

Digital Transformation and the Economics of Banking

Economic, Institutional,
and Social Dimensions

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Chapter 10

Sustainability, Public Security, and Privacy Concerns Regarding Central Bank Digital Currency (CBDC)

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10 Sustainability, Public Security, and Privacy Concerns Regarding Central Bank Digital Currency (CBDC)

Robert Rybski

10.1 Introduction

Currently, over 100 central banks research or develop their own central bank digital currency (further CBDC) (Stanley, 2022). Four projects have already moved into production: DCash in March 2019 (issued by the Eastern Caribbean Central Bank), the Bahamian Sand Dollar in October 2020 (Central Bank of Bahamas), the eNaira in Nigeria in October 2021 (Central Bank of Bahamas) and Jam-Dex in August 2021 (Bank of Jamaica). One major central bank – The People’s Bank of China – currently undertakes an advanced pilot project of CBDC (Bansal & Singh, 2021). Considering this overall development, introducing CBDC by at least one major central bank in the coming years seems unavoidable. This would form a tipping point for the massive spread of CBDC implementations. From that moment, CBDC would stop occupying a niche and would rather enter the mainstream of the banking sector.

For those reasons, it is worth assessing CBDC projects broader than the central banks often tend to. This chapter considers potential concerns regarding the introduction of CBDC – not only whether to introduce it but also what design criteria should be considered. Vocalizing those concerns (and potentially addressing them) at an early stage allows appropriately adjusting the design of CBDC projects. Potential changes at the level of CBDC projects will also bring results at the macro level. Changes suggested by this chapter will generally influence the banking sector’s economic and social effects that this book focuses on – either by extending and reinforcing them or mitigating some of them.

The most obvious concern concerning CBDC concerns central bank money’s public security in the era of growing cyber threats. The other evident concern concerns privacy issues towards the state and keeping information on individual finances secret. However, one particular angle of discussions on CBDC does not get enough attention – sustainability.

Thus, this chapter aims to assess whether and how currently developed projects of CBDC include issues of sustainability, public security, and privacy. Prioritizing the sustainability issue might not have been the case within the

projects currently developed. This chapter assesses different areas of CBDC from the broad perspective of sustainability, with conclusions addressing areas worth further development to increase the implementation of sustainability by the central banks. It then reconstructs a design of CBDC that would be most desired from the perspective of sustainability, public security, and privacy.

Central banks are faced with a hard decision – whether they go forward with their scoping projects on CBDC (or even go live with their pilot projects). Including at every level of CBDC projects, sustainability issues, public security, and privacy concerns might be a trump card for those projects. As a result, CBDC projects might gain economic significance and social acceptance provided that central banks can show through those projects full inclusion of sustainability, public security, and privacy.

10.2 CBDC as Financial Technology

Since this chapter concentrates on particular design aspects of CBDC, there is no need to further address basic questions concerning what money is (Gormez, 2019; Schnabel & Schin, 2018); forms of money exist nowadays (Board of Governors of the Federal Reserve System, 2022, p. 5); what is fiat money (Gormez, 2019); what forms good money (Schnabel & Schin, 2018); what currency (Bossu et al., 2020), or legal tender means (Bossu et al., 2020, pp. 31–33).

The Committee on Payments and Market Infrastructures Markets Committee of the Bank for International Settlements defines CBDC as a “digital form of central bank money that is different from balances in traditional reserve or settlement accounts” (CPMI-MC, 2018). As a result, CBDC bears no credit and no liquidity risk (Board of Governors of the Federal Reserve System, 2022, p. 16), because it has the status of central bank money. Nevertheless, not every CBDC is developed based on distributed ledger technology¹ (further DLT); apart from token-based CBDC (based on DLT), more traditional account-based CBDC can also be developed. With many pros and cons of each of the token-/account-based approaches, it is worth underlining that there is limited scalability of CBDC developed on a decentralized ledger (Ahnert et al., 2022), so developing it to offer this service to massive customers, brings as a result massive increase in ecological footprint. Quick implementations of the CBDC account-based retail system seem well-fitted, as it could mostly use technologies already in place at banks (Schwarcz, 2021). For example, Chinese CBDC does not use the DLT technology (Bansal & Singh, 2021, p. 6).

When considering accessibility, there are three basic types of CBDC (Bossu et al., 2020):

- 1 Wholesale CBDC – with direct access to central bank money limited mainly to banks – it’s a form of business as usual CBDC model.

- 2 Retail CBDC (that is, without wholesale) – with access to central bank money enabled directly to individuals, including non-banking entities. In this scenario, “wholesale” entities keep direct access to central bank money based on existing infrastructural arrangements.
- 3 CBDC for general purposes – access to central bank money within the CBDC project enabled both for “retail” and for “wholesale” entities.

It is worth noting that digitalization is not a novel feature of CBDC because many forms of money have already been digital for years (Carstens, 2018). However, the innovation of CBDC does not come with its digital nature but rather with broad access (Bilotta & Botti, 2021) – retail CBDC has appropriate potential as an innovative financial technology (Cirasino, 2021), because banks already have access to central bank money (CPMI MC, 2018).

10.2.1 CBDC as Programmable Money

The final technical aspect of CBDC that requires presenting concerns the circumstance that CBDC can be programmable. This feature of CBDC became viral at some point, and discussions within public opinion steered in the direction as if the true aim of CBDC was to introduce money with an expiry date. This public notion misses the point as the basic function of introducing an expiry date for pre-defined amounts is to allow offline usage of CBDC and thus allow double spending of electronic money (Kahn et al., 2021). The expiry date for money issued in the form of CBDC could also have application in case of stimulating the domestic economy – either in *ad hoc* packages (helicopter money) – or in the case of a long process of restructuring the economy by stimulating consumption (e.g., Chinese attempts).

