Department of Economics and Finance

Chair of Money and Banking

Bachelor's degree in Economics and Business

Central Bank Digital Currencies (CBDCs): Opportunities and Implications for Payment Systems

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Academic year 2022/2023

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ABSTRACT

The ambition behind this work is to investigate how the emerging Central Bank Digital Currency (CBDC) technology can influence the payment systems. In particular, this work aims at showing how CBDCs can address existing threats deriving from the emergence of digital money and the progressive decline in the use of physical cash. In addition, this study focuses on showcasing advantages deriving from the usage of CBDCs in both wholesale and retail context in order to mitigate frictions and inefficiencies that characterizes cross-border transactions and that limit financial inclusion, particularly in remote areas of the planet.

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INTRODUCTION

Reflecting the growing trend of conducting financial transactions online, an increasing number of consumers are opting for digital payment options, resulting in a discernible decrease in the use of physical currency. In addition, the traditional financial services industry has been shaken up as a result of the development of novel technologies such as cryptocurrencies and blockchains, which have led to an increase in the use of digital currencies. The usage of cryptocurrencies who rely on alternative transaction platforms, which are not subject to rigorous laws, generates ambiguous legal scenarios in which traditional consumer safeguards may not be implemented. This is because alternative transaction platforms are not subject to strict rules. In addition, because cryptocurrencies are intended for use by people all over the world, they frequently fall outside the purview of regulatory jurisdictions and because of their decentralized nature, it is impossible to establish explicit governance over them. Cryptocurrencies are thought to provide a bigger threat to the reliability of the world's financial institutions as compared to earlier types of private currency that were restricted in their use and were only used in specific regions. Central banks all around the world have taken notice of the potential influence that digital currencies may have on the economy as their popularity continues to grow. As a direct reaction to this development pattern, central banks have initiated research into the feasibility of developing their very own digital currencies, which they refer to as Central Bank Digital Currencies (CBDCs). CBDC is a new type of money that exists entirely in digital form and is often defined as an hybrid asset class that is located between cash and bank reserves in the balance sheets of central banks and that is available both to commercial banks and the general public. The potential advantages of CBDCs have generated talks among central banks all over the world, and several nations have already begun conducting pilot projects to test the practicality and efficiency of these digital currencies. CBDCs are anticipated to become an increasingly essential component of the financial landscape as the globe continues to move toward a more digital financial system.

CBDCs substantially come in two forms, each with its own special qualities and benefits. Wholesale CBDC consists of a digital version of central bank currency that can be employed as a supplement or substitute for traditional types of central bank money, such as banks reserve balances held at the national central bank. The utilization of wholesale CBDC is especially fitting for transactions of significant magnitude by financial institutions and notable financial markets participants to streamline interbank settlements and other wholesale payments. On the

other hand, retail CBDC, similar to physical cash, could be utilized by the general public for peer-to-peer transactions, offering a secure and convenient electronic payment solution. In addition, because every economy is unique in both its characteristics and the challenges it faces, the process of putting CBDC into effect needs to be adapted for each economy individually. For example, community development financial institutions (CDFCs) may prove to be a vital tool for fostering financial inclusion in locations where traditional banking institutions are difficult to access due to the presence of geographical restrictions. On the other hand, depending on the particulars of the circumstance, CBDCs may be able to function as a backup payment instrument in the event that other payment mechanisms are unable to complete the transaction. As a consequence of this, central banks are obligated to carry out an exhaustive investigation of the specific conditions of their institutions. This will ensure that CBDCs are able to successfully tackle the individual issues that are unique to each economy, leading to an implementation that is both more efficient and more effective than it would have been otherwise.

Throughout this thesis, the concept of CBDCs and the ways in which they might improve existing payment systems will be investigated. In addition to this, the thesis will investigate the various iterations of CBDC and the potential benefits that could result from putting them into action. The purpose of this thesis as a whole is to provide the audience with an understanding of CBDCs and how they may have an impact on payments in the future. This thesis comprises three chapters, each of which focuses on a distinct aspect of CBDCs and the potential impact those aspects could have on the payment systems. The purpose of the first chapter is to investigate the role that CBDCs play on the balance sheets of central banks as a hybrid asset class that is located between cash and bank reserves. How the implementation of CBDC may make available an extra tool to ensure access to a risk-free asset class, as well as how CBDC would strengthen the robustness of the overall payment system by providing a backup system. The potential of both wholesale and retail CBDCs to improve international financial transactions will be the primary focus of the second chapter. This chapter will discuss the challenges that are associated with making payments across international borders and think about the ways in which CBDCs may improve the speed, efficiency, and transparency of international trade. This chapter will also investigate how CBDCs may influence the international monetary system as well as how central banks may assist with international financial dealings. In the third and last chapter, it will be investigated whether retail CBDCs have the ability to enhance financial inclusion in the area of financial services. This chapter will examine how retail CBDCs could provide more individuals and businesses with access to

financial services, particularly those people and businesses who are now excluded from traditional financial institutions. This idea is going to be broken down with the help of the PAFI "house," which takes into account important features of financial inclusion in retail payments.

Chapter 1. The decline in cash and the necessity for a digital substitute

1.1. Overview of the trend towards a cashless society

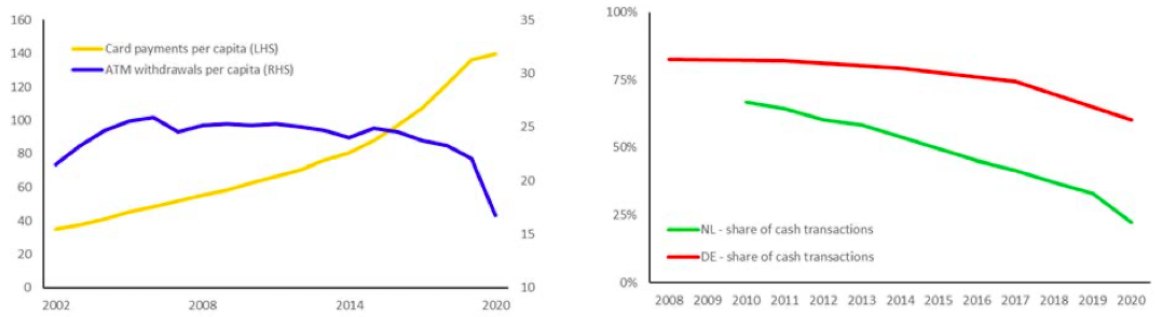
As part of their public policy objectives, central banks have been giving the general public trustworthy currency for many years in the form of cash. This form of money, which is considered to be public money, serves as a shared unit of account, store of value and medium of exchange for purchasing goods and services and settling financial transactions. In our contemporary monetary system, there exists privately issued money and public issued money. Both of these currency types are essential in enabling economic transactions and preserving the operation of the broader monetary framework. Actual money, or cash, is typically only issued by the central bank and is considered public money because the monetary authority is directly liable for it. In contrast, private money available to the general public is created by commercial banks, usually in the form of bank deposits. During the last years the economy's digital transformation has rapidly advanced, with businesses having significantly boosted their investments in information and communication technologies to benefit from the resulting productivity improvements. Simultaneously, the delivery of goods and services has steadily transitioned to digital channels and the digital transformation of the economy has been accompanied by a significant shift towards digital payments. The continuous process of digitalization has caused significant modifications in the overall structure of the economy. In effect, cash usage in payments has been declining in some advanced economies even before the COVID-19 pandemic. Alternatively, there has been significant growth in fast and convenient digital payment options offered by commercial entities. Consumers have been increasingly using mobile devices, digital wallets and other online payment platforms to make purchases and pay bills, while businesses have been adopting new payment technologies to streamline their operations and reduce costs. The expansion of mobile payments has been one of the major forces behind this change. With the widespread adoption of smartphones and other mobile devices, consumers have been increasingly using their phones to make payments, whether through mobile wallets like Apple Pay and Google Pay or through dedicated payment apps offered by banks and other financial institutions. In addition to mobile payments, peer-to-

peer payment platforms, online banking, e-wallets and other types of digital payments have all seen significant growth in recent years. These technologies allow consumers to make payments quickly and easily, often without the need for physical cash or checks. For businesses, the adoption of digital payment technologies can offer a range of benefits, including improved cash flow, reduced transaction costs and increased security. Many businesses are also finding that digital payments can help them improve customer engagement and loyalty by offering a more convenient and smooth payment experience. Digital money is essential for the economy's smooth operation in the current digital age, as conducting business transactions online is becoming more and more common, making cash less desirable as an effective payment method. In the past, a variety of forms of money have developed to meet the economic demands of the day. In recent decades the list of payment technologies has expanded to include new options such as mobile money that is based on phones, smartphone-based payment apps, stable coins and CBDC which represent a new type of central bank issued money. Nowadays, all major central banks worldwide are currently looking into the introduction of central bank digital currency[1]. The main reason for this, together with the increased competition of new forms of money such as cryptocurrencies, is the progressive fall in cash use and the growth of digital payments, which offer serious challenges to the status quo of the current financial system. Despite a rise in the amount of cash actually issued, several nations are seeing a fall in the use of cash for payments as a result of growing digitalization. Just roughly 20% of the cash stock in the euro area is utilized for payment transactions (compared with 35% fifteen years ago) with the remainder being employed as a store of wealth either inside the euro area or outside[2]. Consistent with this view, the number of card payments in the euro area has increased more than four times over the previous 20 years[3] as shown in panel A of Figure 1. Cash withdrawals from ATMs have decreased by about 20% over the same period, with a sharp decrease in recent years. Panel B of Figure 1 shows that the usage of cash as a means of payment (measured as the percentage of transactions settled in cash) has significantly decreased over the past 10 years, according to data from payment diaries in Germany and the Netherlands.

[1] Ahnert, T., Assenmacher, K., Hoffmann, P., Leonello, A., Monnet, C., & Porcellacchia, D. (2022). The economics of central bank digital currency. ECB Working Paper Series No. 2713

[2] Bindseil, U., Panetta, F., & Terol, I. (2021). Central Bank Digital Currency: functional scope, pricing and controls. *ECB Occasional Paper*, (2021/286).

