Central Bank Digital Currencies (CBDCs): prospects, challenges and risks

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I hereby declare that the work submitted is mine and that where I have made use of another's work, I have attributed the source(s) according to the Regulations set in the Student's Handbook.

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Preface

This dissertation was written as part of the LL.M in Transnational and European Commercial Law, Banking Law, Arbitration/Mediation at the International Hellenic University. The selection of the topic was driven by personal curiosity, research and use of digital currencies and distributed ledger technologies, while also investigating the role of central bank money in the digital economy.

We begin the dissertation by highlighting the existing landscape in modern payment systems and arrangements, as they were influenced and shaped by the rapid digitalization of the economy, especially after the Covid-19 pandemic. We stress the enhancements and opportunities they created, as well as some of the key issues that emerged from the new and emerging forms of digital payments, including frictions in cross-border payment arrangements. We then dive into some of the fundamental concepts and principles of central bank digital currencies, or CBDCs, emphasizing on the key design choices and issues arising from the adoption of such a central bank digital instrument for payments, while simultaneously trying to make some predictions and suggestions on the ideal model of CBDC. We conclude with some thoughts on the role of central bank in the digital economy and on the development of CBDCS.

Finishing this dissertation would not have been possible without the help and support from many people. I would like to personally thank all of my professors in the LL.M. program, especially my supervising professor Teresa Rodríguez de las Heras Ballell, as well as professor Athanasios Kaisis, president of the International Hellenic University. Their help and support were unlimited and vital for writing this dissertation and finishing successfully the LL.M program. Lastly, I would also like to give my special thanks to my family and friends who were there for me every time I needed them.

Keywords: central bank, digital currencies, money, electronic payments, digital economy

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Introduction

In 2020, the world experienced a cataclysmic event that meant to influence all areas of life, enforcing changes that altered at a large extent the way people interact, are entertained, work, shop, study, do business and generally live: the Covid-19 pandemic. Social distancing enforced people to turn online in almost everything they normally did with a physical presence. As a direct result, technology and digitalization, which were already being advancing at a fast pace, made a surging growth, mainly fueled by mass adoption of online solutions. Digital technologies infiltrated and, in many cases, totally replaced even the most traditional sectors and business models. The advancement in e-commerce and e-business brought into surface the frictions and challenges of an important sector of the economy that has admittedly been lagging behind the digital economy: payment services globally, both retail and wholesale, including cross-border.

1. Current landscape in payments system and arrangements

1.1. Existing payment systems[1] and the role of central banks

From the advent of humanity and the forming of societies, people have engaged in the exchange of good and services to satisfy their needs and desires. With the evolution of societies payments used in the sale of goods and services and the settlement of economic transactions evolved from using bartering to cowrie shells to metal coins to paper money and modern electronic money used as a medium of exchange, a common unit of account and a store of value to transfer purchasing power over time. A common principle existing in anything used as money is *trust* in its ability to be accepted by other people as a means of payment for economic transactions, a common unit of account and a reliable store of value which allows for the transfer of purchasing power over time. It is on this fundamental principle that central bank money and existing payment systems were established. For centuries and up to the present day, central banks provide safe and trusted money in the form of cash (bill and coins) to the general public, and in the form of (electronic) reserve and settlement accounts to banks and other financial institutions. Moreover, they are entrusted with the key public interest objective of operating the core of the payment system and delivering a safe, efficient and widely accessible payment system with a maximum degree of integrity, by regulating and overseeing the public and private actors involved in the payment sphere, as well as ensuring at all times the smooth functioning of the payment system and the financial stability. In pursuit of these objectives, central banks provide central bank money as the unit of account in the monetary system, ensure finality of wholesale payments by using their own balance sheet for the intraday settlement of wholesale payments, providing sufficient settlement liquidity to avoid system bottlenecks arising from delays in payments, and last but not least, at times of

[1] According to Directive (EU) 2015/2366 (Payment Services Directive 2, PSD 2), which constitutes the revised legal framework for payment services in the EU, 'payment system' means **a funds transfer system with formal and standardised arrangements and common rules for the processing, clearing and/or settlement of payment transactions,** while 'funds' means banknotes and coins, scriptural money or electronic money.

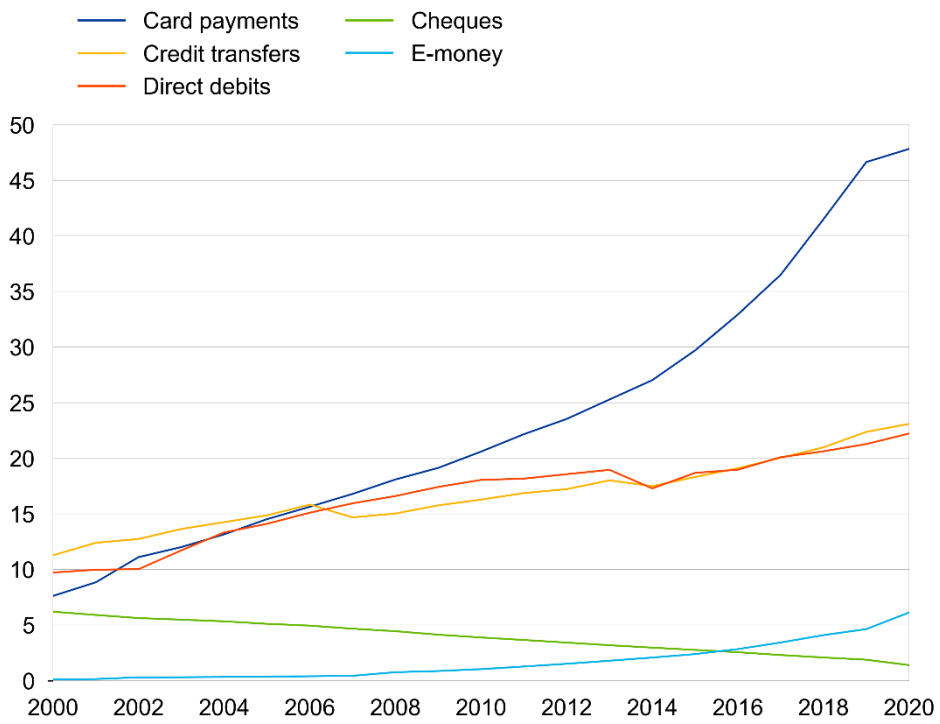
stress, being the lender of last resort for financial institutions. As overseer, the central bank ensures financial stability and integrity of the system by imposing requirements on the participants such as KYC for AML/CFT controls, supervising and regulating commercial banks so that they have sufficient funds to serve their clients, all these while ensuring equal access to the system and a level-playing field for the participants.