10.3 Why Do Central Banks Develop CBDC?

The motivation for central banks to develop CBDC projects is numerous and diversified. These motifs will not always appear jointly, but a general overview of those motivations explains their usefulness. Surprisingly motivational reasons are not that different for general-purpose CBDCs and wholesale CBDCs (Barontini & Holden, 2019, p. 9), and they will thus not be analysed separately. Similarly, also motivations for emerging economies and advanced economies share common grounds. However, in the case of advanced economies with efficient financial systems, the incentives to develop new technology (CBDC) with risks to be identified are not that strong (Chorzempa, 2021, p. 110).

The basic motivation for developing CBDC seems to be increased demand for electronic payment combined with a decline in usage of banknotes (cash) – either as a future projection (Boonstra, 2022; ECB, 2020, p. 10) or as an already happening scenario (Chorzempa, 2021; Barontini & Holden, 2019; Sirai, 2019). By developing CBDC, central banks can adapt to this

megatrend of increasing cashless payments (Bilotta & Botti, 2021). Under this motivation is an attempt for the CBDC to allow using it the same way cash is used today (ECB, 2020, p. 11). That is why the central banks of Sweden and Uruguay, where increased demand for electronic payment and a decline in usage of banknotes (cash) occurred, developed the general-purpose version of CBDC (Barontini & Holden, 2019). This will guarantee the public with offering access to legal tender in the growing cashless transactions (Bilotta & Botti, 2021). More cashless transactions result in the currently growing exposure (in the areas of credit and liquidity risk) to commercial banks and especially to non-banking payment system operators – the introduction of CBDC results in shifting some of those risks back to the central bank (Cirasino, 2021; Bindseil, 2019). Reduction of credit and liquidity risk in the financial system would result from the settlement of securities (that is, cash legs of) transactions in CBDC (CPMI MC, 2018). Moreover, some CBDC implementations mimic cash characteristics, but in the end, CBDC will only have some characteristics of banknotes (Boonstra, 2022). A clear example of similarity to cash forms lack of charging users by the payment system operators in the Chinese pilot project (Bansal & Singh, 2021).

The other basic motivation concerns payments safety and efficiency (Barontini & Holden, 2019; Laboure et al., 2021; Ward & Rochemont, 2019). Surveys from central banks of emerging economies also show that CBDC aims to incorporate the informal economy and fight financial crime (Barontini & Holden, 2019). Further application of CBDC could be a transmission of monetary policy (ECB, 2020). This could be undertaken by appropriately setting the remuneration rate on CBDC (ECB, 2020).

Surprisingly, the motivation for the development of CBDC might also be very general – with a policy purpose for the whole financial system. The European Central Bank might decide to develop CBDC in order to “foster the digitalisation of the economy” (ECB, 2020), but such motivation is also present in the case of central banks from emerging economies (Barontini & Holden, 2019; Laboure et al., 2021). This digitalization could discourage using cash and supporting electronic payments (Barontini & Holden, 2019). This could even take the form of developing a “cashless” society (Barontini & Holden, 2019). Nevertheless, with digitalization, new features of central bank money can be applied. Chinese CBDC pilot programme explores the potential of programmable money (Bansal & Singh, 2021). Application for financial institutions could result in the central bank issuing inactive digital currency, which would be activated after meeting certain conditions – for example, keeping appropriate interest rates (Bansal & Singh, 2021). Applications for the general public have already tested limiting particular issuance of CBDC to enable spending it only on public transportation – without the possibility of re-converting it for general purposes (Bansal & Singh, 2021).

There is a further untold part of the story to CBDC. CBDC projects are developed because “many central bank-operated wholesale payment systems are at the end of their technological life cycles” and those systems

“are programmed in obsolete languages” or they “use database designs that are no longer fit for purpose and are costly to maintain” (Bech and Garratt, 2017, p. 66). It must be noted, however, that few central banks have implemented a new interbank settlement system (Eurozone, Australia, Hong Kong, Brazil) or are implementing it – like US Federal Reserve and Swedish Sveriges Riksbank. But there is another cost: the central banks do not thematize that much in their reports on CBDC, which the CBDC projects can address. Providing constant access to physical cash is a high cost that CBDC, a less costly version of currency, could lower (Allen, 2022; Chorzempa, 2021; Cirasino, 2021). At the same time, introduction of CBDC could lead to increases in seignorage revenue for central banks (Bindseil, 2019; Cirasino, 2021) – although opinions in this regard are mixed (Ward & Rochemont, 2019).

Materialization of a scenario in which foreign central banks offer CBDC has three dimensions that motivate the development of its own CBDC. Firstly, such a scenario brings currency substitution risk and increases the economy’s FX risk (ECB, 2020). The development of its own CBDC is perceived as a factor supporting its currency’s sovereignty and stability (ECB, 2020). Secondly, geopolitical considerations might also stand behind the development of its own CBDC (Boonstra, 2022; Chorzempa, 2021; Laboure et al., 2021). This is the case with the Chinese CBDC project (Allen, 2022; Knoerich, 2021). It is also clearly visible in the case of the US Dollar (further USD), as the potential development of the digital dollar in the form of CBDC is perceived as a measure to preserve the “dominant international role” of the USD (Board of Governors of the Federal Reserve System, 2022, p. 15). Thirdly, development by major central banks their CBDCs can be motivated by the issue of global usage of their currencies. This means preventing a scenario in which the international role of its currency decreases. This is a clear case of the Euro, which forms approximately 21% of foreign currency reserves – the lack of the Eurozone’s CBDC will diminish the international position of the Euro (Boonstra, 2022). Developing CBDC could thus increase the demand for its currency (ECB, 2020, p. 14) or lead to its true internationalization (cf Bansal & Singh, 2021, pp. 10–15). The existing dominance of the USD representing around 60% of foreign currency reserves (Bansal & Singh, 2021) is based on “reliable rule of law, strong and transparent institutions, deep financial markets, and an open capital account” (Chorzempa, 2021, p. 112). The same foundations will also be present in the case of possible internationalization of national currencies offered in the form of CBDC (or lack of materialization of such scenarios).