[3] Ahnert, T., Assenmacher, K., Hoffmann, P., Leonello, A., Monnet, C., & Porcellacchia, D. (2022). The economics of central bank digital currency. ECB Working Paper Series No. 2713.



Source: Ahnert, T., Assenmacher, K., Hoffmann, P., Leonello, A., Monnet, C., & Porcellacchia, D. (2022). The economics of central bank digital currency. ECB Working Paper Series No. 2713.

Panel A: Card payments and ATM withdrawals (euro area) Panel B: Share of cash payments (DE and NL)

Figure 1: Panel A shows the change in the number of card transactions and ATM withdrawals per individual in the Eurozone from 2002 to 2021. Panel B displays the percentage of retail transactions made with physical cash, using information obtained from retail payment records in Germany and the Netherlands[4]

These changes have motivated central bankers to consider the advantages of implementing a retail digital form of currency (CBDC). A retail CBDC offers the chance to enhance payments by using a technologically enhanced version of central bank money that maintains the essential qualities of finality, liquidity and integrity that only the central bank can offer[5]. Furthermore, retail CBDC presents numerous advantages that include reduced expenses, enhanced operational effectiveness and greater visibility for individuals, governmental bodies and banks. In fact, by implementing a retail CBDC, central banks and regulatory authorities can leverage on the increased financial transparency to mitigate the risk of illicit activities being carried out through the payment systems.

[4] Ahnert, T., Assenmacher, K., Hoffmann, P., Leonello, A., Monnet, C., & Porcellacchia, D. (2022). The economics of central bank digital currency. ECB Working Paper Series No. 2713.

[5] Aurer, R., Frost, J., Gambacorta, L., Monnet, C., Rice, T., & S, H. S. (2021). Central Bank Digital Currencies: motives, economic implications and the research frontier. BIS Working Papers No 976. Bank for International Settlements, Monetary and Economic Department

1.2. CBDCs necessary to preserve the role of central banks

Central banks have a crucial function in the issuance and management of physical currency within the present payment system. They bear the responsibility of producing, distributing and regulating physical currency within the economic system. Central banks are responsible for safeguarding a country's monetary policy and implementing decisions that have an impact on interest rates, money supply, and the general economic well-being. Central banks act as the ultimate source of credit for commercial banks in times of financial distress, thereby facilitating the continuous operation of the banking system. Additionally, they oversee and enforce regulatory measures to safeguard the soundness and consistency of the financial system. The act of oversight serves to safeguard the overall economy, maintain confidence in the banking sector, and protect customers' deposits. In contrast, commercial banks serve as intermediaries in the financial sector by offering a range of services such as receiving deposits from clients and extending credit and loans. In addition, they facilitate the exchange of monetary resources among individuals and enterprises, thereby promoting the efficient operation of the economy. In addition, commercial banks provide a variety of financial products and services such as savings accounts, checking accounts, and electronic payment solutions to cater to the diverse requirements of their customers. With the rise of digital payments and the increasing use of new forms of payments such as cryptocurrencies, central banks are facing challenges in maintaining their role as ultimate issuer and regulator of money. One of the primary challenges is the decentralized nature of most of the new forms of payments. For example, unlike traditional currencies, which are issued and regulated by central banks, cryptocurrencies operate on decentralized networks that are not controlled by any single entity. This means that central banks are unable to directly regulate the supply and circulation of cryptocurrencies, and may struggle to maintain control over the monetary system as a whole. Another challenge is the potential for cryptocurrencies to undermine the stability of traditional financial systems. In fact, cryptocurrencies are often subject to extreme volatility, which can create instability in financial markets and lead to systemic risk. In addition, cryptocurrencies can be used for illicit activities such as money laundering and terrorist financing, which can further destabilize the financial system. CBDCs present central banks with a distinctive prospect to reestablish authority and impact over the payment system, while simultaneously guaranteeing the confidence of the general public in central bank currency. CBDCs possess the capacity to

mitigate certain apprehensions linked with cryptocurrencies and other nascent payment mechanisms. In fact, the implementation of CBDCs has the potential to mitigate the occurrence of fraudulent activities, money laundering, and other illicit transactions. In addition, CBDCs offer central banks an opportunity to improve their oversight and control of transactions, thereby augmenting their capacity to identify and deter possible threats and risks. Through obtaining a comprehensive understanding of payment flows, central banks can implement suitable measures and interventions to uphold a secure and stable financial system.

Moreover, CBDCs have the potential to aid in the reduction of systemic risks within financial markets. Enhanced regulatory supervision has the potential to mitigate financial crises and promote the general stability of the payment system. Additionally, the use of CBDCs can also improve transparency as all transactions are recorded and easily traceable. Therefore, introducing CBDCs in the digital era would provide a concrete advantage in maintaining financial and monetary stability, encouraging competition and enhancing efficiency in the payment markets. In fact, by issuing CBDCs, central banks can ensure that their money remains the ultimate form of payments, even in a digital age. This can help to maintain the stability of the financial system and protect the monetary sovereignty of countries. In addition, a CBDC could potentially enhance the confidentiality of digital transactions. Currently, private firms have the potential to monetize the data contained in electronic transactions, which could pose a significant threat to privacy. This risk is further amplified by the emergence of big tech firms that offer financial services and the rapid development of artificial intelligence. While data protection regulations aim to prevent misuse, they may not always be able to keep up with technological advancement, as evident in previous cases of data breaches and misuse by tech companies. Introducing a digital currency through an independent public institution like the central bank, which has no interest in exploiting personal payment data for any purpose, could potentially improve the confidentiality of electronic payments instead of reducing it. In fact, the public has voiced their preference for enhanced privacy in digital payments with privacy identified as the most important factor for the development of a digital currency.

1.3. Access to risk-free central bank money and retail CBDC

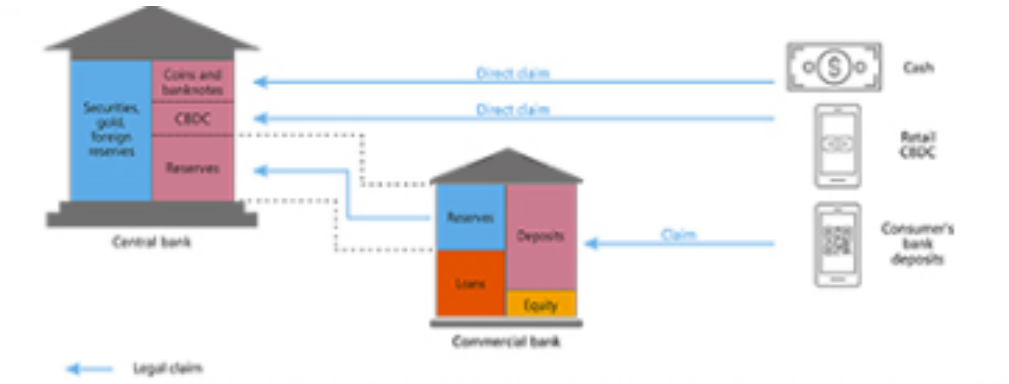
The responsibility of ensuring public access and complete usability of central bank money falls under the authority of central banks. This involves establishing an optimal environment in which both individuals and enterprises can conveniently and effectively interact with currencies issued by the central bank. Nowadays, cash is the only form of money that assures that. As already outlined in the first paragraph, however, the digital transformation of the economy has led to a shift towards digital payments resulting in a fall in cash usage. Cash is considered public money because it is backed by the central bank and therefore deemed entirely secure. However, if cash becomes less available, some economists have expressed concern that households may be left without a secure and risk-free form of money to use. This is because most digital payments are facilitated through commercial banks or private payment platforms, which carry the risk of default. In the event of a bank failure or the insolvency of a payment platform, users may lose access to their funds. In fact, commercial bank money is a form of money that is created by commercial banks when they make loans or investments. It is a liability of the commercial bank, which means that the bank owes the holder of the money an obligation to pay it back on demand. Unlike central bank money, which is issued directly by the central bank and is considered a liability of the central bank, commercial bank money is a liability of various private issuers, namely commercial banks. In addition, the general public believes that commercial bank money is interchangeable at the same value with central bank money. This is due to the anchoring of commercial bank money to central banks, which is the form of currency that establishes the unit of account. In a potential "cashless society" people would not have access to any monetary anchor into which bank deposits or digital currencies could be converted. In effect, the discipline of public money would essentially be lost and its issuance would instead be shaped by other market forces[6]. If there is no mechanism to convert one payment instrument to another, the perfect interchangeability between them may not be ensured. This means that the relative prices of different banks' deposits or various currency networks could fluctuate freely, depending on the creditworthiness of their issuer[7]. To address this concern, supporters of CBDC suggest that central banks should introduce a new type of

[6] Brunnermeier, M. K., James, H., & Landau, J. P. (2019). The digitalization of money. National Bureau of Economic Research Working Paper Series, 26300.

[7] Brunnermeier, M. K., James, H., & Landau, J. P. (2019). The digitalization of money. National Bureau of Economic Research Working Paper Series, 26300

central bank money that provides households with an alternative to commercial bank or private money that can be used for payments and savings. A good alternative would be retail CBDC. The implementation of retail CBDC provides an additional means of exchange for the general public, complementing the existing physical cash in circulation. The asset-backed nature of this currency corresponds to that of cash, as it is supported by reserves held at the central bank. Retail CBDC serves as a digital representation of physical banknotes and coins, offering individuals a new option for storing and conducting financial transactions. Retail CBDC is a regulated and secure form of digital currency that the central bank directly issues. This payment system provides the ease of electronic transactions, equivalent to extant digital payment modalities, while preserving the comfort and confidence linked with tangible currency. Retail CBDC is a digital representation of real money that enables users to store their money in a digital wallet that the central bank is providing. This feature facilitates smooth and immediate peer-to-peer transactions, online acquisitions, and payments at authorized vendors. Users can access retail CBDC funds using electronic tools like smart cards and mobile devices, which provides a high level of accessibility and convenience. A salient characteristic of retail CBDC is its inherent collateralization through assets maintained by the central bank. This implies that the value and stability of each unit of CBDC in circulation is guaranteed by the reserves held by the central bank. The implementation of this support mechanism serves to foster trust and assurance in the retail CBDC as a dependable and credible mode of digital currency. This technology has the potential to enable programmable currency, thereby enabling the execution of intelligent contracts and the automation of specific financial transactions.