Private money is also issued by commercial banks, in the process of the fractional reserve system, which is based on the cooperation of the public and private sector on the creation of money and the facilitation of payments, lending, and other critical roles that the financial system provides to the economy. This system has served the economy well for hundreds of years, building trust and confidence in central bank money and confirming the mission of central banks as public authorities entrusted with the mission of coordinating and safeguarding the stability of the financial system and the smooth functioning of payments. *The widespread use of central bank money as a settlement asset confirms its overall qualities of safety, availability, efficiency, neutrality and finality.*[2]

The last decades cash use in payments and settlement of financial transactions has seen a steady decline, following the digitalization of the economy and the adoption of new electronic means of payment such as credit and debit cards and electronic or digital money which provide speed, ease of use and are fit for the digital era. The Covid-19 pandemic has accelerated the decline in cash and use of digital means of payment, paving the road towards a "cashless society" where digital means of payment dominate. As we can see in Picture 1 (below), the most dominant means of payment is currently card payments (debit and credit cards), followed by credit (bank) transfers, while e-money has had a rapid increase from 2016 onwards. According to a report from McKinsey and Company, cash payments declined by 16 percent globally in 2020 alone.[3]

[2] BIS Annual Economic Report 2021: II CBDCS: an opportunity for the monetary system,

[3] The 2021 McKinsey Global Payments Report, October 2021, page 7, available at https://www.mckinsey.com/~/media/mckinsey/industries/financial%20services/our%20insights/the%202021%20mckinsey%20global%20payments%20report/2021-mckinsey-global-payments-report.pdf



Picture 1: Payments statistics 2020 (Source: ECB)

While bank debit and credit transfers and credit and debit cards are not new in the payments sector, e-money transactions and mobile payments are a relatively new means of payment classified by the law (PSD2) as "alternative means of payment". Electronic money (e-money), defined in the CPMI's glossary of terms used in payments and settlement systems as "value stored electronically in a device such as a chip card or a hard drive in a personal computer", is now commonly used around the world. E-money is issued by commercial banks, technology financial firms and institutions (fintech companies) and digital banks[4], characterized as e-money providers or electronic money institutions (PSD2), and they have been gaining a lot of ground due to the high speed, low costs and ease of use they provide in retail payments, especially for cross-border payments, in comparison with incumbent means of transferring funds such as wire transfer/remittances through the corresponding banking system.

[4] According to *Wikipedia*, a digital bank or neobank (also known as an online bank, internet-only bank, virtual bank) is a type of direct bank that operates exclusively online without traditional physical branch networks.

1.2. Developments and challenges arising from new forms of digital payments

Private payment service providers and financial technology firms have been continuously innovating by leveraging their massive customer network and new technologies to deliver enhanced payment options, new features and fast payment systems (FPS)[5] on an attempt to make payment experience more convenient, easy-to-use, fast and cheap. At the same time, payments providers are competing to offer customized solutions like contactless card payments, QR code, "tap to pay," and link-based payments that make the payment experience seamless, pleasant, and increasingly contactless. In some regions with less developed retail payment systems, new payment services emerged through mobile network operators (eg M-Pesa in several African countries). *Payment services offered by major technology firms have now become more widely used as an alternative to other electronic payment means such as credit and debit cards, especially in regions where the payment system is limited and mobile phone usage is high.* For instance, in emerging economies where a large part of the population continues to have no access to traditional banking services, *the high mobile phone ownership rate has allowed digital delivery of essential financial services*, including cashless payments, to previously unbanked households and small and medium-sized enterprises (SMEs).

On the cross-border level, initiatives like SWIFT GPI (which stands for Global Payments Innovation) adds new rules to the traditional SWIFT network that include transparency of fees, end-to-end payment tracking, and confirmation of credit to the recipient's account. Another example is the leading global payment provider Visa's B2B Connect multilateral network which delivers B2B (business-to-business) cross-border payments that are predictable, secure, final, with transparency in fees and FX rates and cost-effective for financial institutions and their

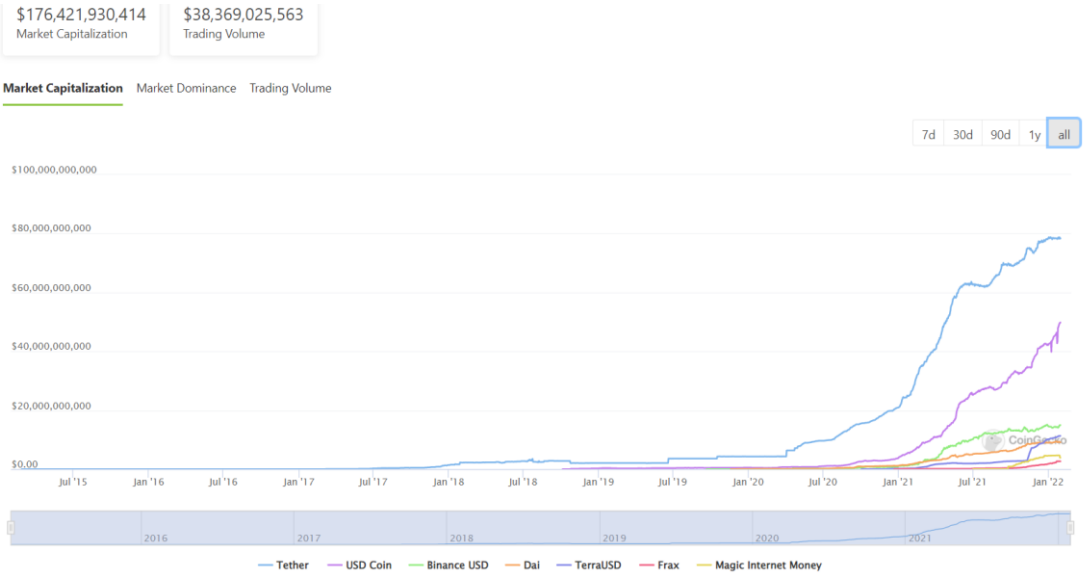
[5] According to BIS glossary of terms, a fast payment system (FPS) is one in which "the transmission of the payment message and the availability of final funds to the payee occur *in real time* or near-real time and on as near *to a 24-hour and seven-day (24/7) basis* as possible." Final funds are funds received *with unconditional and irrevocable access* to them by the payee. Source: BIS - CPMI: Fast payments - Enhancing the speed and availability of retail payments, November 2016, available online at www.bis.org/cpmi/publ/d154.pdf.

corporate clients. Last but not least, cryptocurrencies[6], including stablecoins[7] have been getting a lot of attention from the public. While Bitcoin and other cryptocurrencies have been used more as a speculative asset with characteristics closer to commodities rather that as currencies for payments, stablecoins have raised new challenges. Stablecoins are intended to address the high volatility of "traditional" crypto-assets by tying their value to other more stable assets, such as sovereign currencies. In this way they attempt to bring credibility in the cryptocurrency market by being backed by real currencies. While they have the potential to bring efficiencies to payments (including cross-border payments), and to promote financial inclusion, they are only as good as the governance behind the promise of the backing.[8] For instance, most widely used stablecoins such as Tether, USD Coin and Maker's Dai aim to serve as a means of settlement for automated financial products. They offer also offer the possibility of so-called "smart" contracts, i.e. self-executing code, and possibilities for "programmable money". Potential "global stablecoin" proposals like Facebook's Libra (now rebranded as "Diem") claim that they will make possible new forms of online exchange through their 24/7 availability, borderless nature, fractionalisation and integration with non-financial services. In this light, they aim to challenge existing digital means of payment for e-commerce like traditional bank payments, credit cards and electronic wallets. Total stablecoin market value has risen dramatically over the past year, reaching over 172 billion $ from just less than 10 billion before the Covid-19 pandemic, as seen in the picture below.