CBDC could also be developed as an introduction of a parallel payment system (Cirasino, 2021; ECB, 2020). This parallel function is based on ensuring legal tender for CBDC (Ward and Rochemont, 2019). Scenarios in which such a backup system would be needed concern the materialization of emergency scenarios like cyberattacks on existing (private) infrastructure of payment systems or natural disasters (Cirasino, 2021; ECB, 2020). CBDC could

also be used to immediately pay out support to the general public (helicopter money) – as in some jurisdictions during the COVID-19 crisis (Bindseil, 2019; Cirasino, 2021).

An interesting perspective on CBDC is one of central banks from emerging economies – for their development of CBDC brings a clear benefit of increasing financial inclusion across society (Barontini & Holden, 2019; Boonstra, 2022; Chorzempa, 2021; Laboure et al., 2021). Because of shortcomings in existing financial infrastructure, potential disruptions caused by CBDC would be limited in emerging economies, thus encouraging even more to use this new technology (Barontini & Holden, 2019). This is a clear example of leapfrogging concept because implementations of CBDCs (along with advanced pilot projects) have already happened solely in emerging economies. One must note that motivations concerning promoting financial inclusion are present in emerging economies, and the US Federal Reserve marks for further research potential gains from CBDC for economically vulnerable households and communities (Board of Governors of the Federal Reserve System, 2022, p. 16).

CBDC is also seen as a chance for simplifying, accelerating, and reducing cross-border payments costs (cf Bansal & Singh, 2021, pp. 7–10; Board of Governors of the Federal Reserve System 2022, p. 15; Cirasino, 2021; Laboure et al., 2021). Further motivation for central banks could be improving cross-currency payments thanks to improving interoperability among payment systems dealing with different currencies (ECB, 2020, p. 14). It must be noted in this regard that to increase interoperability, openness is required. For instance, Federal Reserve System committed to publishing as open-source all the codebase that will be developed (Chorzempa, 2021, p. 112). On the other hand, developing interoperability could mean avoiding sanctions enforced by the US, because cross-border transactions will bypass the SWIFT system (Boonstra, 2022).

Similarly, potential engagement in developing CBDC might be an intent to decrease the ecological footprint of the monetary and payment systems by introducing an energy-efficient CBDC and putting pressure on other payment system operators to do the same (ECB, 2020, p. 14).

The final motivation (that quickly gained traction) is connected with the massive deployment of private digital tokens (digital crypto-assets developed based on DLT technology in the form of global “stablecoins”). This covers a scenario in which a particular private global “stablecoin”, developed by a foreign private entity (without financial supervision), acquires a global footprint and becomes popular for retail payments in a particular jurisdiction (ECB, 2020). In such a scenario, CBDC could be developed as a measure to prevent displacing central bank money in transactions (CPMI MC, 2018; Laboure et al., 2021), to keep payments under supervision in a given jurisdiction (ECB, 2020) as well as to keep control of what constitutes money intending to manage the economy effectively (Laboure et al., 2021) and to ensure financial stability (Boonstra, 2022). Of course, central banks became

very interested in exploring the consequences of this scenario (and started working on their own CBDC) after Facebook announced in 2019 the developing Libra (Auer et al., 2020). Paradoxically, if any global stablecoin establishes itself, then potential benefits from introducing widely accessible CBDC might not be limited (Ward & Rochemont, 2019). For those reasons, the broad implementation of CBDC seems even more probable.

10.4 Legal Framework for Central Banks to Develop CBDC

Presented motivations must consider the legal frameworks within which the central banks operate. In a state governed by the rule of law, every action of state authorities (to which also central banks belong) requires an appropriate legal basis with doubtless competencies to act (in this case – to introduce CBDC). Initial assessments of legal frameworks (that cover central bank law and monetary law) show that domestic jurisdictions generally either lack a robust legal basis that would allow central banks to have a full flexibility on the scope of CBDC (wholesale/retail/for general purpose) and the technical (account-based/token-based) side (Bossu, 2020; Schwarcz, 2021) or... central banks “remain unsure” whether they have the authority to proceed with CBDC (Boar et al., 2020).

Those assessments bring us to three possible scenarios covering the implementation phase (stretching from pilot project to fully fledged implementation). The first scenario covers a situation where a central bank develops only such a CBDC for which it has a sound legal basis (in most cases, this would be wholesale CBDC). In the second scenario, a central bank either freezes or drops further work on CBDC (till domestic law is changed appropriately). In the third scenario, the national lawmaker changes the law to allow the central bank to introduce a particular type of CBDC.

From those three scenarios, the most desirable one seems to be the third scenario because the engagement of lawmakers gives a chance to win public acceptance for the CBDC project. Otherwise, CBDC might be perceived as a technocratic project without many benefits for Main Street (contrary to Wall Street).

10.5 Why Is CBDC Not Only About Central Bank Money and Monetary Policy?

Current discussions concerning CBDC concentrate on the policy angle and technological dimension. However, CBDC is not only a story of central banks entering the area of electronic payments, the realm of private financial institutions (with many FinTech enterprises active in this area), because CBDC will have brisk economic and social effects. Thus to properly perceive the development of CBDC, arises the need to assess whether and how currently developed CBDC projects include issues of sustainability, public security, and privacy.