As shown in Figure 2, retail CBDC is a liability of the central bank and, like cash, central banks have a direct claim on it. On the other hand, as shown in Figure 2, deposits, which are private money, are a liability of commercial banks and therefore carry a certain degree of risk. In addition, as depicted in Figure 2, mobile phone devices can play an important role in enabling consumers to access retail CBDC.



Source: Aurer, R., & Bohme, R. (2021). Central bank digital currency: The quest for minimally invasive technology. BIS Working Papers No. 948.

Figure 2: The monetary system with a retail CBDC[8]

Additionally, advocates of CBDC highlight that the provision of central bank money, including currency and settlement balances, helps maintain confidence in the use of commercial bank money and the overall financial system. Retail CBDC might function as a digital banknote which is necessary to preserve the role of central banks as a stabilizing force at the heart of the payment system and to safeguard monetary sovereignty. The trust placed in private forms of payment is dependent on the ability to exchange them for secure public money, which is backed by the State and considered risk-free. In fact, people's willingness to hold private money, such as bank deposits, is a reflection of people's confidence that private money can be converted into cash, which assures that deposits are secure. In addition, financial regulators and deposit insurance ensure that bank-issued money can be converted to cash at its face value, making it a reliable and practical method that many people trust.[9] This, in turn, reinforces people's belief that private money can be converted into risk-free public money at any time. When trust in the ability to exchange private money for public money disappears, bank runs and financial crises can occur. The absence of a secure and reliable form of money, guaranteed by the State, would require individuals to continuously monitor the financial stability of private issuers to determine the value of different types of private money. This would erode the confidence in the uniformity of money and hinder the effectiveness of the payment system. CBDC could solve the problem of eroded confidence in the uniformity of

[8] Aurer, R., & Bohme, R. (2021). Central bank digital currency: The quest for minimally invasive technology. BIS Working Papers No. 948.

[9] Ahnert, T., Assenmacher, K., Hoffmann, P., Leonello, A., Monnet, C., & Porcellacchia, D. (2022). Cold hard (digital) cash: The economics of central bank digital currency (Research Bulletin No. 100). European Central Bank

money since it provides a centralized and trusted form of digital currency backed by the central bank.

1.4. Wholesale CBDCs in interbank transactions and retail CBDC in peer-to-peer transactions to enhance resilience in the payment efficiency

In the current era of information, digital platforms are becoming the dominant business model, posing a challenge to the traditional role of banks in the payment system. Tech giants and financial start-ups are incorporating payment features into their digital services, including online marketplaces, messaging applications and financial services like lending and insurance. Although banks still provide the payment infrastructure for these solutions, they are losing direct access to the customer interface. Innovation is rapidly transforming both domestic and international financial infrastructure. To support a prosperous economy, ensure monetary and financial stability and maintain trust in the financial system, it is crucial to have safe and efficient transactions among banks. The wholesale CBDCs have been developed with the primary aim of expediting the settlement of interbank transfers and other wholesale transactions. These digital currencies fulfill comparable functions to central bank reserves, while also providing supplementary functionalities and features.

An outstanding characteristic of wholesale CBDCs is their capacity to enforce stipulations on transactions. In contrast to conventional settlement mechanisms that involve instantaneous payment execution, wholesale CBDCs enable the implementation of conditional payments.

The implementation of programmability in wholesale CBDCs facilitates the automation of financial transactions, thereby mitigating the need for manual intervention and enhancing operational efficiency. Furthermore, it aids in risk reduction by guaranteeing that payments are carried out solely upon fulfillment of pre-established conditions.

In addition, wholesale CBDCs are constructed using novel technology frameworks, enabling a novel and inventive methodology. The adoption of a clean-slate approach presents a favorable prospect for the development of comprehensive CBDC systems that prioritize conformity with global standards, thereby augmenting their interoperability. Furthermore, wholesale CBDCs

facilitate the mitigation of counterparty risk by allowing financial institutions to engage in direct settlement utilizing central bank funds. The mitigation of counterparty risks related to commercial banks can be achieved by eliminating intermediaries and relying on the central bank as a trusted settlement agent. This mitigates the likelihood of disturbances arising from financial institutions' inability to meet their obligations or their financial collapse. In addition, wholesale CBDCs have the potential to provide expedited settlement of transactions, approaching real-time speeds. The adoption of real-time settlement obviates the necessity for extended settlement periods, thereby mitigating liquidity and credit risks. The enhanced pace of settlement enhances the effectiveness and durability of the payment mechanism by reducing susceptibility to market fluctuations and uncertainties.

The implementation of conditional payments is made possible by the programmable features of wholesale CBDC, resulting in enhanced risk management. This particular ability facilitates the incorporation of measures aimed at mitigating risks and providing improved control over transactions. The incorporation of these stipulations within wholesale CBDC serves to mitigate operational and systemic hazards, thereby fostering a payment system that is more resilient.

As regard peer-to peer transactions, the ongoing transition from cash to electronic payments puts more pressure on electronic payment system[10], which has an impact on the diversity and resilience of the payment landscape. For point of sale (POS) transactions, cards and cash are frequently the only two alternatives, with cards serving as the exclusive payment method for online purchases. As a result, the operational resilience of the card network is becoming more and more important and the payments landscape resilience may be affected by the increased reliance on a single electronic method. Currently, cash serves as a helpful backup for electronic payment systems in the event that card payment networks are disrupted. Yet, if the use of cash for payment decreases, so will its usefulness as a backup payment mechanism. This has become a concern for countries that have highly digitalized payment sectors, where the use of cash is declining. In such countries, there is a growing concern about the potential for disruptions to digital payment services, which can have far-reaching consequences for businesses and individuals who rely on electronic payments for daily transactions. For example, a widespread network outage or cyber-attack could render electronic payment systems useless, leaving people without a means to purchase goods and services. Furthermore, in countries where there are only a few large operators dominating the payment sector, there is a risk of concentration. This means that if one of these operators experiences a disruption, it can have significant

[10] Bank of England (2020), Central Bank Digital Currency: opportunities, challenges and design

implications for the entire payment ecosystem. Such a scenario could lead to a domino effect, causing a ripple effect across the entire economy, with consequences that could be felt for weeks, if not months. Hence, a retail CBDC could improve financial stability by promoting payment resilience and offering some essential payment services outside of the commercial banking system. It could broaden the selection of payment options by offering a new method of payments, especially for e-commerce where cash cannot be used. This would mitigate concentration risk. A retail CBDC network might work as a substitute for card networks, thus being less likely that both would have outages at the same time. It is important to maintain a healthy balance between digital and cash-based payment options. This will ensure that in times of need, there is a reliable backup option that can serve as a safeguard against potential disruptions to the digital payment ecosystem[11]. This element is a crucial point which came up from the collaboration of major central banks of developed countries in producing a joint report which aimed to establish fundamental principles and core characteristics of CBDCs, serving as guiding principles for individual central banks in developing and implementing their own CBDCs initiatives. Even if there has been a significant increase in the adoption of digital and electronic payment methods, traditional offline payments remain largely unchanged, and banknotes continue to be the most commonly used payment method that does not require an internet connection. To address this gap, the development of an offline retail CBDC that enables two users to transact without an internet connection could complement traditional banknotes. The availability of an offline retail CBDC would enhance resilience and increase accessibility for users. Compared to other electronic payment methods, an offline retail CBDC would not rely on an internet connection, this would imply that users can continue to transact even when conventional methods such as credit and debit cards are unavailable due to an internet failure[12]. The offline functionality of a CBDC would be particularly advantageous in areas with poor connectivity, such as rural or remote regions. It would also benefit individuals who do not have access to digital payment methods, bridging the gap between traditional cash-based transactions and digital payments, making it more accessible for a broader range of users. Furthermore, the construction of a CBDC system from scratch allows for the incorporation of decentralized elements, enhancing operational resilience and reducing reliance on outdated systems.

[11] Bank of Canada, European Central Bank, Bank of Japan, Sveriges Riksbank, Swiss National Bank, Bank of England, Board of Governors of the Federal Reserve System, & Bank for International Settlements. (2020). Central bank digital currencies: Foundational principles and core features: Report no. 1 in a series of collaborations from a group of central banks.

[12] Minwalla, C., Miedema, J., Hernandez, S., & Sutton-Lalani, A. (2023, February). A central bank digital currency for offline payments: Staff Analytical Note 2023-2.

1.5. Case studies for CBDCs and financial resilience

Ensuring the ability to pay and providing government transfers to individuals is crucial in all jurisdictions, but in nations that are prone to disaster, like the Bahamas and ECCU (the Eastern Caribbean Currency Union), this policy objective becomes even more important.[13] These island nations are frequently hit by natural disasters that can cause destruction of physical and financial infrastructure, making it difficult to ship cash and provide aid. To address these concerns, the Sand Dollar pilot was launched in the Bahamas after a hurricane in 2019, while the ECCB expanded the D-Cash pilot to areas affected by a volcano eruption in St. Vincent and the Grenadines in 2021.

In countries with highly digitalized payment sectors, there is a risk of disruption of digital services and concentration risk due to the dominance of a few operators, as seen in China where the mobile payment market is dominated by AliPay and TenPay/WeChat PAy. The POBC (People's Bank of China) has expressed concern about the potential consequences of the failure of such firms, highlighting the need for the e-CNY (electronic Chinese Yuan) to function as a backup to existing digital payment solutions. Similarly, the Riksbanken has identified the potential risk of relying on a few dominant actors, which could be worsened in a society where cash is no longer available as a backup system. Therefore, as part of the ongoing modernization of civil defense, Sweden is prioritizing the resilience of payment infrastructures. While the Riksbanken believes that cash should continue to exist, the e-krona (electronic Swedish Krona) could provide an additional backup to existing digital payment systems. Both the POBC and the Riksbanken recognize the role that cash can play as a backup when digital payment methods fail. However, they are concerned about the declining usage of cash, which could impair the overall resilience of the payment system. In this context, CBDCs could serve as an additional backup to address these concerns and strengthen payment resilience.