[6] A **cryptocurrency** is a medium of exchange that is digital, encrypted and decentralized.

[7] **Stablecoins** are cryptocurrencies whose price is designed to be pegged to fiat money, a cryptocurrency or to exchange-traded commodities (such as precious or industrial metals). Source: Wikipedia.org

[8] For a discussion of the risks to stablecoins' value backing, see Arner et al (2020) and Frost et al (2020), BIS.

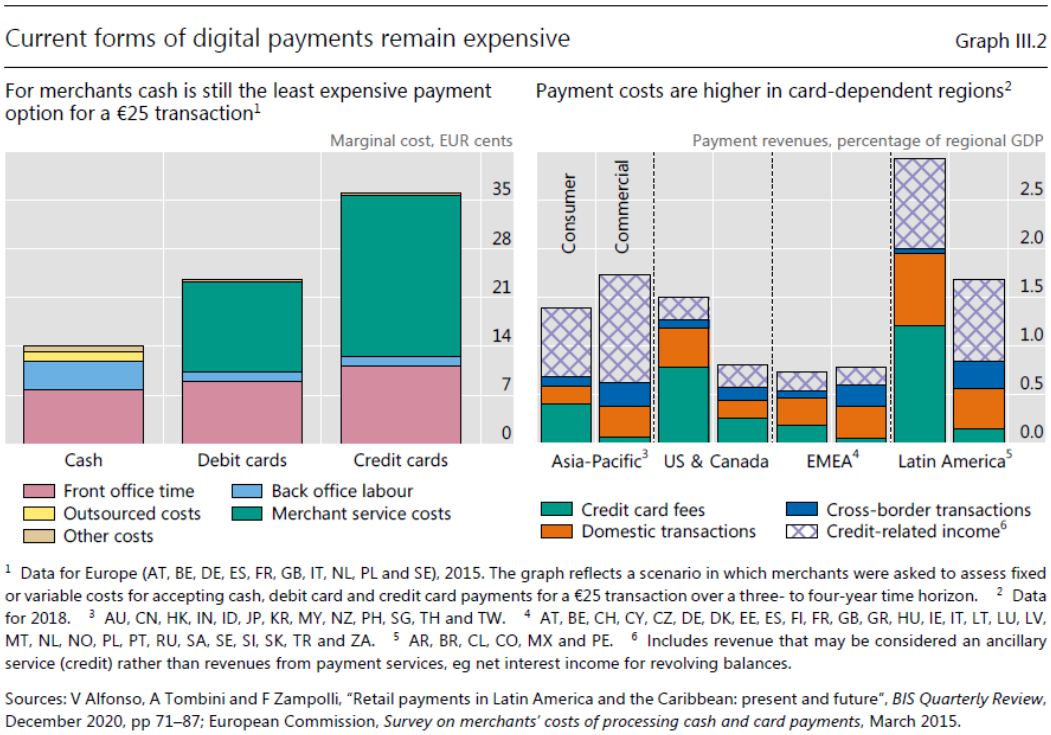


Picture 2: Total market value of stablecoins as of January 2022 (Source: Coingecko.com)

These innovations in the payment services sector do not come without costs, risks and challenges. Concerns have been raised about the infiltration of big financial technology firms on the payments services sector. These firms have large customer networks and a small number of giants dominate the biggest percentage of the market, creating unsurmountable barriers to entry for smaller players. For example, in China, just two big techs jointly account for 94% of the mobile payments market[9]. There are concerns that this high concentration and market monopolies may allow them to build a dominant position in the payments sector as well, eventually pushing payment fees higher. For instance, the debit and credit card payment network providers impose *costly fees* to merchants. The typical credit card processing fee charged by the "big four" card payment network providers who dominate the global market, currently ranges from about 1.3% to 3.5%, plus the payment processor's cut, which varies depending on the card processor and plan chosen.[10]

[9] See J Frost, L Gambacorta, Y Huang, H S Shin and P Zbinden, "BigTech and the changing structure of financial intermediation", Economic Policy, vol 34, no 100, October 2019, pp 761–99.

[10] These rates where calculating from listed fees of four big card payment networks. Sources: Visa USA Interchange Reimbursement Fees published on July 17, 2020, Mastercard 2019-2020 U.S. Region Interchange Program and Rates, Wells Fargo Merchant Services Payment Network Pass Through Fee Schedule, and Wells Fargo Payment Network Qualification Matrix effective Oct. 16, 2020.



Picture 3: debit and credit card merchant fees across the world (Source: BIS)

Related to the persistently high cost of e-payment options is the lack of universal access to digital payment services. Despite the improvements in access to banking accounts and services, which in a large percentage was the result of new digital payment solutions providing by these private institutions, a considerable amount of people, both from emerging and developing countries and from developed, remain unbanked, underbanked or has no access to digital payment options.[11] Lower income individuals, the homeless, migrants and other vulnerable groups are most likely to rely on cash. The cause for this can be either the lack of access to technology equipment such as smartphones for mobile payments, or low profit margins and/or other risks such as political instability, armed conflicts, legal uncertainty etc. that deter financial institutions from creating establishment and providing their services to certain locations. *Broad financial inclusion[12], therefore, remains a challenge* even with newest options for digital payments.

[11] According to World Bank's latest Findex Report (2017), globally, about 1.7 billion adults remain unbanked—without an account at a financial institution or through a mobile money provider. In 2014 that number was 2 billion. (Source: World Bank Findex Report 2017, available online at https://globalfindex.worldbank.org/

[12] Financial inclusion is defined as universal access to, and frequent use of, a wide range of reasonably priced financial services, in particular transaction accounts. Source: World Bank Group, Bank for

Considerable privacy concerns also arise from the increasing *concentration and commercialization of personal data*[13] of users gathered by big tech companies who own and control most of the widely used digital payment systems. Many cases of *data exploitation and abuse* have been reported in the past. In a survey on 27.000 US consumers who were asked whom they trust with safeguarding their personal data, the respondents reported that they trust big techs the least.[14] There are even some signs that big techs' sophisticated algorithms used to process personal data could develop biases towards minorities. For these reasons, data concentration, anti-competitive practices, and the issue of data governance has emerged as a key public policy concern. Proper use of personal data and ensuring that privacy is protected against unjustified intrusions by both commercial and government actors constitutes a basic human right and a public policy mandate at the top of the agenda.

1.3. Cross-border payment systems and arrangements

Cross-border payments are financial transactions where the payer and the recipient are based in separate countries.[15] We can define two main types of cross-border payments: wholesale and retail. *Wholesale* payments are made between financial institutions, either to support their customers' activities, such as to transfer funds cross-border on behalf of their clients, or to support its own cross-border activities (such as interbank borrowing and lending, foreign exchange, and securities trading). Governments and large companies also use wholesale cross-border payments for large transactions generated by the import and export of goods and services or trading in financial markets. *Retail* cross-border payments, on the

International Settlements (BIS), available online at www.worldbank.org/en/topic/financialinclusion/brief/achieving-universalfinancial-access-by-2020 and www.bis.org/cpmi/publ/d191.pdf.