10.6 Linking CBDC with Sustainability

The easiest starting point for assessing CBDC from the perspective of specific areas is the one that has recently become viral – sustainability, especially since School Strike for Climate (Wallis et al., 2021; Wehrden et al., 2019), almost every public and private entity started presenting its efforts towards sustainability. In this context of plenty, interesting results brought public consultation on a CBDC developed by Eurosystem (digital euro). Respondents await a few features of the digital euro: “privacy, security, usability, low cost and accessibility” (ECB, 2021). Not a particular word demanding the inclusion of sustainability seems to be coming out of this public consultation. However, this emptiness does not arise from the lack of interest of the general public in regard to sustainability but from the construction of the text that was shared then within public consultation (ECB, 2021, pp. 35–37). The template for public consultation lacked any reference towards sustainability and any potential different policy choices that could be taken on this front. Although authors of the text of public consultation were seeking feedback from future users of the digital euro on its preferred features, the lack of any gradation on this front is hard to follow. If that option was included, the general public might come back with a demand to implement strict changes supporting a high level of ambition regarding sustainability. An example of potential ecological gains already pops up during discussions regarding scoping the final design of Eurosystem’s CBDC – choosing an offline payment tool results in lower energy consumption – compared to payment devices being non-stop connected (ECB, 2020, p. 31). However, public consultation – when it polls on whether payments through CBDC should be confirmed online or offline lacks any reference towards energy savings coming along with choosing offline functionality (ECB, 2021, pp. 35–37). Similar omission of sustainability issues also happened in public consultation undertaken by the Federal Reserve System (Board of Governors of the Federal Reserve System, 2022).

The lack of sustainability issues inclusion in the Eurosystem’s public consultation and the US Federal Reserve System is remarkable. Already preliminary report on Eurosystem’s CBDC discussed (a little) energy efficiency and ecological footprint of payment systems in regards to the potential introduction of digital euro in the form of CBDC (ECB, 2020, p. 15). ECB (2020, p. 15) has noted that “payment instruments and infrastructures may not always be energy-efficient” and it further underlined that a “well-designed digital euro may thus help to reduce the overall costs [...] and ecological footprint of euro area payment systems”. This enigmatic statement (regarding reduction of overall costs) most probably refers to reducing overall costs thanks to the reduction of energy costs by increasing energy efficiency. ECB stressed further that the Eurosystem should

play a catalyst role and lead by example [...] creating incentives and putting pressure on providers of payment services to reduce their costs

and ecological footprint. This would be achieved by highlighting the cost and energy efficiency of the digital euro, compared with other payment solutions, when promoting its use.

(ECB, 2020, p. 15)

Despite the lack of addressing the issue of ambitions regarding sustainability during public consultation, ECB confirmed that it treats the sustainability dimension seriously within its CBDC project by including two straightforward requirements in the design of the future Eurosystem's CBDC. According to ECB, digital euro should thus be (a) cost-saving² and (b) environmentally friendly.³ This statement and those requirements on the design of the digital euro form a clear declaration that CBDC, developed by ECB, intends to compete with private payment providers on the front of ecological footprint (including its energy efficiency).

This particular development within Eurosystem has at least seven dimensions – and most of those findings are universal (that is, relevant to every jurisdiction). Firstly, offering a low-carbon payment system might open a new toolbox with measures to help achieve climate policy goals. Secondly, by introducing CBDC designed sustainably, central banks can give their input into climate policy.⁴ The amount of this input will depend on two things:

- 1 How much priority will the central banks put into minimizing the ecological footprint of CBDCs and
- 2 the scope of CBDC – the broader the application of CBDC then, the more input they can bring.

Thirdly, this new climate policy measure (namely, using CBDC payment infrastructure with a lower carbon footprint) will vehemently open the market for new services: low-carbon payment services. Fourthly, this development, on the one hand, might be perceived as a partial squeeze-out of private actors out of the market of low-carbon payment services. This is the case because public authorities (i.e. central banks) will use public funds to develop and start offering this service (even if that is not the initial motivation of central banks developing CBDC). On the other hand, it must be noted that in the area of sustainability, this leading role of public bodies is much needed and welcomed to increase environmental standards. Fifthly, despite considerations regarding limiting access to CBDC developed by ECB for actors outside the Eurozone (ECB, 2021, p. 29), introducing the digital euro in this low-carbon form will attract an influx of assets handled by the actors willing to lower their ecological & carbon footprint. Global (payment) providers might want to switch to the broadest possible extent to using CBDC (instead of developing their low-carbon solutions). It becomes a policy question to what extent the central banks will be willing to welcome this influx of assets in seeking this low-carbon payment service. Sixthly, other central banks developing CBDC will need to follow the standard set by the Eurosystem. Otherwise, using their currencies for payment purposes might become

much less attractive with further monetary consequences (already recognized by central banks). Seventhly, such an approach gives hope that CBDC developed by central banks will not one day be assessed as socially wasteful and environmentally bad – as nowadays central bankers assess mining bitcoins (Carstens, 2018). Taking into account the critical approach of central banks towards crypto-assets, it is thus important for central banks that CBDC differs from crypto-assets in a way that CBDC includes sustainability.