[13] Soderberg, G., Bechara, M., Boss, W., Che, N. X., Davidovic, S., Kiff, J., Lukong, I., Mancini Griffoli, T., Sun, T., & Yoshinaga, A. (2022). Behind the Scenes of Central Bank Digital Currency: Emerging Trends, Insights, and Policy Lessons. International Monetary Fund.

Chapter 2. Increased payment efficiency and CBDCs

2.1 Importance of innovation in payment systems

Innovation is the key to success in any industry, and the payment sector is no exception. In today's world, where technology is advancing at an unprecedented rate, companies that fail to innovate and keep up with the latest trends risk being left behind by their competitors. One of the primary reasons why innovation is crucial is to meet the evolving needs and expectations of customers. With the advent of technology, customers expect payment processes to be faster, secure, and more convenient. Innovation in payment systems helps in meeting these expectations and providing an enhanced user experience.

The payment user is the most critical stakeholder in the payment system. While the current payment systems fit for some segments of the society, many users still have unfulfilled needs. This aspect is particularly evident with vulnerable or financially excluded users who might struggle with traditional payment systems. Therefore, it is essential to encourage innovation in this space to address these gaps and better serve all payment users. Transparency of funds within the financial system is a critical factor in improving the customer experience. Unfortunately, even today, there are still instances where funds get lost in transit, causing significant inconvenience and concern for customers. Horror stories of money taking weeks or even months to reach its intended destination are all too common[14], therefore transparency is vital. For example, a relative who sends emergency money abroad. In this case, time is crucial and delays or uncertainties in the transaction can have critical consequences. In such a situation, customers need to know that their money has reached its intended destination, giving them peace of mind and allowing them to plan accordingly. According to this, innovation that improves transparency of funds within the financial system can help address these concerns. Furthermore, innovation in the payment system can help reduce costs in several ways. Firstly, traditional payments involve high fees and transaction costs, such as the cost of processing and storing payment data. By introducing new technologies, such as digital currencies and mobile payment platforms, the payment industry can significantly reduce these costs. For instance,

[14] https://www.theguardian.com/money/2018/dec/09/banking-swift-money-transfer-worldwide-delay

digital currencies facilitate peer-to-peer transactions without the need for intermediaries, such as banks or payment processors, thus reducing transaction fees and associated costs. Similarly, mobile payment platforms can eliminate the need for physical payment cards, thus reducing the cost of producing and distributing them. In addition, enhanced efficiency thanks to innovation can further cut costs. Many traditional payment systems are slow and require multiple intermediaries to complete a transaction, which can add to the overall cost. By making use of new technologies, the payment industry can facilitate the payment process, reducing the time and costs associated with transactions. In addition to that, innovation can help reduce costs by improving security and reducing fraud. In effect, it is important to highlight that the payment system is not immune to abuse and criminal activities, including money laundering. Criminals often exploit the payment system to move and hide illicit funds, making it a crucial area for identifying and preventing financial crimes. Luckily, innovation combats financial crime and improves the security and integrity of the payment system. For example, the use of big data analytics and artificial intelligence help identifying patterns and anomalies that may indicate illicit activity. In fact, by analyzing data from various sources, such as transaction data and customer information, in the financial system, AI-powered systems can identify suspicious activities[15]. This in turn could help prevent and disrupt criminal activities such as money laundering, terrorist financing and other financial crimes. Other examples include blockchain and biometric authentication which are used to enhance the security and transparency of the payment system. In fact, blockchain can provide an immutable and transparent ledger of transactions, making it easier to trace the movement of funds and identify potential laundering activity[16]. However, it is important to highlight the fact that the ultimate goal of innovation should be meeting customers' needs. In fact, the core of payment innovation should be the payment experience for customers. In recent years, payment systems have made great steps ahead in meeting this expectation. Contactless payments, mobile payments and online payments have made the payment process more convenient and faster, thus improving the consumer experience. However, it’s important to highlight that this should never be at the cost of basic security and resilience, which are essential for building trust and confidence in the payment system. Customers need to be sure that their transactions are secure and their personal data are protected and therefore any innovation should prioritize security and resilience. A

[15] https://www.barclayscorporate.com/insights/innovation/ai-payments-revolution/.

[16] https://www2.deloitte.com/mt/en/pages/financial-services/articles/mt-risk-article-can-blockchain-turn-the-tide-on-financial-crime-compliance.html.

payment system can be considered safe only if it is used widely and consistently by users[17]. However, for users to rely on payment systems, they must ensure fast, efficient, user friendly and inclusive transactions.

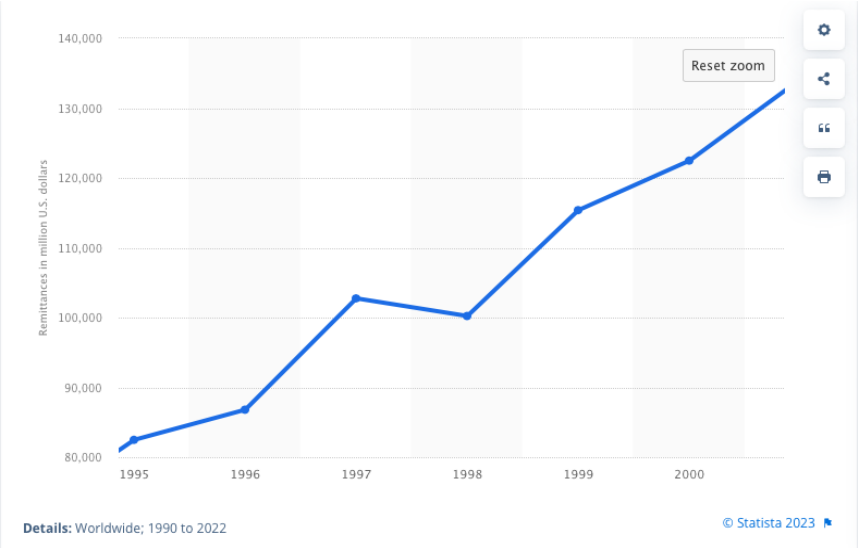
The evolution of technology has brought a significant transformation in the payment systems. Within the domestic space, payment methods have become more convenient, faster and instantaneous. This has been made possible by innovations such as mobile banking, digital wallets and peer-to-peer payment platforms, which have replaced the traditional methods such as cash and checks. Despite the industry's progress, several customers' needs are still unmet, and it's crucial for the payment system sector to address them in order to be competitive and relevant in the future. In particular, the first challenge is cross-border payments. Despite being a crucial element of the global economy, cross-border payments are often costly, slow and complex. These inefficiencies can disproportionately affect individuals and businesses in emerging markets and developing economies (EMDEs). The second major challenge is accessibility. In effect, a significant proportion of the global population still lacks access to formal financial services. There could be multiple reasons for this such as regulatory barriers, financial infrastructures and remoteness.

[17] Bank of England (2020), Central Bank Digital Currency: opportunities, challenges and design

2.2. Overview of the challenges and inefficiencies for cross-border payments

Cross-border payments refer to financial transactions in which the payer and the payee are situated in different countries or jurisdictions[18]. Cross border payments play a crucial role in enabling international trade and finance to function smoothly. These systems play a crucial role in enabling individuals, businesses and governments to transfer money across borders, thus facilitating the flow of goods and services and promoting economic growth.

There are two main categories of cross border payments: retail and wholesale[19]. Retail payments refer to transactions between non-financial businesses or individuals, such as payments made by international migrants to their families or students studying abroad. These transactions tend to be of smaller value but high volume, indicating that they occur frequently. As shown in Figure 3, remittance inflows from migrants worldwide have seen a continuous rise since 1990, with a significant surge in the early 2000s. Figure 3 shows that the total amount of remittances received has grown from 122 billion U.S. dollars in 2000 to 794 billion dollars in 2022[20].



Source: https://www.statista.com/statistics/1377780/remittances-world-migrants-inflows

Figure 3: The total amount of inflows of remittances from migrants in the world[21]

[18] Bech, M., Faruqui, U., & Shirakami, T. (2020). Payments without borders. Bank for International Settlements

[19] Bindseil, U., & Pantelopoulos, G. (2022, August). Towards the holy grail of cross-border payments. European Central Bank

[20] https://www.statista.com/statistics/1377780/remittances-world-migrants-inflows/

[21] https://www.statista.com/statistics/1377780/remittances-world-migrants-inflows

On the other hand, wholesale cross border payments refer to high value transactions that take place between financial institutions. These transactions may be initiated on behalf of clients for the purpose of settling retail payments or for a range of foreign exchange (FX) operations. These types of payments can involve large sums of money and are typically carried out by commercial banks.

It's important to note that both retail and wholesale cross border payments play a significant role in facilitating global trade and commerce. In particular, retail payments are essential for individuals and businesses to conduct transactions across borders, while wholesale payments enable financial institutions to transfer large amounts of money nationwide.

However, cross border transactions suffer from several inefficiencies, the primary obstacles are related to costs, security, time efficiency, liquidity and transparency.

Firstly, cross-border transactions usually entail various expenses fees, which makes the overall cost of the transaction high. These costs include currency exchange fees which arise from the conversion of one currency into another. Additionally, intermediary charges may be incurred when a payment passes through multiple financial institutions, each charging a fee for their services. Regulatory costs may also come into play, such as fees associated with complying with anti-money laundering and countering financial terrorism (AML&CFT) and other financial regulations.