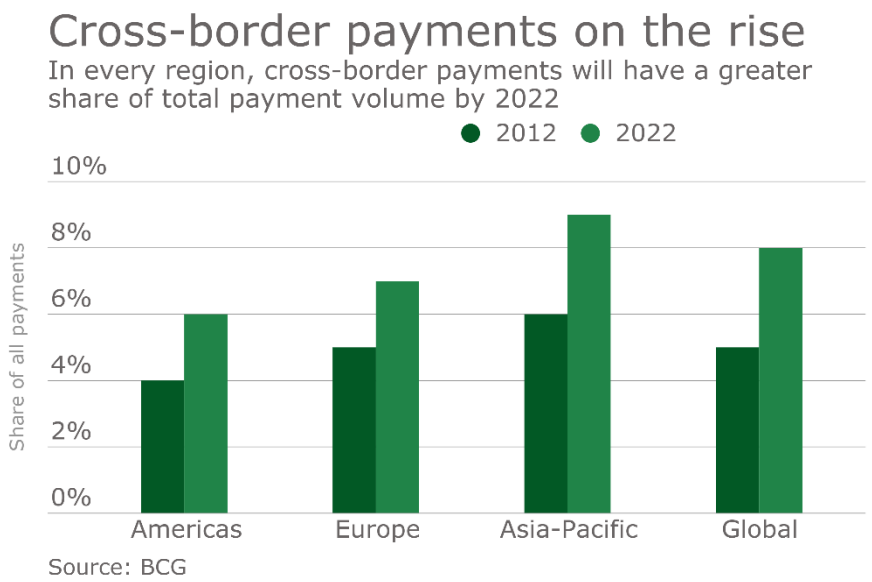
[13] Data commercialization can be defined as taking existing data obtained from business operations and turning it into a new revenue stream.

[14] Sources: BIS Bulletins, no 42, May 2021, "Whom do consumers trust with their data? US survey evidence"; "The fintech gender gap", BIS Working Papers, no 931, March 2021.

[15] Bank of England, Cross-border payments survey, available at https://www.bankofengland.co.uk/payment-and-settlement/cross-border-payments

other hand, are typically between individuals and businesses. They can be either person-to-person (C2C), person-to-business (C2B) and business-to-business (B2B). A notable category of cross-border payments are *remittances*, most notably money that migrants send back to their home countries. Remittances play a vital role in low and middle-income economies where they may even be considered the primary source of development finance.

The economic importance of cross-border payments has become crucial in the globalized modern economy, which is characterized by an increasing international mobility of capital, goods and services, people and businesses, and a large dependence on international trade and e-commerce. As we can see in Picture 2, cross-border payments make up an increasing share of total payments. The value of cross-border payments is estimated to increase from almost $150 trillion in 2017 to over $250 trillion by 2027, equating to a rise of over $100 trillion in just 10 years.[16]



Picture 4: Cross-borders payments as a percentage of total payments (Source: BCG)

The rising use and demand for cross-border payments have increased the need for end users to have access to cross-border payment services that are efficient and safe as comparable domestic services.

[16] Ibid

Cross-border payments, like domestic ones, can be made in a number of different ways. Bank transfers, credit card payments and alternative payment methods such as e-money wallets and mobile payments are currently also the most prevalent ways of transferring funds across borders.[17] Current cross-border arrangements include *correspondent banking*[18], interlinked domestic payment systems, card networks, remittance services such as money transfer operators and innovations based on new financial technology, to name a few.[19] However, unlike domestic ones, where payments are processed by a relatively small number of institutions (a classic domestic payment would involve one or two banks, for the payer and the recipient respectively, as well as a financial institution like Visa or Mastercard and a payment processor in the case of credit and debit card payments), cross-border payments are traditionally carried through a diverse multi-layered set of networks with a large number of participating intermediaries. They are by definition more complex than domestic ones, since they involve more, and in some cases, multiple players, time zones, jurisdictions and regulations. Many of these are also cross-currency payments - that is, payments where the payer and payee are respectively debited and credited in different currencies. The inherent complexity and multi-jurisdictional nature of cross-border payments creates a number of frictions that often results in high costs, low speed, limited access and insufficient transparency. [20]

1.4. Frictions in existing cross- border payments

The need to transmit cross-border payments across multiple jurisdictions with diverse legal and regulatory practices can create frictions. Current arrangements can delay payments and increase the cost of offering services across many currency corridors. Each jurisdiction has

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Ibid

[18] Correspondent banking is an arrangement whereby one bank (correspondent) holds deposits owned by other banks (respondents) and provides those banks with payment and other services (CPMI (2016)).

[19] Financial Stability Board, Enhancing cross-border payments, Stage 1 report to the G20, available at https://www.fsb.org/2020/04/enhancing-cross-border-payments-stage-1-report-to-the-g20/

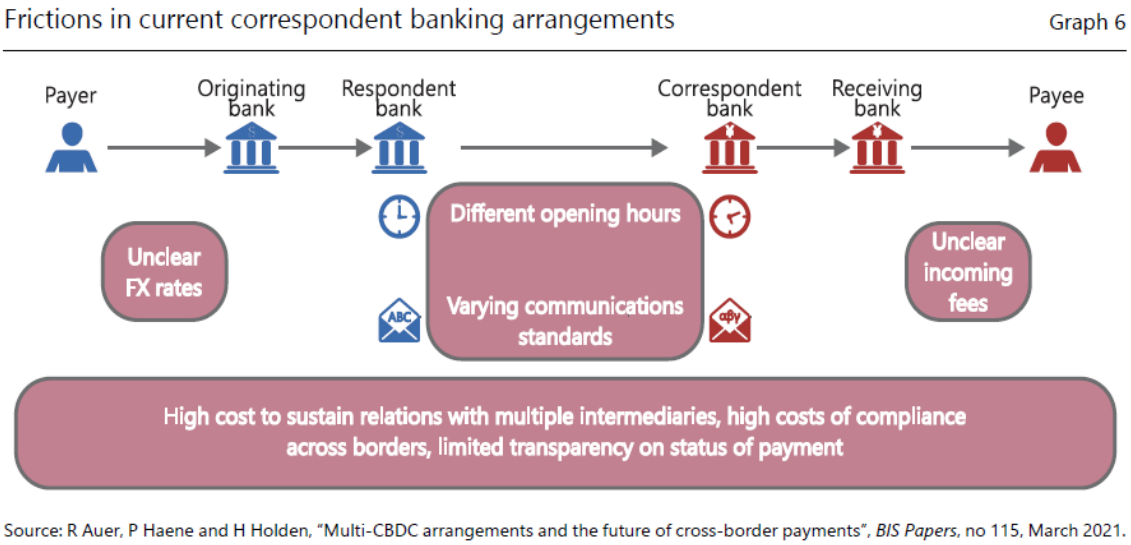
[20] Bank for International Settlements, Committee of Payments and Market Infrastructure, Enhancing cross-border payments: building blocks of a global roadmap, Stage 2 report to the G20, July 2020, available at https://www.bis.org/cpmi/publ/d194.pdf