10.7 Designing CBDC in Accordance with Sustainability

Sustainability issues in the payment system (such as CBDC) are focused on the energy intensity and emitting greenhouse gases (further GHG). However, sustainability is much more than that because it influences the economic and social effects of the banking sector that this book analyses. Firstly, the sole concept of sustainability is diversified as there are different “shades of sustainability” (Rybski, 2022), which represent different levels of ambition – starting from the growth-oriented concept of green growth through just transition, sustainable development, and towards degrowth concepts. Secondly, sustainability covers direct environmental impacts and social and governance issues. This is especially visible in the case of the 17 United Nations Sustainable Development Goals⁵ (further SDGs). For simplification purposes, the framework of SDGs will be used as a reference point to analyse CBDC’s links to sustainability – with full awareness of criticism of SDGs (Spaiser et al., 2017). One must also note that because agencies of the United Nations traditionally promote the concept of green growth (Kasztelan, 2021), that is, decoupling economic growth from GHG emissions, the level of ambition represented in the 17 UN SDGs also remains strongly (green) growth-oriented. Out of all seventeen SDGs, eight (i.e. SDGs 1,⁶ 5,⁷ 8,⁸ 9,⁹ 10,¹⁰ 12,¹¹ 13,¹² and 16¹³) remain relevant in the context of CBDC. Because the structure of SDGs is based on achieving them in 2030 – for that reason 169 indivisible targets were introduced. Thus further assessment of CBDC will include making connections of particular design features of CBDC that could help achieve particular SDG.

10.7.1 *Maximizing Decreases in Energy Usage by Payment Systems*

Implementing the assumption of achieving low energy intensity of CBDC (and low GHG emissions) and making it work in practice requires making a few choices already at the design phase. Two choices relating to the basics of the structure have to be made. The first concerns whether settlements will be undertaken within a centralized or distributed ledger infrastructure – where the centralized ledger lowers CBDC energy consumption (Lee & Park, 2022). Another vital characteristic is the potential usage of renewable energy (or carbon-neutral electricity).

In the case of a centralized system, it is relatively easy for the central bank also to decide (or leave it as an option for the future) to run CBDC on renewable energy (or on carbon-neutral electricity). In the case of distributed ledger infrastructure, the possibility of reducing ecological footprint by deciding on the energy consumption choice looks bleak. Within a CBDC based on distributed ledger infrastructure, the central bank would lose influence on the type of energy consumed because it would depend on particular energy consumed for processes within a particular ledger. In most cases, this would mean using electricity coming directly from the power grid – and GHG emissions of such a CBDC (based on the distributed ledger) would be fully dependent on the carbon intensity of the power grid in a particular country. Because the implementation of CBDC will probably be much ahead of carbon neutrality of power in most jurisdictions, then keeping energy intensity as low as possible is the most important issue in controlling the ecological footprint of CBDC. Despite some opinions regarding energy consumption of cryptocurrencies and future CBDC that “energy consumption, per se, is not an issue in the context of climate change” (Laboure et al., 2021), it must be noted that reducing energy consumption as fast as possible should be the highest priority (also in the case of CBDC), because lasting reduction of energy consumption is much more valuable than an effort to decarbonize the same amount of energy out of four reasons:

- 1 Renewable energy installations are not produced and transported currently with carbon neutral energy.
- 2 Before whole energy used for the purpose of cryptocurrencies or CBDC is carbon-neutral, already vast amounts of GHGs will be emitted (in regards to the amount of energy that could have been saved).
- 3 The same renewable energy (or other carbon neutral) capacity that was intended to be used for cryptocurrency or CBDC, could already be used for further decarbonizing the energy consumption.
- 4 Decarbonizing energy mix is an effort that is based on the (relative) share of renewables in global energy consumption – thus reducing energy consumption (without increasing the energy output of renewables that mostly generate energy one way or the other) – remains the most efficient way to decarbonize our energy mix. Those circumstances cause that while developing CBDC, central banks should decrease the energy usage of CBDC to the maximum and put pressure on all payment system operators to introduce such a new standard.

The second design choice concerns the consensus mechanism, which is an additional computation used to increase the resilience of the system in the case when some of its members act maliciously (Lee & Park, 2022). Although this choice is relevant only for systems based on the distributed ledger, it immensely influences the energy intensity of potential CBDC based on it,

depending on the chosen method of proof and the number and distribution of entities participating in a system (Lee & Park, 2022; OSTP, 2022). This is why Bitcoin was intentionally designed to operate resiliently in a trustless environment, based on an energy-intensive computation process that secures its resilience (Lee & Park, 2022). However, this verification at every step of all the previously existing transactions results in absurd environmental impacts. Crypto-assets mining generated in 2022 around 110 to 170 million metric tons of carbon dioxide, with electricity usage in a range from 120 to 240 TWh per year (OSTP, 2022). This vast amount of yearly electricity usage is (for a lower estimate) equal to the electricity consumption of the whole economy of Argentina (around 0.5 USD trillion GDP in 2021) or (for a higher estimate) equal to Australia (around 1.5 USD trillion GDP in 2021).

Making design choices that will allow reducing energy usage – like limiting the number of participants – reduces system security level as it multiplies vulnerabilities to attack (Lee & Park, 2022). It must be noted that CBDC will not operate within an unfriendly environment in which trust has to be gained through the additional effort put into computation (as in the case of Bitcoin), but rather trust in CBDC stems from the sole fact that it is backed by a central bank (Lee & Park, 2022). Because of that, CBDC does not have to gain a resilience level similar to that of Bitcoin, so this already allows for lowering energy-usage thanks to a lack of computation or mining (Lee & Park, 2022). How low can energy consumption go regarding transactions with CBDC? This cannot be verified till a CBDC project of one of the main central banks goes into full swing, but some projections have already been made. Interesting findings compare electricity consumption per transaction, where Bitcoin required in 2020 around 700 kWh, Ethereum 30 kWh, USD paper money around 0.044 kWh, and credit card payment systems – Visa around 0.0008 kWh and Mastercard around 0.0006 kWh (Lee & Park, 2022; OSTP, 2022). Because a CBDC system can be designed with similar characteristics to the credit card network (Lee & Park, 2022), it could be estimated that the energy consumption of CBDC could be then located at the levels of the credit card payment system (instead of those energy consumption levels per transaction present in the case of Bitcoin). As a result, it would be very hard for central banks to develop a CBDC in such a way that it ends up as an ecological catastrophe. The proper design of CBDC is important to decrease its ecological footprint and to ensure social backing for CBDC because CBDC is a project developed by public authorities.

