the public chain. For example, the ability to privately interact with other decentralised applications or other private blockchain implementations within that ecosystem. However, so far these solutions are less tested at scale than non-hybrid approaches.



Privacy

Based on the level of information central bank authorities would have via the CBDC, steps are required to provide privacy protections. Some European countries are looking to abolish cash altogether, significantly raising privacy concerns. Sweden plans to abolish cash by 2030,¹⁵ citing money laundering, tax evasion, and terrorism as the reasons.

Cryptocurrencies rely on pseudonymity to provide greater privacy than other digital payments. However, since cryptocurrency users have to complete KYC/AML checks to use many blockchain services, such as exchanges, their transactions can be traced back to the user's identity. In CBDCs, however, the government and validators on the blockchain would be able to directly trace all transactions, even small, low risk payments.

To address these concerns, the ECB has floated the idea of anonymity vouchers.¹⁶ These vouchers would be issued regularly, and be non-transferable. To shield a transaction from AML-checks, the account holder would have to attach a sufficient number of vouchers to the transaction.

This effectively grants all CBDC users a cumulative limit on the amount of money they can shield, rather than merely screening all transactions over a certain benchmark.

Large transactions, or even a high number of small transactions, would not be able to be covered by the vouchers, and subject to AML-control. This effectively grants all CBDC users a cumulative limit on the amount of money they can shield, rather than merely screening all transactions over a certain benchmark.

To further limit validator information about transactions, a technique called Secure Multi-Party Computation (SMPC) can be used. Information is split up and processed by different nodes without the need to leak any information to other nodes. Thus, every validator only has a small, seemingly random piece of information to verify. As long as all of the pieces are verified, the entire transaction can be completed.



However, the central bank needs all the information in its entirety to perform AML functions. The central bank would therefore have to implement a backdoor providing access to all transaction information. Depending on its implementation, such a backdoor can either screen all transactions (unless they are backed by an anonymity voucher), or specifically target risky transactions, such as transfers of large amounts or those that are associated with suspicious activities.

This presents a security risk, but as the network would be permissioned, the nodes would be identifiable and could be sanctioned in the event of a security breach. While this would provide privacy from validators other than the central bank, whether or not it is worthwhile with the necessity of a backdoor, remains to be seen.

Security

However, ensuring the veracity of the information added to blockchains is more difficult and presents the point of weakness in blockchains.

Blockchain technology is lauded for its security, as it is immutable and resistant to retroactive tampering. However, ensuring the veracity of the information added to blockchains is more difficult and presents the point of weakness in blockchains. As such, there are high validation standards, of which there are several main systems in place - Proof of Work, Proof of Stake, and Proof of Authority.

While for permissionless blockchains Proof of Work and Proof of Stake are necessary to retain the greatest amount of privacy and decentralisation, in a permissioned blockchain, they present certain difficulties or overly complicate the system.²⁸ Despite this, validation of blocks for all types of blockchains are still necessary to retain the integrity of the information; this is especially true at the scale of a CBDC, with a large number of participants and transactions.

The likely solution for a permissioned blockchain would be Proof of Authority.¹⁷ Under this consensus model, the central bank grants and, if necessary, withdraws authority to certain blockchain nodes, allowing them the authority to perform various functions, such as transaction validation.

Rather than competing to receive the validation reward, validators could be hired on a freelance basis by the governing central bank.

This could also be an option on a hybrid blockchain, where members of a pre-selected consortium get a higher level of authority than permissionless members. The central bank would, in any case, have the highest level of authority, which would also give it the power to reverse transactions or freeze accounts.

Additionally Proof of Authority removes the competition to validate a block. Rather than competing to receive the validation reward, validators could be hired on a freelance basis by the governing central bank.

There are multiple consensus models and ongoing research around the best solutions for a CBDC implementation. Over the coming years, standards and best practices will be outlined and many of the questions about permissioned, permissionless, hybrid, non-hybrid approaches will be answered.

Wallets

While cold wallets require additional steps to access funds, the security they provide has proven necessary.

Wallets are secure storage for crypto assets, and would have to be implemented on scale for the entire population. Hacking risks requires both hot and cold wallets. Hot wallets are kept on a device with an internet connection, making funds available for use. Meanwhile, cold wallets are not connected to the internet, similar to paper or hardware wallets. Cold wallets are necessary to secure assets against hacking threats.

While cold wallets require additional steps to access funds, the security they provide has proven necessary. If most transactions are switched to digital currencies, both authorities and residents have a stake in cybersecurity. The challenge is to provide a solution that is both highly secure while remaining user friendly.