its own domestic payment system with its own data standards, designed for domestic uses and lacking interoperability with payment systems in other jurisdictions, which results in *fragmented data standards* cross-border and a *lack in cross-border interoperability.*[21] Moreover, each country has its own regulations, which leads to *complexities in meeting compliance requirements*, including for anti-money laundering and countering the financing of terrorism (AML/CFT), and data protection purposes. Furthermore, differences in time zones result in *different operating hours*; and finally, payments are being processed through *outdated legacy technology platforms*. What is more, the length of the transaction chain can add to costs and delays. For instance, the widely utilized in cross-border transactions SWIFT system has been criticized for its inefficiency. In 2018, the London-based Financial Times noted that transfers frequently "pass through multiple banks before reaching their final destination, making them time-consuming, costly and lacking transparency on how much money will arrive at the other end". SWIFT has since introduced an improved service called "Global Payments Innovation" (GPI), claiming it was adopted by 165 banks and was completing half its payments within 30 minutes. Overall, the length of correspondent banking transaction chains can range from just over one intermediary on average for cross-border payments on SWIFT to five or more intermediary banks for 20% of euro-denominated cross-border payments (ECB (2020a) and international payments will normally take from *2 to 5 business days to clear* and a fee counted in double- and in some cases- triple-digit dollars (ranging from $45 to $75 but sometimes can surpass $100 dollars, depending on the volume and complexity of the payment and the number of institutions involved in the network). In addition, the *decline of cross-border banking relationships* for the past decade might leave some jurisdictions with inadequate access to the global financial system[22]. These frictions increase complexities and

[21] Interoperability is the technical or legal compatibility that enables a system or mechanism to be used in conjunction with other systems or mechanisms. Interoperability allows participants in different systems to conduct clear and settle payments or financial transactions across systems without participating in multiple systems. (Source: BIS)

[22] According to a report from BIS, the total number of active correspondent banking relationships and active corridors continues to decline. Over the last seven years, active relationships in the global correspondent banking network have declined by about 20% and the number of active corridors has fallen by roughly 10%. (Source: BIS, New correspondent banking data - the decline continues, available at https://www.bis.org/cpmi/paysysinfo/corr_bank_data/corr_bank_data_commentary_1905.htm)

delays and additionally, create cost barriers to entry that may weaken competition in providing cross-border payments services.[23]



Picture 5: Frictions in current correspondent banking arrangements (Source: BIS)

The challenges with cross-border payments affect end-users and service providers, especially *individuals and small companies*, who usually conduct low-value payments that may come with *high fees as a percentage of the amount sent* and face cumbersome processes. Notably, despite increasing efforts to reduce global remittances costs, sending remittances currently costs a global average of 6.30 percent of the amount sent, with banks remaining the most expensive type of service provider at an average cost of 10.64 percent, and mobile money being the least costly instrument to originate and receive remittances.[24]

[23] Financial Stability Board, Enhancing cross-border payments, Stage 1 report to the G20, available at https://www.fsb.org/2020/04/enhancing-cross-border-payments-stage-1-report-to-the-g20/

[24] The World Bank Group, Remittances prices worldwide, Issue 38, June, 2021 available at https://remittanceprices.worldbank.org/sites/default/files/rpw_main_report_and_annex_q221.pdf

1.5. Conclusion: a need for further improvement, change and innovation

From all the above, we can reach the conclusion that central banks now stand at the center of a rapid transformation occurring globally in the financial sector, where the role of central bank money is challenged by new private forms of money issued by private actors such as financial technology firms and electronic money transfer providers, while cross-border traditional arrangements such as corresponding banking continue to suffer from high costs, delays and inefficient transparency. Innovations that come as solutions to current problems in the payment system from the private sector's initiatives, such as cryptocurrencies, stablecoins and digital payment platforms of neobanks and big techs, which can promote broad access, lower costs and enhanced services, may also result in entrenched market power and data concentration.[25] On the cross-border level, the high costs, low speed, limited access and insufficient transparency that continues to exist in traditional cross-border arrangements creates barriers to entry for many small players in the international markets, impedes financial inclusion, limits the amount of money being sent by migrants to their families, which in many cases is crucial for their survival, and overall creates unnecessary inefficiencies in the global economy. Therefore, as highlighted by the FSB in its report to the G20 on enhancing cross-border payments, "faster[26]

In order to facilitate faster payments, central banks around the world have introduced real-time gross settlement (RTGS) systems[27] that allow for the *instant settlement of payments* in a continuous 24/7/365 basis. Furthermore, the G20, which is comprised from the world's largest economies that account for around 90% of gross world product (GWP) and 75–80% of international trade, has made enhancing cross-border payments a priority during the 2020 Saudi Arabian Presidency. The Financial Stability Board together with the Bank for International Settlements' Committee of Payments and Market Infrastructure and other

[25] See BIS, Big techs in finance: opportunities and risks, BIS Annual Economic Report 2019

[26] Financial Stability Board, Enhancing cross-border payments, first consolidated progress report, released at 13 October 2021 and available at https://www.fsb.org/wp-content/uploads/P131021-1.pdf

[27] Real-time gross settlement (RTGS) systems settle payments on an individual order basis, as opposed to netting debits with credits out of bundles of multiple compiled transactions at the end of the day, in the books of a central bank. (Source: Investopedia)

international organizations and standard-setting bodies have led the work on creating a Roadmap of building blocks to address current frictions by improving existing payments system, while at the same time investigating new payment infrastructures such as central bank digital currencies, assisted by emerging technologies such as blockchain or distributed ledger technologies (DLT).

Improvements of existing arrangements are directed towards the following key target areas: operational enhancement of cross-border payment systems, through an even wider adoption of real-time gross settlement systems, automated clearing houses (ACH) like BACHS, PE-ACH and FedACH, and interlinked national payments systems that foster greater cross-border interoperability; standardization of data and market practice through the adoption of common message formats and protocols, such as a harmonized version of ISO 20022 and common rules of mapping/converting data between different data formats, and harmonizing API[28] protocols for data exchange across payment infrastructures and jurisdictions; promoting full transparency of fees and status of processing; aligning operating hours; creating an internationally harmonized legal, regulatory and oversight framework by facilitating improved customer due diligence mechanisms for Anti-Money Laundering/Combating the Financing of Terrorism (AML/CFT) laws, greater use of the Legal Entity Identifier (LEI) for firms and digital IDs to reduce costs of AML/CFT checks and other compliance processes without compromising on the quality of compliance and at the same time ensuring adequate oversight.

Finally, additionally to these gradual improvements, many central banks are measuring the potential of a *CBDC* issuance *as an advanced representation of central bank money for the digital economy.* On this dissertation we will focus on the potential of CBDCs to foster a new payment system infrastructure with international dimension that may deliver efficiency, security and resilience, interoperability, high speeds, low costs and a large degree of transparency and financial inclusion. We will discuss possible implications, legal issues, data governance, privacy, potential macro-financial and monetary effects on the global financial system which may arise from the adoption of CBDCs as a means for both domestic and cross-border payments.