Payment systems developed by public authorities should not only consume excessive amounts of energy (and natural resources used for generating it) but also should rather use as low as possible. The potential to design CBDC in a way that should bring maximum decreases in energy usage by payment systems (which also brings pressure for other payment system operators to follow that central bank) has three strong anchor points in the UN SDGs. Firstly, such a design of CBDC would deliver towards the overall aim of doubling the “global rate of improvement in energy efficiency” (SDG 7 – target 7.3¹⁴).

Secondly, achieving as low as possible energy usage is also a sign of efficient use of natural resources that enables decoupling economic growth from environmental degradation (SDG 8 – target 8.4¹⁵ and SDG 12 – target 12.2¹⁶). Thirdly, this kind of approach towards developing CBDC would mean input of central banks into global actions against climate change (SDG – targets 13.2¹⁷ and 13.3¹⁸).

Summing up, if the CBDC is to be developed according to the sustainable development principles, it has to represent as low as possible energy usage.

10.7.2 Usage of Renewable Energy

The design of CBDC could also foresee that a CBDC runs solely on renewable energy (though not eligible for every form of CBDC). Taking such a policy choice would have an input into increasing renewable energy usage (SDG 7 – target 7.2¹⁹) as well measures that provide input of central banks into global climate action (SDG – targets 13.2²⁰ and 13.3²¹). This design postulates that central banks consider running CBDC on carbon-neutral and sustainable energy has rarely been expressed (G7, 2021; Lee and Park, 2022). However, as noted earlier, the most important thing is to keep energy usage at the maximum low level.

10.7.3 Input into Digitalization of the Economy

Some central banks perceive CBDC projects as an input into the digitalization of their economies. This approach plays along with the SDGs, as SDGs support achieving „higher levels of economic productivity through [...] technological upgrading” (SDG 8 – target 8.2²²) and also encourage to adopt “development-oriented policies that support [...] decent job creation, entrepreneurship, creativity and innovation” (SDG – target 8.3²³). As a result, only proceeding forward with the CBDC project to lower the amount of physical cash in the economy brings necessary input into the digitalization of the economy.

10.7.4 Reducing Costs of International Transfers due to Enhanced Interoperability

The common introduction of CBDCs by most central banks poses a chance to reduce costs of international. The condition for this constitutes developing CBDCs based on the interoperability of those systems. This feature should be developed by central banks from emerging and advanced economies. All those elements are crucial to achieving SDG 10, which directly requires to “reduce [by 2030] to less than 3% the transaction costs of migrant remittances and eliminate remittance corridors with costs higher than 5%” (target 10.c). Taking into account that remittances constitute significant capital influxes for many economies, all CBDCs should be developed to address this social aspect of sustainability.

10.7.5 *Fighting Financial Crime*

Sustainability (surprisingly) also includes the obligation to fight financial crime. This obligation has been directly phrased within SDG 16: “By 2030, significantly reduce illicit financial [...] flows, strengthen the recovery and return of stolen assets and combat all forms of organized crime” (target 16.4). CBDC projects should thus, from the beginning, include also an approach that requires fighting financial crime. On a practical level, this would mean the choice of introducing account-based CBDC (instead of token-based CBDC) to help fight illicit financing (Laboure et al., 2021).

Nevertheless, the sole introduction of CBDC should generally increase the standard of AML/CFTC compared to its current level (Sandner et al., 2020). This would also cope with SDG 10, which requires improvements in implementing already existing financial regulations (target 10.5), which also covers AML/CFTC regulations.

10.7.6 *Programmable CBDC*

Enhancing sustainability can also be approached from the most viral controversy around CBDC – from its... programmability. The programmable functionality of CBDC could be applied to increase the efficiency of measures undertaken within sustainable finance. In the case of Green Bonds, where proceeds should be spent on particular types of investments, using CBDC for that functionality could increase green bonds’ transparency (Laboure et al., 2021). Such a design option could then be classified as a measure towards achieving SDG 7 (target 7.2) and SDG 13 (targets 13.2 and 13.3). However, full functionality will be achievable when developing CBDC based on DLT (Sandner et al., 2020). This is a problematic aspect from the perspective of sustainability. On the other hand, to increase social acceptance of CBDC policy, stakeholders might want to develop CBDC in a technique that does not allow programmable functions.

10.7.7 *Ensuring Social Inclusion*

The motivation of many central banks to develop CBDC is connected with increasing financial inclusion within society. This has a few dimensions. Firstly, this covers engaging unbanked people (Laboure et al., 2021). Secondly, in the case of persons that live in rural or remote areas, CBDC should also increase their access to financial services (G7, 2021; Sirai, 2019). Thirdly, this improves the efficiency of payments and, as a result, improves the cost of money transfers – internally and internationally (Laboure et al., 2021).