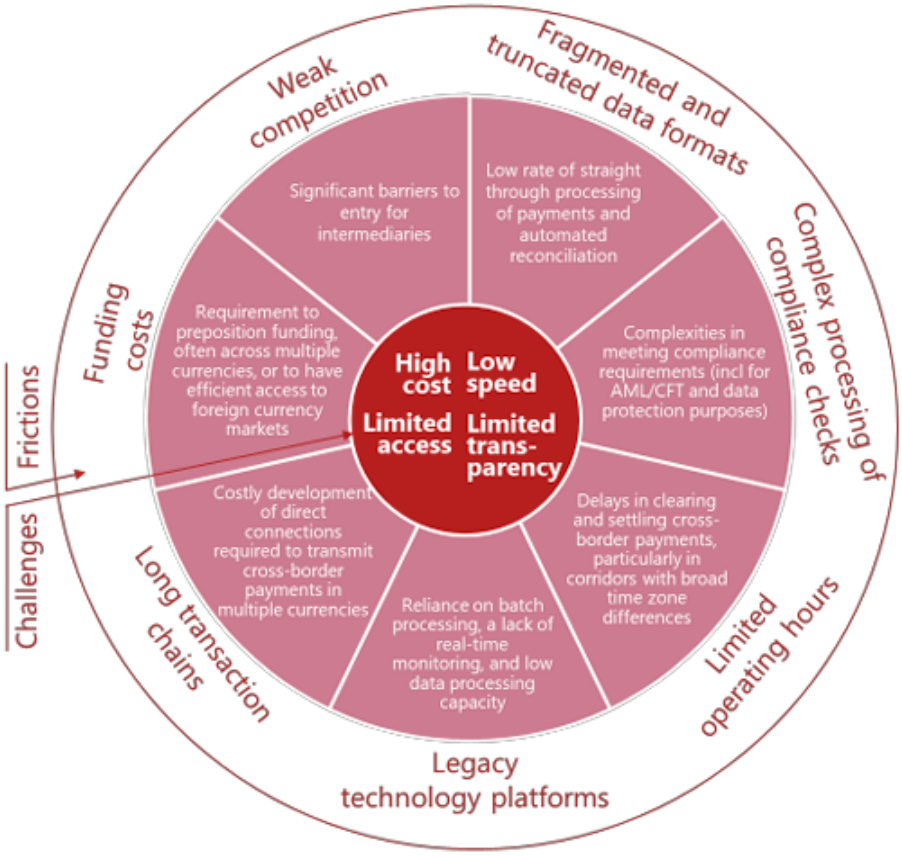
According to a survey conducted by the Committee on Payments and Market Infrastructures (CPMI) in 2018[22], the process of completing a cross border payment can be a time-consuming affair. The survey found that in some cases, it can take up to seven days to complete a cross border payment. This prolonged timeline is often attributed to various factors such as regulatory requirements, time zone differences and technical limitations. One of the main factors contributing to this long process is compliance with regulatory requirements. Cross border payments must adhere to the laws and regulations of both the sending and receiving countries, which can often result in additional delays. Moreover, cross border payments typically involve multiple parties, including banks and financial intermediaries, each of which may have their own processes and requirements, thus further increasing the processing time.

Due to the difficulty in tracking cross border payments, the rate of fraud in cross-border payments is higher compared to domestic. This makes it crucial for financial institutions to have strong security measures in place to prevent fraud and to ensure the security of cross

[22] Bank for International Settlements. (2018). Cross-border retail payments. Committee on Payments and Market Infrastructures.

border payments, banks and other financial institutions are expected to comply with regulations and guidelines set by regulatory bodies.

Most cross-border transactions work on the pre-funding of accounts to ensure the timely settlement of payments. Therefore, it becomes crucial for financial institutions to maintain adequate liquidity in their correspondent bank accounts to meet payment obligations within deadlines. However, managing liquidity for cross-border payments can be challenging. Financial institutions need to effectively deploy funds and manage their liquidity positions to ensure timely settlement of payments, which requires efficient communication and coordination between multiple parties involved in the payment process. In addition, maintaining sufficient liquidity helps financial institutions to manage their risk and maintain their reputation in the market. Due to the high entry barriers, offering cross border payment services is a difficult challenge for businesses. Due to the small number of established competitors in the industry, there is less competition, which may result in higher pricing for businesses and end customers. This could decrease investment in modernizing cross border payment procedures. To encourage a more open, transparent and competitive cross border payments ecosystem, it is crucial to solve these concerns. In Figure 4, the primary obstacles and difficulties faced by cross-border payments, both in retail and wholesale context, are depicted. Figure 4 outlines that the main frictions encompass intricate compliance checks procedures and extended transaction chains. Meanwhile, the main challenges involve high cost, sluggish transaction speeds and limited accessibility.



Source: CPMI based on FSB (2020b)

Figure 4: Challenges and frictions in cross-border payments[23]

[23] CPMI based on FSB (2020b)

2.3. CBDCs for cross-border payments

There is a growing recognition of the potential for CBDCs to improve the efficiency of cross border payments. In effect, enhancing cross border payment systems is a significant driver of CBDC development efforts.

During the 2020 Saudi Arabian Presidency, improving cross border payments was identified as a top priority by the G20[24]. The aim was to create cross-border payment services that are faster, cheaper, more transparent and more inclusive. This would provide substantial benefits for people and economies across the world, as it would support economic growth, international trade, global development and financial inclusion. Achieving faster, cheaper and more transparent cross border payments would lead to a greater efficiency and cost savings for business, governments and individuals. For example, it would make it easier for small and medium sized enterprises (SMEs) to engage in cross-border trade, as they would no longer have to navigate the complexities of expensive and time-consuming payment systems. Additionally, faster and cheaper cross border payments would enable international remittances to be delivered more quickly and at a lower cost, benefiting millions of families that rely on such transfers to support their families. In October 2020, the Financial Stability Board (FSB) with the cooperation of the CPMI and other international organizations and standard setting bodies designed the roadmap for improving cross border payments[25]. The roadmap focuses on enhancing the existing payment system, while also considering the development of new technologies, such as CBDCs. As part of their effort, Action 1 of the roadmap calls for collaboration between the CPMI, the BIS Innovation Hub, the International Monetary Fund (IMF) and the World Bank to conduct a review of current domestic CBDC designs and central bank experiments, with a particular focus on their potential use for cross border payments[26]. Additionally, the IMF will work alongside other relevant stakeholders to analyze the macro-financial implications of cross border CBDC usage. By undertaking these actions, the roadmap aims to promote greater interoperability and efficiency in cross border payments while ensuring the safety and stability of the global financial system.

[24] Committee on Payments and Market Infrastructures. (2020, July). Enhancing cross-border payments: Building blocks of a global roadmap. Stage 2 report to the G20. Bank for International Settlements

[25] G20 Roadmap for Enhancing Cross-border Payments: Priority Actions for Achieving the G20 Targets.(2023). Financial Stability Board

[26] Central bank digital currencies for cross-border payments. (2021). Committee on Payments and Market Infrastructures. Report to the G20. Bank for International.

In this context, many central banks view CBDCs as a way to streamline and improve the effectiveness of cross border payments, allowing for 24/7 settlement outside payment providers that control the entire process. As such, CBDCs represent an opportunity for central banks to simplify and enhance cross border payments by providing a more efficient and accessible solution. The issuance and adoption of CBDCs for cross border payment have the potential to simplify intermediaries involved in the process, accelerate transaction speeds and reduce costs. Therefore, improving cross border payment efficiency is a significant driving factor for CBDC issuance. A survey conducted among central banks in 2020 highlighted the significance of this aspect, particularly in relation to wholesale CBDC initiatives[27]. The importance of this motive further intensifies for central banks that are in advanced phases of CBDC development. This indicates that as central banks progress towards implementing CBDCs, they become more aware of the importance of ensuring interoperability and consistent standards across different jurisdictions. However, if central banks consider the global aspect while creating their domestic CBDCs and pledge to ensure interoperability, uniform standards and synchronization of CBDC designs, numerous difficulties associated with the current outdated technologies and procedures could be bypassed[28]. In the wholesale sector, CBDC arrangements could closely resemble the ongoing efforts to achieve interoperability in traditional payment systems by bridging the payment legs between two different jurisdictions. On the other hand, in the retail sector, solutions could be developed that enable end-user payments across borders by allowing payments to be made in retail CBDCs between different jurisdictions. It is important to highlight that these two scenarios of cross border CBDC supply are not mutually exclusive, and their interplay can have a significant impact on the economic and monetary implication of CBDC issuance. Therefore, it is essential to carefully consider both wholesale and retail aspects when designing and implementing CBDC arrangements to ensure that they are effective, efficient and aligned with overall objectives of CBDC issuance[29]. The objective to achieve interoperability with other CBDC systems is to enable seamless cross border payments between different countries. Interoperability is a general term that includes any features of systems that might facilitate information exchange thus reducing frictions. The interoperability of payment systems can aid in removing obstacles. Additionally, it can promote innovation by enabling

[27] C Boar and A Wehrli, "Ready, steady, go? Results of the third BIS survey on central bank digital currency", BIS Papers, no 114, January 2021

[28] Aurer, R., Frost, J., Gambacorta, L., Monnet, C., Rice, T., & S, H. S. (2021). Central Bank Digital Currencies: motives, economic implications and the research frontier. BIS Working Papers No 976. Bank for International Settlements, Monetary and Economic Department

[29] Auer, R., Haene, P., & Holden, H. (2021). Multi-CBDC arrangements and the future of cross-border payments. BIS Papers, (115), Monetary and Economic Department

new players to enter the market and offer their services to a wider range of customers. This can be achieved through the implementation of multi-CBDC arrangements, which are essentially frameworks that link two or more CBDCs.

2.4. Multi-Central Bank Digital Currency arrangements

The implementation of multi-CBDC systems provides central banks with an opportunity to address existing challenges by commencing with a fresh approach, free from the limitations imposed by traditional systems. These arrangements prioritize the synchronization of national CBDC designs, ensuring uniform access frameworks and interconnectedness, thereby enhancing the efficiency of cross-currency and cross-border transactions.