[28] An application programming interface, or API, enables companies to open up their applications' data and functionality to external third-party developers, business partners, and internal departments within their companies. This allows services and products to communicate with each other and leverage each other's data and functionality through a documented interface. (Source: IBM)

2. Fundamental concepts and principles of CBDCs

According to Hyun Song Shin, economic adviser and Head of Research of the Bank of International Settlements (BIS), "you can think of central bank digital currencies, or CBDCs, as *a digital form of cash*." CBDC is a digital form of central bank money that is different from balances in traditional reserve or settlement accounts (CPMI-MC (2018)). It is a digital payment instrument, denominated in the national unit of account, that is, like cash, *a direct liability of the central bank.*

2.1. Motivations and key drivers for CBDCs development

Central banks have begun to take interest in CBDCs the last few years, after closely monitoring the latest developments and innovations in the payments sector, which were briefly highlighted in the previous chapters. Three main innovations and developments have particularly forced central banks to speed up their efforts in CBDCs exploration and potential issuance: the growing attention and use bitcoin and other cryptocurrencies have received the last few years, especially during the pandemic; the rise of global stablecoins; and the entrance of the major technology firms (the so-called "big techs") into financial services, all of who, together with promises of enhanced efficiency, speed, low costs and financial inclusion, brought into surface a number of critical concerns, such as increased danger for cyber-attacks with potentially widespread impacts on the system, data governance and user privacy, market concentration and anti-competitive practices, consumer protection and potential dangers to financial stability and monetary policies.

As a result, large and diverse number of motivations began fueling central banks' interest in CBDCs. By experimenting on novel forms of digital innovations such us DLT, they aim to *enhance payments inclusion and efficiency*, as well as *ensure competition, data privacy and the integrity of their payment system*. In particular, for central banks of advanced and

developed economies, the primary research motivation seems to be the use of CBDCs as *a domestic central bank digital means of payment*, fit for the digital era, which would preserve confident in the currency in a cash declining world. They perceive CBDCs as means to *mitigate risks* regarding the safety of digital payments, such as cyber-attacks and data plus market concertation by big techs, and also, to *reduce costs*, all while at the same time promoting the smooth functioning of retail and wholesale payments in the digital era. Secondary motivations, such as introducing a digital instrument to the financial system for *enhancing monetary policy tools*, are also taken into consideration. Last but not least, concerns around financial stability, stemming from the growing adoption of private alternatives to sovereign fiat currency and the threat that they may eventually become dominant, issued by private actors who are not accountable to the public and may not support the stability of the financial system, are also fueling research and development interest of central banks.

On the other hand, for central banks in many emerging market economies, the main motivation for the development of a CBDC is the opportunity to *promote wider access to banking and thus improve financial inclusion* by providing a modern central bank payment instrument fit for the digital age, with ease of use and *universal access* for the mass population, especially for those who don't currently have full all even minimum access to the formal and traditional banking system, ie. the underbanked and the unbanked.

The ultimate target and key driver for the development of a CBDC, however, should be serving the public interest in the digital era. As highlighted by the BIS, "*the exploration of CBDCs provides an opportunity to review and reaffirm the public interest case for digital money.* Most notably*, the public interest should be taken broadly to encompass not only the economic benefits flowing from a competitive market structure, but also the quality of governance arrangements and basic rights, such as the right to data privacy.*"[29]

2.2. Operational features, technology and design choices

CBDCs can be seen as *a digital extension* of the existing forms of central bank money (cash and settlement accounts). They can be designed either for wholesale use, ie for

[29] See BIS, Annual Economic Report 2021: III. CBDCs: an opportunity for the monetary system

wholesale payments (like interbank transfers) between financial institutions (*wholesale CBDCs*), like reserve or settlement accounts are used today, or they can be destined for retail use, ie by households and businesses – the general public (*retail or general purpose CBDCs*). In terms of the type of their user identification, they can be designed as either *account-based*, meaning that they would rely on some form of user identification, or *token-based*, meaning that they would allow for anonymity in payments, like cash. As regards for their underlying infrastructure's technology, they can be based on decentralized models such as distributed ledger technology (DLT) or conventional and/or centralized technological infrastructures. Last but not least, as far as the extent of the public and private sector involvement in their issuing, holding and distribution is concerned, a proper division of labor between the public and private sector that would allow for the preservation of the two-tier structure of the monetary system is preferrable for preventing a disruption in the system with potentially unwanted consequences for the financial stability and monetary sovereignty.

2.2.1. Wholesale CBDCs

Wholesale CBDCs are intended for the settlement of wholesale transactions, e.g., the settlement of payments between financial institutions. As a digital liability of the central bank, wholesale CBDCs could become a new instrument for settlement between financial institutions. They operate at a similar level as reserve and settlement accounts: commercial banks and other payment service providers (PSPs) send their transactions on the account they keep on the central bank and then the latter settles wholesale payments on its balance sheet. The contribution of wholesale CBDCs lies in the reduction in costs resulting from the simplification of the system, since being a direct liability on the central bank, they allow payments to be directly settled, without delays and further intermediaries involved. Furthermore, they add an additional function to current bank reserves and settlement accounts: its digital nature and underlying technology enables the programmability of payments, making central bank money programmable, to support automation and mitigate risks, such as settlement or liquidity risk. One example is the conditionality of payments, whereby a payment only settles if certain conditions are met. *Hence, the case for wholesale CBCCs depends on their ability to improve efficiency and reduce settlement costs.* Additionally,

the new technology stacks wholesale CBDCs would be implemented on allow for a clean-slate approach that would[30], as discussed in the next sections.

2.2.2. Retail CBDCs

Compared with wholesale CBDCs, however, a more disrupting development is the issuance of a retail CBDCs. Such kind of a central bank digital payment instrument introduce fundamental changes to the traditional two-tier monetary system, since they allow central bank digital money, which is now available only to financial institutions in the form of electronic reserve and settlement accounts, to be accessible by the general public, just as cash is today. Furthermore, a key difference from conventional digital money is the fact that they are backed by central bank, who is responsible for their provision. On the contrary, other forms of digital retail money, such as money issued by e-payment providers, stablecoins and commercial bank retail reserves, represent a claim on an intermediary, and such private intermediaries could experience illiquidity due to temporary lack of funds or even insolvency. While such risks may be reduced through collateralisation and other safeguards in most cases, retail CBDCs would put an end to any similar risks.[31]

2.2.3. Technology design choices

Beyond the architecture of the operational design, a second consideration is the optimal technology underpinning it. In this context, much emphasis has been put on novel forms of decentralization enabled via distributed ledger technology (DLT). DLT use a digital ledger in which all transactions are recorded, send to all the participant nodes in the network for validation and are then stored forever in the system. Bitcoin and most major cryptocurrencies use the so-called ”permissionless“ model, in which everyone can join the network and validate the transactions; there is also the ”permissioned” model, in which only a number of known and preselected validators confirm the transactions and update the digital ledger. While the ”permissionless” model may come with easier and better governance of the system, running a ”permissionless” CBDC would be inefficient, costly and environmentally

[30] See BIS, CBDCs for cross-border payments, Report to the G20
[31] See, eg. the case of Tether backing

harmful.[32] This is mainly due to the fact that in the ”proof-of-work” mechanism used for reaching consensus in the validity of transactions executed in the bitcoin network, every batch of transactions has to be accompanied by a proof that a substantial quantum of computations has been performed, and the execution of these computations that provide the “proof-of-work“ consumes a lot of energy.[33] Therefore, the suitable model in a decentralized design case is in the “*permissioned*” DLT.