This inclusive functionality of CBDC is broadly reflected within different aspects of SDGs 1, 5, 8, 9, 10, and 16. The commitment to ensuring equal access to financial services (by 2030) is directly provided in numerous sub-targets: for all men and women, in particular from vulnerable groups (SDG 1 – target 1.4,²⁴ SDG 8 – target 8.10,²⁵ SDG 10 – target 10.2²⁶); for

women – that is, as a measure to ensure equal access to economic resources (SDG 5 – targets 5.a and 5.b combined²⁷); for small-scale industrial and other enterprises (SDG 9 – target 9.3²⁸). This vast amount of sub-targets clearly shows how important the perspective of sustainable development remains to ensure social inclusion. The additional requirement is the one that laws and policies developed for sustainable development should promote and enforce lack of discrimination (SDG 16 – target 16.b²⁹) – this only reiterates that once a central bank intends to develop a CBDC as a sustainable measure, this CBDC needs to offer access on a non-discriminatory basis. There is a different side of the coin here. Social inclusion also means that rights arising from access will be honoured once access is granted broadly. For that reason, a retail CBDC should have a legal tender status (Bossu, 2020), so that persons entitled to it can broadly use it.

However, sustainable development standards go even further as they formulate clear requirements for developing any new infrastructure because when “reliable, sustainable and resilient infrastructure, including regional and transborder” is developed, it should be “affordable” and provide “equitable access for all” (SDG 9 – target 9.1³⁰). As a result, accessibility to the CBDC should not be legal (that is, on a non-discriminatory basis), but also this accessibility should be on economic terms. Because of that, costs of the whole CBDC and incurred charges should not be too high (in relative terms).

Those reconstructed elements (concerning social inclusion) clearly show the need for central banks to develop CBDC for general purposes, accessible to everyone, with a close look at the costs (especially for vulnerable social groups).

10.8 CBDC and Its Links to Public Security

Another fundamental issue in regard to the economic and social effects of CBDC is public security, which contains an array of sub-issues, like cybersecurity, business continuity, and operational resilience. This covers matters that build trust towards an architecture of central bank money that CBDC will form. Although it does not stay in visible focus in the literature, including position papers of central banks, as not that many thematize them (Board of Governors of the Federal Reserve System, 2022; G7, 2021), it is an issue that is part of basic function of central banks, because on the one hand we have reputational risk of central banks – on the other – public trust towards this is core function of central banks – that is, to issuing fiat money.

10.9 CBDC and Its Links to Privacy

A further vital area for CBDC, from the perspective of its economic and social effects, forms the issue of privacy. This matter seems well-thematized in the public discussion, in position papers of central banks, and academic literature, but some remarks need to be posed.

On the one hand, discussions on the amount of privacy within CBDC are directly related to fighting financial crime. Central banks are in no position that would allow them to allow CBDC to be used as a platform for illicit activities. Thus one should distinguish privacy from anonymity. Although token-based CBDC could be formed in a way to provide anonymity similar to Bitcoin and Co. (CPMI MC, 2018), one should rather expect that the CBDC will not guarantee anonymity for at least two reasons:

- 1 To enforce the AML/CFTC regulations, and
- 2 To verify whether assets in CBDC are being held by eligible persons – in case scope of particular CBDC would be limited (ECB, 2020).

On the other hand, privacy directly relates to the social perception of CBDC and its acceptance. Respondents to the ECB survey directly pointed out to the need for CBDC (digital euro) should have the following particular features: “privacy, security, usability, low cost and accessibility” (ECB, 2021).

There are two dimensions of privacy that need to be distinguished in the context of economic and social effects of CBDC:

- 1 The amount of data collected by the state and its purpose.
- 2 Commercialization of the collected data.

Regarding the first dimension, one has to bear in mind that liberal democracies are founded on the assumption that the amount of information that state authorities collect on their citizens should be minimal and always related to public functions that this data retention and data processing serves. This approach serves a clear authoritarianism-preventive purpose. This forms a viable question: What do the state authorities have to amass those amounts of personal financial data, and whether this is necessary? The immediate response would probably always appeal to the enforcement of AML/CFTC regulations. But the amount of intrusion should be assessed on a jurisdiction-by-jurisdiction base by the courts – the same as in the case of telecommunications data retention (Zubik et al., 2021). For that reason, every CBDC project should become its own dedicated legal framework – so that the courts can properly assess the scope of the intrusion into individual privacy.

Regarding the second dimension, consumers’ payment data (other than those going through cryptocurrencies) is currently monetized by operators of those payment systems (Bilotta, 2021). Those privacy losses undertaken by private entities intensify with the decrease in physical cash use. The introduction of retail CBDC could be a (mild) game changer in two ways. Firstly, this should spark public discussions regarding the amount of future intrusion into privacy from the side of CBDC and self-reflection regarding the broad invasion of personal privacy by private payment system operators. Secondly, central banks do not have the motive to profit from payment data of consumers (Keister et al., 2021). As a result, all the consumers’ payment data will not be

monetized (for example, resold for e-marketing purposes) by central banks. In that sense, CBDC might become the first choice for its users that would be willing to stop intrusions into their privacy from private payment operators.

10.10 Conclusions, Future Research Directions, and Policy Implications

CBDC remains at the just-before introduction phase, but it is worth beginning this concluding section by underlining one of the most important features that the concept of CBDC offers. In two (out of three) scenarios, CBDC offers access to central bank money to the general public (mainly for retail payment purposes). This is a big novelty because currently general public uses private entities for electronic payments and is thus exposed to the credit risks of those private entities (which increase along with the decrease of physical cash usage). The scalability of CBDC technology enables central banks to offer a new service to the general public – parallel to providing physical cash. Keeping a fair share of public services within the area of public authorities translates into keeping the sovereignty of particular states in the area of their national economies.