The central bank would then be responsible for ensuring that most funds are stored in cold wallets and would insure funds against hacks.

As central banks would also likely have to approve wallets to be used on their system to track, regulate, and tax payments, custodial wallets are a solution. Custodial wallets are under the care of a "custodian", and therefore not as decentralised as most cryptocurrencies attempt to be. However, they come with built-in safety guards against lost keys and can help manage assets between hot and cold wallets.

Since this would make wallet creation permissioned, the central bank itself might act as the custodian for funds stored in CBDC wallets. The central bank would then be responsible for ensuring that most funds are stored in cold wallets and would insure funds against hacks. Only a small percentage of the funds would be stored in hot wallets to provide liquidity.

To reduce the strain of maintaining so many wallets and make this more scalable, commercial banks might be incorporated as an intermediary. They would provide many user-facing services, as well as potentially aiding central banks in completing AML and KYC checks to facilitate faster and more secure payments.



03

Societal Issues

Societal Issues

At worst, the introduction of a CBDC could further increase the financial divide.

Along with technical consideration, the societal impacts of a digital currency must also be appraised. While cryptocurrencies were touted as a solution for the roughly 1.7 billion unbanked adults in the world¹⁸ to gain access to financial services, it is questionable whether a CBDC can live up to that promise. At worst, the introduction of a CBDC could further increase the financial divide.

When designing a CBDC, the needs of groups that could suffer from an exclusion must be addressed. The following factors might make a person vulnerable to such an exclusion.

Generational Divide

Digital literacy is lower among older populations. To ensure that older clients are not cut off from their funds, wallets have to be designed to be used with limited technological knowledge, while remaining highly secure. For a smooth adjustment, custodians should consider offering services that resemble current cashless payment methods, such as plastic cards.

Additionally, it might be desirable to prevent minors from making risky transactions, such as investments that are akin to gambling.

While younger generations are typically more adept with digital technology, the questions of if and how minors should be allowed to interact with CBDCs remain. Young children might neither have an ID card nor a bank account, and would therefore be unable to complete AML/KYC procedures. Additionally, it might be desirable to prevent minors from making risky transactions, such as investments that are akin to gambling.

Limited digital wallets with greater privacy protections and parental controls have been suggested as a solution. However, this does not fully answer the question of how restrictive these wallets would be, and whether these restrictions would be primarily governmentally or parentally imposed. As the legal working age is under 18 for many countries, wallets with fewer restrictions would likely be made available to older minors who do have the necessary ID and parental permission, reducing some of the difficulties.

However, while solutions for minors with reliable legal guardians are fairly easy to imagine, ensuring that homeless youths or youths who need to be fiscally independent are not cut out of financial systems is more difficult. Much more research and development needs to take place to ensure that

introduction of a new type of currency does not further cut out minors, particularly homeless minors.

Failed KYC Checks

For any immigrant, it can often be a difficult and lengthy process to obtain proper identification, which might exclude them from a CBDC system.

Besides minors, a number of adults might also be unable to complete AML/KYC procedures. This might be because a person does not have a valid ID card, which is often the case for refugees or undocumented immigrants. For any immigrant, it can often be a difficult and lengthy process to obtain proper identification, which might exclude them from a CBDC system.

The same holds true for people with an unclear residence, such as the homeless. While unbanked people typically rely on cash to make ends meet, it presents issues if cash is replaced by a CBDC, either fully or partially. Already, it is difficult for homeless people without a bank account to find a permanent residence that would allow them to open a bank account.

When designing a CBDC, utmost care must be taken to not accidentally create such a catch-22, where it becomes impossible to obtain a proper ID without a digital wallet and vice versa.

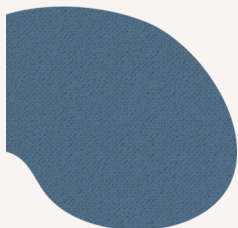
When designing a CBDC, utmost care must be taken to not accidentally create such a catch-22, where it becomes impossible to obtain a proper ID without a digital wallet and vice versa. These special cases require consideration, as the homeless people or children who cannot obtain a CBDC wallet would have trouble making ends meet in a cashless society.¹⁹

Such issues are already clear in Sweden, where cash is fairly scarce. This led to some charitable projects to equip homeless people with card readers.²⁰ Directly accepting donations and spending money digitally would however require the homeless to have access to a bank account, or in the case of CBDCs, a digital wallet. So far, no solution has been proposed in order to address this problem.