Another problem with DLT models is the fact that the interests of each participant much be aligned and proper incentives must be given to ensure that the nodes are committed to constant validation and not committing fraud, which makes the whole system costly and difficult to maintain. Last but not leasst, due to the multiple rounds involved in the validation of the transactions, delays in payments are innevitable. These issues, known in the crypto world as ”the blockchain or Buterin trilemma”, challenge the integrity of the ledger on which credit transactions rely.

The fact that operational resilience of similar level can also be achieved in traditional systems via storage of transaction data in multiple times and in physically separate locations, suggest that, despite the potential economic benefits of DLT models in financial markets and payments due to enhanced robustness and the potentially lower cost of achieving good governance, a centralised operational design may currently be superior, unless weaknesses in the rule of law and contract enforcement would necessitate a decentralised ledger.

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3. Key focus areas for CBDCs development

3.1. Identification, privacy and data governance

[32] For example, according to the Cambridge Center for Alternative Finance (CCAF), Bitcoin currently consumes around 110 Terawatt Hours per year — 0.55% of global electricity production, or roughly equivalent to the annual energy draw of small countries like Malaysia or Sweden.
[33] Ibid

Digital innovation implies a "triple imperative" for the central bank in its role at the centre of the monetary system: competition, data privacy and the integrity of the payment system.[34]

3.1.1. User identification in CBDCs payments

Identification at crucial in the design of CBDCs in order to safeguard the integrity of the system. When customers open an account in a commercial bank or a payment service provider, regulations demand that he hands over physical documents, eg passports or driving licenses in order for banks and PSPs to validate the identity of the customer. Cash transactions are by nature anonymous, but identity checks also apply to high-value payments. Retail CBDCs with *token-based* access allow similar anonymity in payments, by giving individual users access to the CBDC based on a passwordlike digital signature using private-public key cryptography, without requiring personal identification. On the other hand, retail CBDCs with *account-based* access verify user's identity by creating a *digital ID*. In this scheme, by drawing on information from national registries and from other public and private sources, such as education certificates, tax and benefits records, property registries etc, a digital ID serves to establish individual identities online. Due to the ability to identify users, account-based CBDCs are thus by nature more compatible with the monitoring of illicit activity in a payment system and therefore, should be preferred over fully anonymous token-based CBDCs. However, safeguards on data privacy should be implemented, as discussed in the next sections.

3.1.2. Data governance and privacy in CBDC designs

The availability of massive amounts of user data that would be concentrated in the CBDC payment system gives rise to another important issue – that of data governance. Ensuring privacy against unjustified intrusion by both commercial and government actors is a mandate at the top of the agenda. As the issuers of CBDCs and at the same time key operators and overseers of the financial system, central banks can lay the groundwork for assuring privacy and the responsible use of data in payments. *The key is to ensure that governance for digital identity is appropriately designed*. This could be achieved by building *an intermediated*

[34] See BIS, Annual Economic Report 2021: III: CBDCs: an opportunity for the monetary system

architecture, in which central banks process and keeps record of wholesale transactions, while commercial banks and PSPs onboard client and are thus responsible for enforcing KYC and execute the retain payments. In this model commercial banks and PSPs should by closely supervised to ensure that data collected in not used in an abusive way and is sealed from third parties. Central bank itself, as a non-commercial entity, has no incentive to use private transaction data, and can credibly commit to leaving such data untouched in a way that a private bank or digital platform provider could not. The intermediated model could be supplemented by the use of application programming interfaces (APIs), which would constrict data exchange to only the necessary information for any given transaction and give users greater control over the data that they generate (BIS (2021)). In this model, however, data exploitation may also come from public authorities who could use the data gathered by the central banks to track individuals and control their transactions. Therefore, additional institutional safeguards would be required in this case to ensure protection from public authorities as well as private actors.[35]

3.2. Effects on financial intermediation, financial stability and monetary policy

CBDCs introduce a number of changes in the way financial markets and infrastructure currently work. They influence the number of commercial bank deposits and the degree of financial intermediation in the monetary system, while also potentially generating financial stability and currency substitution risks.

3.2.1. Financial intermediation in CBDC systems

A key goal in the design system of a CBDC is the appropriate division of labor between the central bank and the private sector. In the case of a one-tier system fully operated by the central bank, or a so-called "direct CBDC", the central banks would have to take over a large number of operational tasks and costs associated with user-facing activities such as account opening and maintenance, as well as KYC and AML/CFT rules enforcement, which are now the

[35] For example, the Bank of Jamaica has declared that individual CBDC data can only be shared with a court order.

core responsibility of commercial banks and other payment service providers (PSPs). Such a shift would detract from the institutional role of the central bank. Private actors are better placed to use their expertise and creativity for such tasks, while also creating innovative initiatives that enhance customer experience and create better services. For these reasons, *CBDCs are best designed as part of a two-tier system*, where the central bank and the private sector each do what they are best placed for ie. the central providing the infrastructure, recording and settling all wholesale transactions, while also supervising and overseeing the smooth functioning of the payment system, while commercial banks and other payment service providers handling all the other operational tasks, onboarding clients and enforcing AML/CFT rules and providing retail services on a competitive level playing field.

3.2.2. Financial stability concerns

There are also concerns about the potentially negative effects of CBDCs on the financial stability: Being a liability of the central bank, a CBDC is a safe substitute for commercial bank deposits, that in times of crisis can be seen, as cash in previous crisis, as a safe haven. There is thus a risk that, in a crisis, the availability of a CBDC would induce deposit holders to shift their holdings from the commercial banking system to the CBDC. However, in an intermediated or hybrid CBDC system where the central bank also keeps records of balances in real-time data, the central bank can be informed in real time in a case of a "digital run" to the CBDC, and what is more, the programmability CBDCs offer can allow them to react quickly and take measures to stop the outflow of funds, for example imposing thresholds-caps in the amounts of CBDCs an individual user can hold.

3.2.3. Currency substitution concerns

One other concern with digital currencies in general, is that they could threaten the monetary sovereignty of countries by substituting the domestic currencies. Similar concerns apply to CBDCs. In some countries, for example, especially in emerging economies, people tend to use more a foreign currency, mainly dollar or euro, than their own, a phanomenon called "dollarisation". However, dollarisation is generally driven by the lack of public trust in the stable value of the local currency rather than by the technological format of a domestic or foreign currency. Central bank cooperation could also mitigate the risks of currency

substitution, as central banks from different jurisdictions would have little interest in destabilising one another's economies through widespread use of a CBDC beyond the issuing country's borders. Thus, there is little risk that CBDCs in particular would facilitate currency substitution, even with an international dimension and cross-border use in mind, as we highlight in the next section.