The difference between a payment arrangement and a payment system is that while a payment system is a collection of tools, processes and guidelines for the exchange of money between or among players and the participants and the system's operational entity are considered part of the system, a payment arrangement is a world that encompasses a wider variety of activities, such as decentralized networks of participants working together to send and receive payments without the use of a multilateral or comprehensive agreement (ex. correspondent banking arrangement)[30].

There are three different models for multi-CBDC arrangements. The first model, known as the "compatible" model, involves achieving interoperability through the use of common standards. In this model, the participating CBDC systems would adhere to a set of shared technical specifications, which would enable them to communicate with one another and facilitate cross-border transactions. This model focuses on achieving interoperability between separate CBDC systems by adhering to common international standards. This approach is similar to traditional cross border payment arrangements. By implementing common technical standards such as message formats, cryptographic techniques, data requirements and user interfaces, financial institutions can reduce the operational burden of participating in multiple systems. In addition to technical, regulatory and supervisory standards, it can simplify the Know-Your-Customer

[30] Aurer, Haene, & Holden. (2021). Multi-CBDC arrangements and the future of cross-border payments. Monetary and Economic Department. Bank for International Settlements.

(KYC) and transaction monitoring processes. It is important to note that achieving interoperability through Model 1 is not a straightforward process. While the use of common technical standards can simplify the process, there are still challenges related to regulatory and supervisory standards that need to be addressed. Moreover, there might be concerns related to data privacy and security, which need to be taken into consideration. Therefore, policymakers need to carefully consider the potential benefits and challenges associated with Model 1. They need to ensure that standards are widely accepted and that theory are compatible with existing financial infrastructures[31]. The second model, known as the "interlinked" model, takes interoperability a step further by establishing additional interlinkages between the participating CBDC systems. This can be achieved through the implementation of a shared technical interface or a common clearing mechanism[32], which would allow for more efficient and smooth cross border transactions. With a shared technical interface, participants in one CBDC system, whether retail or wholesale, can make payments to participants in another system through a contractual agreement between the systems. Alternatively, a common clearing system links CBDC systems through designated settlement accounts[33]. This mechanism provides a centralized way of settling cross border payments, reducing operational complexities and costs associated with maintaining multiple bilateral relationships. However, designing and implementing a common clearing mechanism can be challenging due to various operational considerations. The implementation of such a system would require close cooperation between different central banks, financial institutions and technology providers to ensure the same integration and efficient functioning of the various systems[34]. The third model, known as the "single payment" model, involves even higher-level cooperation between participating CBDC systems. In this model, there would be a single system, a single rulebook and a single participation set, which would enable all participating countries to use the same CBDC for cross-border payments. Therefore, this model involves the highest level of cooperation among central banks, where a single multi-CBDC system operates across different jurisdictions. By creating a single multi-CBDC system, Model 3 aims to achieve a higher degree of operational functionality and efficiency compared to Models 1 and 2. It reduces the complexity of

[31] G20 (2021). Central bank digital currencies for cross-border payments. Report to the G20. July 2021

[32] A set of rules and procedures whereby financial institutions present and exchange data and/or documents relating to transfers of funds or securities to other financial institutions at a single location

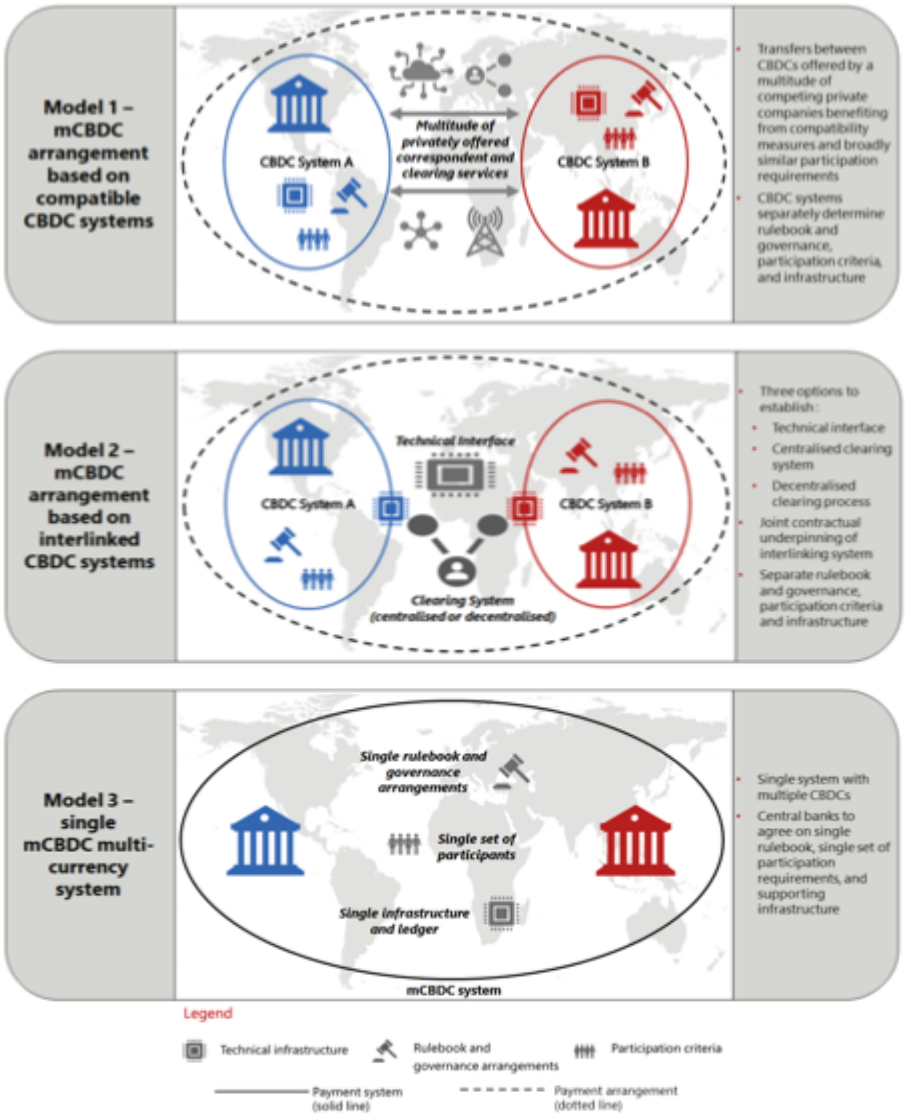
[33] An account containing money and/or assets that is held with a central bank, central securities depository, central counterparty or any other institution acting as a settlement agent.

[34] Auer, R., Banka, H., Boakye-Adjei, N. Y., Faragallah, A., Frost, J., Natarajan, H., & Prenio, J. (2022). Central bank digital currencies: A new tool in the financial inclusion toolkit? FSI Insights on policy implementation, No. 41. Bank for International Settlements.

managing multiple CBDC systems, eliminating the need for interoperability standards or interlinkages between different systems. A single system also simplifies the regulatory and supervisory processes, making it easier to monitor transactions and detect illicit activities. However, creating a single multi-CBDC system poses significant governance and control challenges and increases the concentration risk. The system requires a robust governance structure that ensures the participation of all central banks involved in the arrangement[35].

These three models can provide inspiration for policymakers who can take the best out of them in order to develop the most efficient multi-CBDC system. For example, the compatible model (Model 1) would foster the development of open, competitive payment systems which would enable a wider range of banks and non-banks to have wholesale access to central bank money for payment settlement. This would potentially allow for a greater diversity of cross border payment services, which could decrease both payment fragmentation and concentration. To further enhance the potential benefits of compatible CBDC systems, interlinked CBDC systems (Model 2) could be implemented to provide additional security. Implementing a single multi-CBDC (Model 3) could provide similar advantages as interlinked CBDC systems, but with greater integration. Interlinked CBDC systems (Model 2) could allow for greater resilience and flexibility in the face of system failures or attacks, as well as increased cross border payments. However, a single multi-CBDC (Model 3) could also potentially streamline the payment process and reduce transaction costs for both consumers and businesses. Figure 5 summarizes the key elements of the three multi-CBDC arrangements outlined in this paragraph.

[35] Auer, R., Banka, H., Boakye-Adjei, N. Y., Faragallah, A., Frost, J., Natarajan, H., & Prenio, J. (2022). Central bank digital currencies: A new tool in the financial inclusion toolkit? FSI Insights on policy implementation, No. 41. Bank for International Settlements.



Source: Aurer, Haene, & Holden. (2021). Multi-CBDC arrangements and the future of cross-border payments. Monetary and Economic Department. Bank for International Settlements.

Figure 5: Interoperability can be enabled via multi-CBDC arrangements[36]

[36] Aurer, Haene, & Holden. (2021). Multi-CBDC arrangements and the future of cross-border payments. Monetary and Economic Department. Bank for International Settlements.

Chapter 3. Financial inclusion and Retail CBDC

3.1. Overview of financial inclusion and its importance

Financial inclusion is a concept that refers to the provision of accessible and affordable financial products and services that meet the needs of individuals and businesses. These products and services include transactions, payments, savings, credit and insurance, which should be delivered in a responsible and sustainable manner. In many contexts, financial inclusion can be seen as a key goal of a central bank's mandate. In some instances, it is expressly stated as a primary purpose of the central bank's agenda; in other instances, it is an implicit objective that is integrated into the central bank's more general goals of maintaining a sound and effective payment system and promoting economic growth. Central banks can support a reduction in poverty, an increase in economic growth, and a strengthening of financial stability by granting underserved or marginalized areas access to cheap financial services. The institutions may take special actions to increase access to financial services for underprivileged areas in nations where financial inclusion is specifically stated in the central bank's mandate. This could entail establishing laws and rules that encourage financial institutions to reach out to underrepresented groups, encouraging financial literacy initiatives, and setting up a regulatory framework that is friendly to cutting-edge financial technologies. In addition, actions of central banks may entail taking activities like lowering the cost of financial transactions, expanding the loan options available to small and medium-sized businesses, and promoting digital financial services.