Digital Divide

To participate in a CBDC-based financial system, internet access and internet-capable devices, such as smartphones, are necessary. Both might be a problem in impoverished communities, which would further decrease their ability to gain an economic foothold, if excluded from the financial system.

Also, not all areas in the EU have a reliable and sufficiently fast Internet infrastructure. This might affect merchants and their ability to receive CBDC payments. When considering the launch of a CBDC and the gradual phasing out of cash, the costs of rolling out and maintaining Internet infrastructure should be factored in.

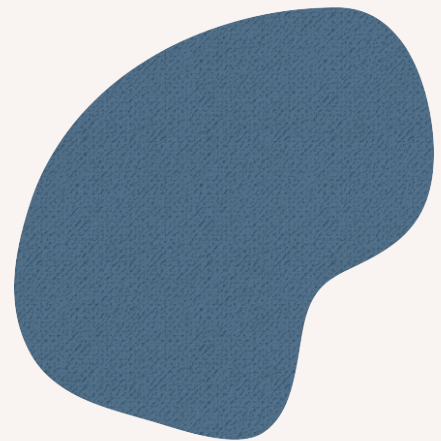


Disabilities

When designing a CBDC, the needs of disabled people should be considered as well. This can include people with visual or mobile impairments, as well as neurodivergent communities. This is another part of the population that is especially vulnerable to privacy breaches.

Their needs must be addressed to make sure that money remains accessible to these populations, without forcing them to reveal sensitive information to others or cede control of their finances due to poor design.

Their needs must be addressed to make sure that money remains accessible to these populations, without forcing them to reveal sensitive information to others or cede control of their finances due to poor design. Already, the rise in mobile banking has led accessibility procedures for visually and mobility impaired people to be developed. However, these accessibility aides need to be expanded to account for new systems and a greater portion of the population. These considerations need to be designed in at the core of CBDC banking, to mitigate issues down the line.



04

The Digital Euro in Practice

The Digital Euro in Practice

A digital Euro is a huge undertaking as the EU is the largest trading bloc and second largest economy in the world, spread across 19 different countries.

Therefore, introducing another form of currency has the ability not only to shake the financial status of this trading bloc, but the entire world.

As seen during Greece's financial crisis, using a common currency already links the economic fate of these countries deeply. Therefore, introducing another form of currency has the ability not only to shake the financial status of this trading bloc, but the entire world. However, the benefit of increased trading power is also great, and could cement the Eurozone as a financial powerhouse in the future.

Introducing a digital Euro requires all member states to agree on this step and implement the necessary technical infrastructure simultaneously. Furthermore, it is questionable how the countries that were struck hard by the financial crisis, like Greece or Italy, will react to another form of the Euro, and whether the more economically healthy states will agree to further tie their economies to the Euro.

CBDC Distribution and Replacement of the Fiat Euro

Digital currencies might be seen as more liquid and having greater potential for the future than traditional fiat currencies.

At present, one of the greatest concerns for a retail digital currency is that it will upset current financial systems and lead to a bank run on traditional finance.²¹ Digital currencies might be seen as more liquid and having greater potential for the future than traditional fiat currencies. Thus, cash might be phased out too quickly by the introduction of a digital Euro.

On the flipside, financial institutions and citizens might be reluctant to adopt a digital Euro, not seeing the impacts fast enough. For this reason, there should be some financial incentives to adopt, but they must not lead to a rushed replacement of the physical Euro.

Replacing cash-based currencies would therefore be a gradual move, compared to the looming threat of private stablecoins taking over the market.

To this end, many central banks, including the ECB, have proposed a two-tiered interest system that incentivises the switch, but makes it unprofitable to hold too much digital currency. Replacing cash-based currencies would therefore be a gradual move, compared to the looming threat of private stablecoins taking over the market.

Bank Incentives

Oddly enough, the ECB's main refinancing rate is already at zero, while the central bank charges a negative interest rate of -0.5% on deposits. Since the ECB still fails to achieve its inflation target of "below, but close to 2%",²² it seems unlikely that interest rates will increase in the near future.

With a digital currency, this deterrent would be altered, since storing would likely not incur any costs, or much lower costs.

Negative deposit rates make it cheaper for commercial banks to pay the deposit than physically store cash in their own vaults. They encourage banks to issue loans as a means of avoiding paying the deposit or developing and maintaining their own storage. With a digital currency, this deterrent would be altered, since storing would likely not incur any costs, or much lower costs.