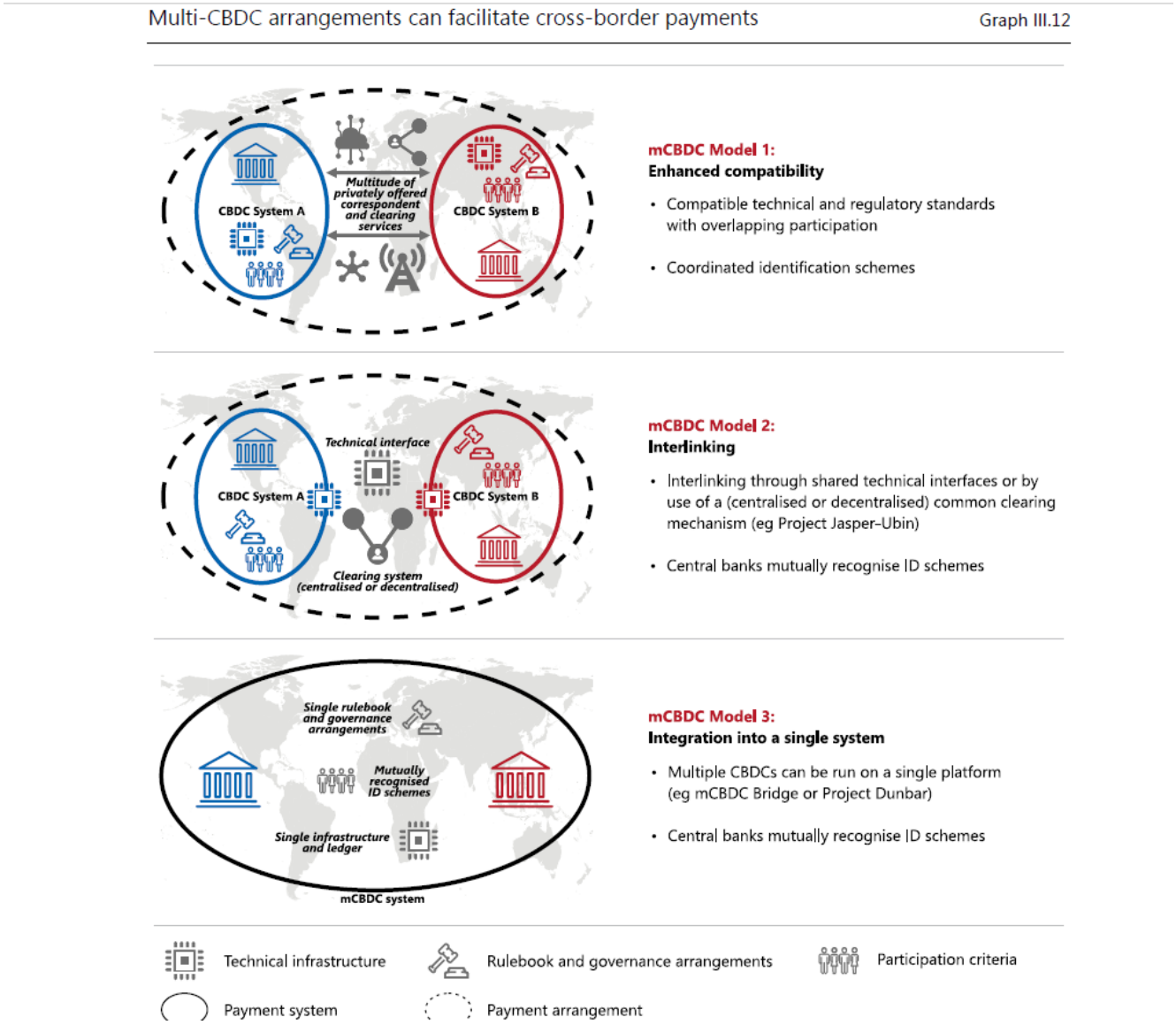
3.3. CBDCs in cross-border payments

A key difference between CBDCs and efforts to improve the existing payments infrastructure, which were highlighted in chapter 1, is the opportunity to start with a "clean slate". Because many of today's frictions are rooted in differences between domestic payment systems (eg opening hours, technical standards, data requirements), as highlighted in the previous sections, making large-scale changes across jurisdictions is challenging. *If central banks take the international dimension into account when designing their domestic CBDCs and commit to interoperability, consistent standards and coordination of CBDC designs, many problems inherent in today's legacy technologies and processes could be avoided.*

The cross-border use of account-based CBDCs will however require international cooperation. One option involves fostering KYC and sharing information on identity across borders. Mutual recognition of national IDs are an even more promising approach. Aligning regulatory, supervisory and oversight frameworks for cross border payments, AML/CFT consistency, PvP adoption and payment system access will also be critical for cross-border CBDC use.

The most far-reaching and promising approach, however, for a highly efficient cross-border payment scheme are *multi-CBDC (mCBDC) arrangements* that join up CBDCs to interoperate across borders. These arrangements focus on coordinating national CBDC designs with consistent access frameworks and interlinkages to make cross-currency and cross-border payments more efficient. In this way, they also represent an alternative to private sector global stablecoin projects. Multi-CBDC arrangements would allow central banks to mitigate many of today's frictions by starting from a "clean slate", unburdened by legacy arrangements. There are three potential models of mCBDCs arrangements, as highlighted in Picture 6 below, ranging from cross-border cooperation and interoperability to total

integration in a single multi-CBDC payment system. In particular, model 1 enhances compatibility for CBDCs via *similar regulatory frameworks, market practices, messaging formats and data requirements*. Model 2 involves *interlinked CBDC systems*. Model 3 involves *a jointly operated mCBDC payment system hosting multiple CBDCs*.



Picture 6: Multi-CBDCs cross-border arrangement models (Source: BIS)

The potential benefits of these arrangements increase with the degree of harmonisation and technical alignment. Each would require increasingly intertwined identification schemes, but in all cases, ID would remain at a national level. Enhanced compatibility (model 1) might require some coordination of digital ID schemes across payment areas, such that the same necessary information could be used in each case to comply with

AML/CFT requirements single ID system would not be needed; it would be sufficient for participating jurisdictions to recognise one another's IDs. Making the most out of CBDCs in cross-currency transactions thus requires international cooperation.

Conclusions

CBDCs are now becoming no more a matter of "if" but more a matter of "when". With the proper design that takes into account and effectively address all the issues arising from their adoption, they could form the backbone of a highly efficient new digital payment system by enabling broad access, while at the same time helping to provide strong data governance and privacy standards. As such, further research and development on CBDCs projects is needed to ensure that risks and concerns around data governance, privacy, financial implications and operational hazards are addressed properly before a major CBDC project in launched.

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