A critical step towards achieving financial inclusion is to ensure that individuals and businesses have access to transaction accounts[37], which enable them to store money, send and receive payments, and gain access to other financial services. As a gateway to other financial products, a transaction account plays a vital role in expanding financial inclusion and empowering people to take control of their finances. The World Bank Group (WBG) recognizes the importance of expanding access to transaction accounts and has made it a priority area of focus. By increasing access to transaction accounts, the WBG aims to facilitate

[37] It is an account that you use on a day to day basis which your wage and other payments can be paid into

financial inclusion and promote economic development and poverty reduction in developing countries. This includes working with governments and private sector stakeholders to create an enabling environment for financial inclusion, promote digital financial services and support the development of financial infrastructure. Furthermore, the WBG recognizes the need for responsible and sustainable financial practices to ensure that financial inclusion benefits everyone, particularly vulnerable and marginalized populations. This includes promoting financial literacy and consumer protection, as well as encouraging responsible lending practices.

Monetary exclusion is a widespread problem that has a disproportionately negative impact on economies that are still emerging on the global scene (EMDEs). This phenomenon is rather common, and it affects a sizable percentage of the population in each of these nations. The lack of access to capital resources, which in turn restricts access to financial services and products, is one of the key factors that contribute to financial exclusion. As a consequence of this, people who are living in poverty are frequently the most affected by financial exclusion. This is because these persons are unable to gain access to credit, savings accounts, or other financial instruments that could assist them in improving their current economic status.

In addition to this, the lack of access to financial services can have a significant negative effect on the economic growth of EMDE nations. It impedes the expansion of both small and medium-sized firms, reduces the number of chances for investment, and, as a result, stunts overall economic growth. As a result of this, there is a potential for an increase in the income gap, which can exacerbate the socioeconomic inequities that already exist inside these countries.

Financial exclusion is a problem not only in EMDEs, but also in developed countries. In fact, despite being high income countries, a fraction of the population in the United States, the United Kingdom, France and Spain does not have access to basic financial services. It is surprising to note that between 4 and 7 percent of the population in these countries do not have a bank account. These figures suggest that financial inclusion is not as universal as one might have initially thought, and there is still a need to address the issue of financial exclusion. This situation can have severe implications for individuals and families, including limited access to credit, inability to save money and difficulty paying bills or receiving payments. Such financial exclusion can lead to economic instability and inequality, with certain populations being disproportionately affected. De facto, research has shown that households and businesses that have access to financial services are more resilient in the face of financial crises and economic

shocks than those who do not[38]. This is because having access to financial services such as saving accounts and credit facilities can help individuals and businesses to cope with unexpected expenses or other financial challenges. In addition, direct deposit of payment, such as wages and government support, into a bank account can contribute towards achieving development objectives. Research has demonstrated that individuals who receive their wages through direct deposit tend to have higher savings compared to those who receive cash payments. This is because direct deposit encourages account holders to keep their money in the account and take advantage of automatic transfers to saving accounts[39]. The implementation of financial inclusion faces numerous barriers that impede its progress. One of the primary reasons for financial exclusion is limited access to financial services in isolated areas with small populations. This can be attributed to a lack of infrastructure, including limited banking facilities and inadequate telecommunication networks. As a result, low-income individuals and members of minority ethnic groups may be unable to access essential financial services that could improve their social and economic prospects. In addition, limited opportunities for new enterprises also contribute to financial exclusion. Without access to financial services such as credit accounts, entrepreneurs may struggle to start or grow their businesses. This can be particularly challenging for those in remote or underserved areas, who may lack the necessary collateral or credit history to secure loans from traditional institutions. Furthermore, social and cultural factors may contribute to financial exclusion. For instance, individuals who are not familiar with financial systems or who lack the necessary financial literacy may find it challenging to navigate the complex financial landscape. This can prevent them from taking advantage of available financial services or accessing the resources needed to improve their economic situation[40].

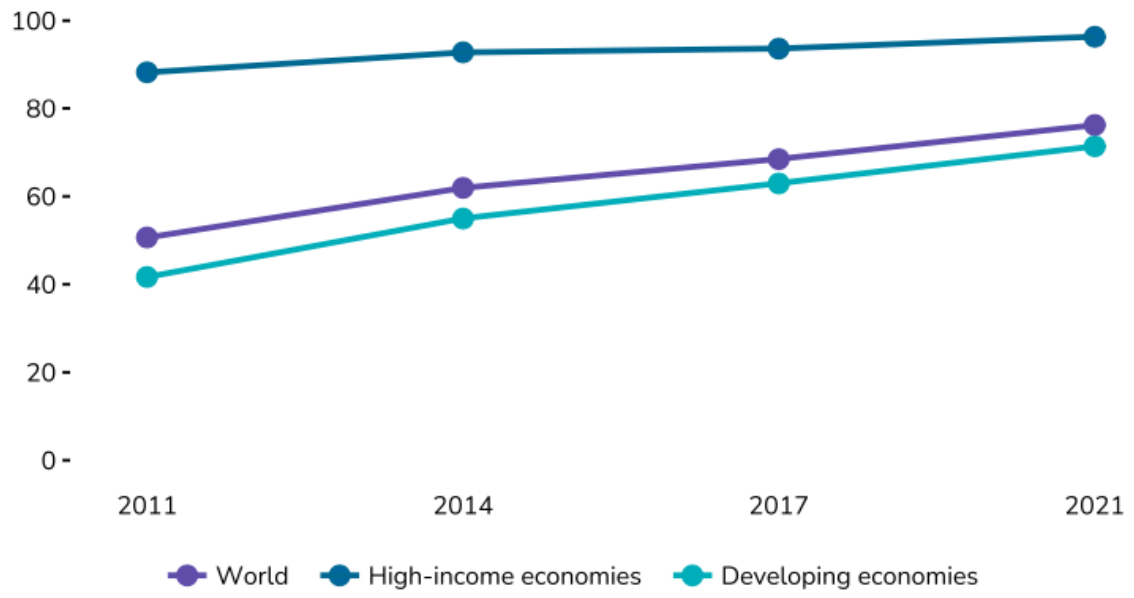
However, over the past few years, the world has witnessed significant progress in financial inclusion, particularly in EMDEs. Figure 6 shows the World Bank's Financial Inclusion Index (Findex) and approximately 76% of people globally have access to bank accounts or accounts with regulated institutions, such as credit unions, microfinance institutions or mobile money service providers. Figure 6 marks a significant increase in account ownership over the past decade, from 51% in 2011 to 76% in 2021. In EMDEs there has been a notable increase in the

[38] Shaddady, A., & Moore, T. (2019). Investigation of the effects of financial regulation and supervision on bank stability: The application of CAMELS-DEA to quantile regressions. Journal of International Financial Markets, Institutions and Money.

[39] Blumenstock, J., Callen, M., & Ghani, T. (2017). Why do defaults affect behavior? Experimental evidence from Afghanistan. NBER Working Paper Series, Working Paper 23590.

[40] Kaligis, N. V. B., Tewal, B., Maramis, J. B., & Mangantar, M. (2018). Financial inclusion profile: Determinants and barriers. International Journal of Economics and Financial Issues

average rate of account ownership, which rose by 8 percentage points from 63% of adults in 2017 to 71% in 2021[41]



Source: Demirgüç-Kunt, A., Klapper, L., Singer, D., & Ansar, S. (2021). The Global Findex Database 2021: Financial Inclusion, Digital Payments, and Resilience in the Age of COVID-19.

Figure 6: Global account ownership increased from 51% to 76% between 2011 and 2021[42]

This significant progress, especially in developing countries, can be attributed to various factors, including increased financial inclusion initiatives, the expansion of mobile banking services and improvements in digital infrastructures. However, the primary reason is the adoption of new digital technologies, which are often supported by government and central bank policies. In various markets across Sub-Saharan Africa and Asia, innovative digital payment channels such as mobile money, agent-based distribution models, payment applications and QR codes have significantly improved access to and use of financial services. This has allowed people in remote areas to access financial services more easily and cheaply through their mobile phones. In addition, this progress has led to increased usage of digital

[41] Demirgüç-Kunt, A., Klapper, L., Singer, D., & Ansar, S. (2021). The Global Findex Database 2021: Financial Inclusion, Digital Payments, and Resilience in the Age of COVID-19.

[42] Demirgüç-Kunt, A., Klapper, L., Singer, D., & Ansar, S. (2021). The Global Findex Database 2021: Financial Inclusion, Digital Payments, and Resilience in the Age of COVID-19.

transaction accounts, which has helped improve the financial inclusion of previously unbanked populations. As a result, there is evidence that this has contributed to poverty reduction and greater resilience of households[43]. Therefore, having access to formal financial services can provide a safety net for individuals and businesses during difficult times, and enable them to save, invest and borrow funds for entrepreneurship and wealth creation and technology can play an important role in ensuring this. However, despite the sharp increase in account ownership in the last few years, a fraction of the population, especially in EMDEs, remains unbanked. As stated in the previous chapter, financial accessibility to enhance financial inclusion is one of the main aspects for which central banks are considering the issuance of CBDC. By leveraging a retail CBDC, central banks can help to promote financial inclusion by providing a secure and accessible payment infrastructure that can reach underserved communities.

3.2. Potential benefits of retail CBDCs for financial inclusion

Despite significant progress in expanding access to payment services, universal access remains a challenge, particularly for low-income populations and those living in remote locations. These groups continue to face significant barriers to accessing digital payments, including high costs for domestic retail payment services and even greater challenges for cross border payments, such as remittances. By giving the general public access to a safe, convenient, and affordable payment infrastructure, retail CBDC can significantly contribute to the promotion of financial inclusion. Retail CBDC can make sure that everyone and any organization, no matter where they are located or how wealthy they are, always has access to public funds.