Therefore, if the ECB plans to decrease the interest rates for a digital Euro even more, this requires negative interest rates on lending. This essentially means that commercial banks who borrow money from the central bank would have to pay less money back. A working paper published by the ECB explicitly states that a CBDC could allow its issuer to overcome the zero-lower bound on lending rates.²¹

Since something like this has rarely been tried before in the history of central banks, it is impossible to say what the consequences would be on the economy. Already, economists warn about the dangers of having low interest rates for a prolonged timespan. As banks must operate under a lower interest margin, they have an increased risk of failure. This is currently the case throughout much of Europe.

At the same time, this creates an environment in which uncompetitive businesses are allowed to stay on the market, since they have access to cheap business credit. This could lead to a huge economic bubble forming within the Eurozone, so it is highly questionable whether a negative lending rate would be advisable.

Another equally extreme measure to increase inflation rates is the issuance of helicopter money, i.e. handing out equal amounts of money to every citizen. A CBDC could potentially facilitate this process, which we might see in action with the current COVID-19 pandemic.

Recently, there have also been discussions in Hong Kong about a potential relief plan that foresees a handout of 10,000 Hong Kong Dollars (~\$1300) to every adult citizen.²³ While if implemented, this would be the fourth such handout since

2011, this scheme is different from helicopter money, as the money is drawn from government reserves, instead of inflating the money supply.²⁴

Retail vs. Wholesale CBDC

To sidestep many of the issues with instating a retail CBDC, available to individual people, businesses, and banks in an economic zone, the central bank could opt to instate a wholesale CBDC. Wholesale CBDCs are available only to financial institutions, and would essentially allow for large settlements to clear much faster. While this would not create a “digital cash” that solves some of the privacy concerns currently at play, it would be much simpler to implement.

Their hope is that improved large scale payments will fend off the risks of private stablecoins, and can be implemented more quickly without many of the risks associated with a broader retail CBDC.

France’s central bank has been quite vocal in calling for a wholesale CBDC, citing outdated cross-border payment methods as a reason to move forward. Additionally, fears of poorly conceived stablecoin approaches from the private market, mean that France feels a wholesale CBDC needs to be implemented soon. Their hope is that improved large scale payments will fend off the risks of private stablecoins, and can be implemented more quickly without many of the risks associated with a broader retail CBDC.

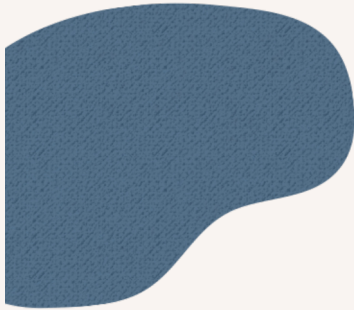
Benefits of a Wholesale CBDC

A wholesale digital currency could boost trade, both between EU member states and countries outside of the EU, as it will make cross-border payments faster and easier between banks. Despite being the largest trading bloc in the world, the Eurozone’s economic growth is fairly slow. In 2019, the Gross Domestic Product (GDP) growth in the Eurozone was only 1.2% compared to the US GDP growth of 2.3%.²⁵ France’s calls for a wholesale CBDC are a clear move to reinvigorate the EU’s trading power.

If the Chinese central bank succeeds in its attempts to create a digital Yuan, this might weaken the Euro as well.

Besides competition from the private sector, the ECB faces heavy competition from other central banks. The People’s Bank of China is currently pushing to be among the first to release a CBDC, named Digital Currency Electronic Payments (DCEP). This is largely seen as an attempt to upset the current global hold that the US-Dollar has.

If the Chinese central bank succeeds in its attempts to create a digital Yuan, this might weaken the Euro as well. Therefore the ECB faces pressures to act quickly in order to keep up with the competition from other central banks.



However, due to the size and diverse nature of the zone that the Euro serves, quickly implementing a digital Euro seems unlikely.

While wholesale CBDCs are exclusionary by nature since they can only be used by financial institutions, they can offer a testing ground for the ECB to run their first CBDC experiments. When successful, these experiments could be upscaled towards a fully-fledged retail CBDC, similarly to how the Euro was initially implemented as an “invisible” currency for three years, before retail adoption.²

Brexit and other Eurozone Opt-outs

Aside from the technical and societal considerations that must be taken, political shifts have also raised concerns for the Euro. Brexit heralded a shift in the EU and its political and financial power in the world. With it, there are increased fears that other member states will also opt to leave the EU. Quite a few political parties present in both the European Parliament and the parliaments of their respective home countries, call for their country to abandon the Euro and return to their previous national currency.