This chapter has assessed whether and how currently developed projects of CBDC include issues of sustainability, public security, and privacy. Research results of this assessment presented in this chapter should encourage central banks to prioritize within their policies the sustainability issue. Broad support for sustainability, public security, and privacy will (positively) influence social acceptance of CBDC. This is important because one of the biggest risks that the central banks are facing is a scenario in which, after launching their (retail) CBDC projects, they will not be able to win over (mass) users (Passacantando, 2021). To address this risk, central banks should include all aspects reconstructed from the broadly understood sustainability in their policies. This includes achieving as low as possible energy usage, ensuring social inclusion by offering broad access to CBDC, significantly lowering remittance costs, and bringing input into fighting financial crime. After weighing cost/benefits, CBDC could also, through its programmable functionality, offer a better implementation framework for green bonds.

What's more, the privacy angles of CBDC will be verified through judicial review. To encourage this process, every CBDC project should become its own, dedicated legal framework – so that the courts can properly assess the the scope of the intrusion into individual privacy.

For those reasons, central banks should appropriately adjust their policies to design their CBDC projects in a way that would be most desired from the perspective of sustainability, public security, and privacy. Adapting CBDC projects following those reconstructed directions will be a step towards decreasing the ecological footprint of CBDC and gaining social acceptance for those projects.

Notes

- 1 Functioning of DLT technology is based on the circumstance that “DLT enable the direct exchange of digital claims (often referred to as “tokens”) without the need for a trusted third party. The system relies on an immutable public transaction record (the “ledger”), which is maintained on different nodes of a peer-to-peer network and updated regularly by means of a consensus protocol. In the extreme case of full decentralization with a “permissionless” ledger, anyone who forms part of the network can certify transactions” (Ahnert et al., 2022).
- 2 Requirements 7a: “The design of the digital euro should achieve a reduction in the cost of the current payments ecosystem” (ECB, 2020, p. 15).
- 3 Requirements 7b: “The design of the digital euro should be based on technological solutions that minimise its ecological footprint and improve that of the current payments ecosystem” (ECB, 2020, p. 15).
- 4 There is a lot of public interest (or even public pressure) in regards to actions that central banks undertake as their input into this global effort.
- 5 Resolution adopted by the General Assembly on 25 September 2015 ‘Transforming our world: the 2030 Agenda for Sustainable Development’, A/RES/70/1.
- 6 SDG 1: “End poverty in all its forms everywhere”.
- 7 SDG 5: “Achieve gender equality and empower all women and girls”.
- 8 SDG 8: “Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all”.
- 9 SDG 9: “Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation”.
- 10 SDG 10: “Reduce inequality within and among countries”.
- 11 SDG 12: “Ensure sustainable consumption and production patterns”.
- 12 SDG 13: “Take urgent action to combat climate change and its impacts”.
- 13 SDG 16: “Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels”.
- 14 Target 7.3 of SDG 7 foresees: “By 2030, double the global rate of improvement in energy efficiency”.
- 15 Target 8.4 of DG 8 foresees: “Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation, in accordance with the 10-Year Framework of Programmes on Sustainable Consumption and Production, with developed countries taking the lead”.
- 16 Target 12.2 of SDG 12 foresees: “By 2030, achieve the sustainable management and efficient use of natural resources”.
- 17 Target 13.2 of SDG 13 foresees: “Integrate climate change measures into national policies, strategies and planning”.
- 18 Target 13.3 of SDG 13 foresees: “Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning”.
- 19 Target 7.2 of SDG 7 foresees: “By 2030, increase substantially the share of renewable energy in the global energy mix”.
- 20 Target 13.2 of SDG 13 foresees: “Integrate climate change measures into national policies, strategies and planning”.
- 21 Target 13.3 of SDG 13 foresees: “Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning”.
- 22 Target 8.2 of SDG 8 foresees: “Achieve higher levels of economic productivity through diversification, technological upgrading and innovation, including through a focus on high-value added and labour-intensive sectors”.

- 23 Target 8.3 of SDG 8 foresees: “Promote development-oriented policies that support productive activities, decent job creation, entrepreneurship, creativity and innovation, and encourage the formalization and growth of micro-, small- and medium-sized enterprises, including through access to financial services”.
- 24 Relevant elements of target 1.4. of SDG 1 foresee: “By 2030, ensure that all men and women, in particular the poor and the vulnerable, have equal rights to economic resources, as well as access to basic services, ownership [...] and other forms of property, inheritance, [...] appropriate new technology and financial services, including microfinance”.
- 25 Relevant elements of target 8.10 of SDG 8 foresee: “Strengthen the capacity of domestic financial institutions to encourage and expand access to banking, insurance and financial services for all”.
- 26 Relevant elements of target 10.3 of SDG 10 foresee: “By 2030, empower and promote the [...] economic [...] inclusion of all, irrespective of age, sex, disability, race, ethnicity, origin, religion or economic or other status”.
- 27 Relevant elements of targets 5.a. and 5.b. of SDG 5 foresee: ““undertake reforms to give women equal rights to economic resources, as well as access to ownership [...] other forms of property, financial services, inheritance [...] in accordance with national laws” (target 5.a) and to “enhance the use of enabling technology, in particular information and communications technology, to promote the empowerment of women” (target 5.b).
- 28 Relevant elements of target 9.3 of SDG 9 foresee: “Increase the access of small-scale industrial and other enterprises, in particular in developing countries, to financial services [...]”.
- 29 Target 16.b. of SDG 16 foresees: “Promote and enforce non-discriminatory laws and policies for sustainable development”.
- 30 Target 9.1. of SDG 9 foresees: “Develop quality, reliable, sustainable and resilient infrastructure, including regional and transborder infrastructure, to support economic development and human well-being, with a focus on affordable and equitable access for all”.

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