As the current sentiment is to move away from both the EU and the Euro, garnering further commitment to the ECB through a CBDC is a precarious position.

The reasons cited for this are concerns for the Euro’s stability and national sovereignty. Especially for the countries that were the most affected by the financial crisis of 2008, such as Greece and Italy, voices were raised that called for those countries to either withdraw voluntarily, or to be expelled from the Eurozone.²⁶

The EU is in a difficult position, as there might be more pressing issues than launching a digital Euro. As the current sentiment is to move away from both the EU and the Euro, garnering further commitment to the ECB through a CBDC is a precarious position. Moreover, since at least one member state, namely France, is planning to introduce a national CBDC, this could be seen as a first step towards a soft opt-out of the Euro.

With all the problems both the EU and the ECB are facing, they might have to rethink the role of the Euro. The argument brought against centralised systems is that they create a single point of failure. The same is true for the heavily centralised Euro: if an economic bubble bursts within the Eurozone, all member economies will face a major depression. The fallout of the current COVID-19 global pandemic may expose this fragility.

As such, it might be desirable to add a certain degree of decentralisation to the Euro, by allowing countries to launch their own CBDCs.

While changes to the system are unavoidable, it will likely be slow, however there is still room for commercial banks to be incorporated in these new systems.

As such, it might be desirable to add a certain degree of decentralisation to the Euro, by allowing countries to launch their own CBDCs. These could be retail CBDCs intended to be used by private persons and businesses within their respective national borders, while a digital Euro can be used for cross-border payments.

In a less drastic measure, the ECB might also allow national banks to create their own wholesale CBDC, which can be upscaled to a retail CBDC in the case of a Euro failure. This would create a failsafe mechanism for countries to safeguard themselves against a major crisis within the Eurozone. However, the financial impacts of partially fracturing the Eurozone are unclear, and require further research.

Industry Impact

A CBDC will have major impacts on commercial banks. Many speculate that it will lead to greatly diminished reliance on commercial banks, and could thus threaten their existence, especially if CBDCs are ultimately seen as a replacement for cash. This could have serious repercussions for the 6000+ banks operating in the EU and the 2.67 million people employed by these credit institutions.²⁷

However, there is also a need for validators and service providers. Some plans for CBDCs foresee that this work would be outsourced to commercial banks. Transforming these institutions to provide this work could prove to be difficult and will likely take a lengthy process. While changes to the system are unavoidable, it will likely be slow, however there is still room for commercial banks to be incorporated in these new systems.

Other Considerations

Introduction of a CBDC raises many questions about other financial services, as well. For instance, if CBDCs remove many commercial banks from the market, what will happen to these loan options? Will the central bank become the only lender that is available?

Also, how does this play into the idea of negative lending rates? Should private persons and businesses even be allowed to take out loans at a negative interest rate, or should this privilege be reserved to banks? Regardless, limitations must be applied to lending.

Decentralized Finance (DeFi) is a potential alternative with

growing importance. DeFi is developing means of providing loans and other financial services without banks or other intermediaries. However, this market is in its infancy, and not yet scaled enough to replace all financial services.

Another consideration is that CBDCs will likely facilitate forex and cryptocurrency trading as well. This may once again threaten the sovereignty of central banks.

05

Summary and Conclusions

Summary and Conclusions

At present, the ECB is cornered by various threats to its financial strength. The position of the Euro as one of the world's reserve currencies could be diminished by cryptocurrencies such as Bitcoin, private large-scale stablecoins such as Facebook's Libra, and other national banks' CBDCs which will likely beat the ECB in the race to market.

Since the introduction of the Euro as a common currency was already a controversial move, and remains so to this day, introducing another layer on top of that with a CBDC is a challenging task. It will once again require all member states to align interests.

In that regard and considering all technical and societal challenges, a wholesale digital Euro would be far easier to implement than a retail CBDC, and would likely face less political resistance. However, wholesale CBDCs are somewhat exclusionary, as only institutions can profit from their capabilities. Allowances for national Eurozone banks planning their own CBDCs also remain to be determined.

While the ECB has halted Estonia's plans to introduce a CBDC, they have not attempted to stop France, largely as the French national bank made it clear that they are only considering a wholesale CBDC.

Clearly, national banks creating their own currencies within the Eurozone is a danger to the ECB, as this plays into the hands of Euro-critics. Despite this, there are certain benefits to letting national banks create their own wholesale or retail CBDCs, as these would be easier to implement on a national scale, than for the entire Eurozone.

Individual national CBDCs would not necessarily mean that the Euro failed, even if there is a widespread return to national currencies. First of all, this would ease some of the political and economic tension surrounding the Euro and could even prove as a saving measure if there is another economic crisis in the upcoming years. Such national retail CBDCs could then be used for intranational payments, while a wholesale digital Euro facilitates cross-border payments.

This approach would also give a certain degree of national sovereignty back to Eurozone members, by letting them choose how they want to implement their national CBDCs. Some countries that are more progressive towards blockchain technology might want to put more emphasis on

Individual national CBDCs would not necessarily mean that the Euro failed, even if there is a widespread return to national currencies.

decentralisation with semi-permissioned, or even one day permissionless blockchains. However, we expect almost all initial implementations to be focused around permissioned or hybrid solutions.

National and wholesale implementations add some interesting considerations, but there are many technological and societal challenges to overcome first.

Whether we are able to realise the concept of digital Euro seems quite a way off. National and wholesale implementations add some interesting considerations, but there are many technological and societal challenges to overcome first. We hope our analysis helps more people understand the problem at hand and helps promote more conversations on the topic.





About dGen

After Gen X, characterised by big societal shifts, Gen Y, better known as millennials, and the digital native Gen Z, the **decentralised generation** will grow up in a future shaped by different dynamics and technological developments. AI, blockchain technology, and IoT will individually bring disruption to many industries, but it's at the crossroads where we expect our whole socio-economic fabric to change.

dGen is a not-for-profit think tank based in Berlin, Germany. We focus on how blockchain technology can contribute to a decentralized future in Europe and what this might mean for people, society, private entities, and the public sector over the coming decades.

Emerging technology focused on decentralising society will shape the next part of the twenty-first century; The dGen will grow up with opportunities for borders to fade and traditional networks to dissipate. Meanwhile, most blockchain developments are still in the early stages; focusing on building solid products and exploring regulatory requirements to create a fertile yet safe environment for companies and investors. The industry is focused on solving the big topics right now, while we encounter a lot of great ideas in the blockchain community about adoption. It's time for those ideas to find a purpose and for the real decision-makers in the world to learn what decentralisation will mean for them.

We're working with a team of researchers exploring how decentralisation will shape our future. Our insight reports focus on specific topics and industries to drive ideas for adoption in Europe. If you're researching how decentralisation is shaping our future, and would like to get involved, please get in touch at dgen.org.

dGen is part of Beyond, a venture studio exploring a new world. For more information, go to beyond.ventures.

Contributors

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Before founding dGen, Jake was originally a partner at Signal Ventures, investing in blockchain tech. In late 2017 he founded hype partners to help build and nurture ecosystems for blockchain projects and has worked with many top 100 projects. Jake is one of the founding partners of Beyond, a venture studio exploring a new world.

Nick Dijkstra



One of the founders of dGen and with a rich background in tech, Nick is a former Product Manager and Director of Customer Success. He shipped software to a user base over 15% of the US population and has organised 200+ events in Berlin. At hype partners he is currently helping top-tier blockchain firms strategise their market approach and is one of the founding partners of Beyond.

Tobias Kaiser



Tobias is a cryptoeconomics researcher focused on tokenomics and decentralized business models. His academic background combines computer science, cognition, and economics.

Maggie Clarendon



Maggie is a writer, researcher, and editor. Trained in literature, critical theory, and gender studies, they are now exploring the ways that technology is changing the landscape of human interaction.

Francisco Rodríguez Berenguer



Francisco has a degree in Business and Law, and is currently working for dGen to communicate its vision for blockchain adoption to an audience of thought leaders in tech companies, corporates, and the public sector as a researcher and marketer.

Paula Petkevič



Paula is a recent graduate from the Vilnius University where she obtained a degree in Business Information. She has a background in SEO and online marketing.

Interested in Partnering on Our Next Report?

We're looking for partners operating in blockchain ecosystems, corporates, universities, the public sector, and other stakeholders to engage in conversations about how blockchain and emerging tech is shaping the decentralised generation.

We're open for any collaboration on this topic and the broader study of decentralisation in Europe.

You can reach us at partners@dgen.org for more information.

Research Agenda

Developments in Decentralised Finance (DeFi)

Scheduled
Q2 2020

Made in Italy - Safeguarding Artisans From Counterfeiting

Scheduled
Q2 2020

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