One of the most relevant reasons among central banks that supports the issuance of CBDCs is financial inclusion. For example, the Central Bank of the Bahamas introduced the Sand Dollar, a general retail CBDC, in 2020, making the Bahamas one of the first nations to do so[44]. The promotion of financial inclusion was one of the main drivers for the issuance of the Sand

[43] Auer, R., Banka, H., Boakye-Adjei, N. Y., Faragallah, A., Frost, J., Natarajan, H., & Prenio, J. (2022). Central bank digital currencies: A new tool in the financial inclusion toolkit? FSI Insights on policy implementation, No. 41. Bank for International Settlements.

[44] Wright, A., McKenzie, S. C., Bodie, L. R., & Belle, C. L. (2022). Financial Inclusion and Central Bank Digital Currency in The Bahamas. Research Department, Central Bank of The Bahamas

Dollar. In effect, the central bank was aiming to increase financial access, particularly for people living in remote locations with little access to banking services.

Retail CBDC has the ability to lower the cost of electronic payments, which is one of its main advantages. It can assist in removing some of the financial obstacles that currently keep low-income individuals from using payment services by offering a cheap substitute for conventional payment methods. This is especially important for cross-border transfers because traditional banking services are frequently costly and time-consuming in these situations.

For certain consumer groups that might not have a bank account, which is necessary to use the current digital payment tools, retail CBDC has the potential to enable access to digital payments. These people may be financially excluded as a result of their lack of access, which also reduces their chances of fully engaging in the economy. By providing customers with a safe and convenient payment infrastructure that can be accessed through digital devices like smartphones without requiring a traditional bank account, retail CBDC can assist in resolving this problem. To reach underserved communities and give them access to digital payments at little or no cost, central banks can use retail CBDC to establish an alternative payment system[45].

The adoption of digital payments could be accelerated by retail CBDCs, particularly in situations where the private sector lacks adequate incentives to innovate or if preexisting oligopolies hinder new players from entering the market. Private sector businesses may frequently be discouraged from making investments in digital payment infrastructure in sectors with small markets or low profit margins. Retail CBDCs can close this gap by offering a public, open-access digital payment system that anybody can use, regardless of location or socioeconomic status. Additionally, long-standing oligopolies may make it difficult for new competitors to enter the digital payments sector, lowering competition and restricting innovation. Central banks can offer an alternative payment system that can help level the playing field and promote competitiveness by making a publicly accessible retail CBDC available. In fact, the payment industry is sensitive to network effects[46] which can result in monopolies or industry fragmentation[47]. Payment service providers are motivated to develop closed-loop systems, which can lead to high entry barriers and higher prices for retailers. On the other hand, the phenomenon of fragmentation happens when there are several payment

[45] Panetta, F. (2018). 21st Century Cash: Central Banking, Technological Innovation, and Digital Currencies. SUERF/BAFFI CAREFIN Centre Conference.

[46] Value or utility a user derives from a good or service depends on the number of users of compatible products.

[47] European Central Bank, Bank of Japan, Sveriges Riksbank, Swiss National Bank, Bank of England, Board of Governors of the Federal Reserve System, Bank for International Settlements, & Bank of Canada. (2021). Central bank digital currencies: Foundational principles and core features. Report No. 1 in a series of collaborations from a group of central banks

systems which have different proprietary messaging standards [48] that makes interoperability more complex and expensive. Such fragmentation can increase costs and cause annoyance, which promotes social inefficiency. However, retail CBDC can offer a different, open and interoperable payment infrastructure to alleviate this circumstance. Retail CBDCs are able to provide a standard payment platform that is independent of any specific platform or payment service provider. This can increase competition, lower entry barriers and cut costs for both users and operators.

Retail CBDCs can stimulate economic growth by facilitating transactions and lowering transaction costs in addition to encouraging competition and innovation. Digital payments have the potential to boost productivity, decrease economic friction, and encourage financial inclusion, all of which can contribute to economic growth and job creation. Furthermore, retail CBDCs can also provide greater transparency and security in financial transactions, which can help to reduce fraud and corruption. This can lead to increased trust in the financial system and further stimulate economic growth. In fact, financial inclusion is severely hampered by financial distrust, especially among underserved and unbanked groups. Numerous members of these groups may have historically been excluded from the formal financial system and may have been subject to financial prejudice or exploitation. Because of this, individuals could have a low level of confidence in financial institutions and be reluctant to use private financial products, which might worsen their financial exclusion[49]. By offering a central bank backed digital payment option that can foster trust and confidence in the established financial system, the creation of retail CBDC has the potential to alleviate this problem. Ensuring the safety and resilience of payment is critical; however, it is equally important to promote the usage of these systems. A payment system is effective only if people are willing to use it. Users require quick, effective and user-friendly services that are inclusive and accessible to all in order to promote the use of payment systems[50]. For those who may have previously been the victims of financial prejudice or exploitation, retail CBDCs can provide a level of transparency and protection that may not be available with regular financial services.

Because retail CBDCs are a new type of currency that may be used for regular transactions in the same way that actual cash is used and because they are directly issued by the retail CBDC,

[48] Messages from the customer to the Bank giving instruction to the Bank to process a payment or take any other action in relation to the account.

[49] Cipollone, P. (Deputy Governor of Banca d'Italia). (2020, October 28). The Implementation of CBDCs by Central Banks: Challenges, Risks and Opportunities. Banca d'Italia.

[50] Bank of England (2020), Central Bank Digital Currency: opportunities, challenges and design.

they impose higher responsibility on central banks to make sure that retail CBDC access is widely available to everyone, regardless of location or socioeconomic background, because they are recognized as legal cash[51]. This enhanced obligation on the part of central banks to ensure that everyone has access to retail CBDC, regardless of their circumstances, emphasizes the significance of financial inclusion as a top public policy concern. It signals the necessity for governments and financial institutions to concentrate on bridging the financial inclusion gap by giving underbanked and unbanked populations access to affordable financial services. Additionally, retail CBDCs may be able to offer financial services at a lower price than traditional financial services, which can be a big benefit for people who are wary of financial institutions or who might be subject to exorbitant fees or transaction expenses.

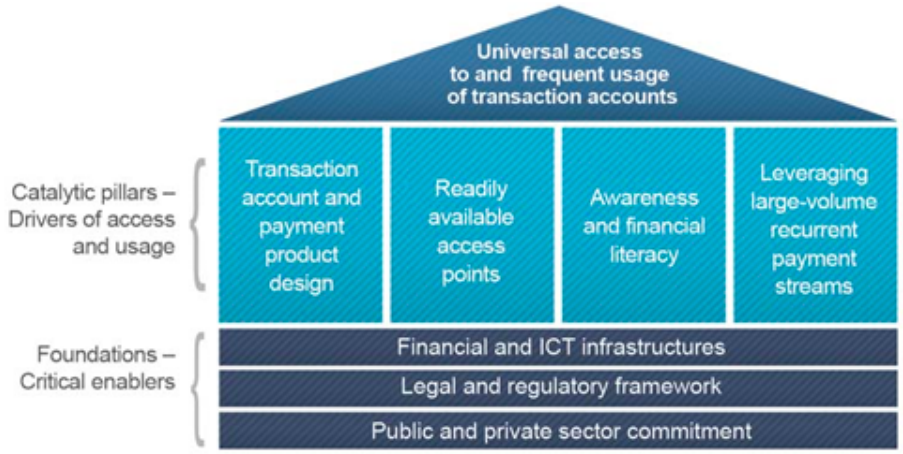
3.3. Payment Aspects of Financial Inclusion (PAFI) framework

The CPMI and the World Bank collaborated in 2016 to release the Payment Aspects of Financial Inclusion (PAFI) report, which marked the first examination of financial inclusion from a payment perspective. In the report, the PAFI "house", which was a framework outlining all barriers to transaction accounts access and usage, was implemented[52]. Since its release, the PAFI framework has served as a fundamental reference point for various global initiatives and country level reforms aimed at enhancing financial inclusion. Policymakers, financial service providers and development professionals can use the framework's conceptualization and catalytic pillars to help them identify the main obstacles to obtaining financial inclusion. The PAFI framework has also been crucial in the creation of surveys and measuring tools to monitor the evolution of transaction account usage and access. These tools assess many aspects of account access and usage, such as affordability, availability, ease and trust in payment systems and providers, in order to quantify financial inclusion. Policymakers can create customized interventions to address particular causes and barriers to financial inclusion by adopting the PAFI framework. To increase consumer protection and financial literacy, for example, as well as to increase access and convenience and expand agent networks and digital infrastructures.

51 World Bank Group. (2021). Central Bank Digital Currency: A Payments Perspective.

52 Bank for International Settlements. (2020). Payment aspects of financial inclusion: application tools. Committee on Payments and Market Infrastructures, World Bank Group.

The PAFI framework can also help policymakers to identify and address the needs of specific demographic groups, such as women, youth, and rural populations, who may face unique challenges in accessing financial services. By tailoring interventions to these groups, policymakers can promote greater financial inclusion and help to reduce inequality. Figure 7 depicts the PAFI "house", it examines the key components of retail payments that play a crucial role in promoting financial inclusion. It explores how enhancing payment infrastructure and services can facilitate broader access to transaction accounts. Additionally, it highlights the significance of measuring the impact and effectiveness of financial inclusion initiatives specifically in relation to payment. Figure 7 shows that to expand access to transaction accounts, countries must establish a foundation encompassing public and private sector commitment, a robust legal and regulatory framework and adequate financial and ICT infrastructures. In addition, Figure 7 shows that essential elements include the design of convenient payment and transaction account products, ensuring widespread accessibility and raising awareness and financial literacy to guide individuals in selecting and utilizing these accounts.



Source: Bank for International Settlements. (2020). Payment aspects of financial inclusion: application tools. Committee on Payments and Market Infrastructures, World Bank Group.

Figure 7: Framework for the guidance on payment aspects of financial inclusion[53]

[53] Bank for International Settlements. (2020). Payment aspects of financial inclusion: application tools. Committee on Payments and Market Infrastructures, World Bank Group.

The graph can be a useful framework to explain why retail CBDC has a good propensity for financial inclusion. A retail CBDC necessitates that public authorities take the initiative in its design and execution, and as such is supported by a significant public sector commitment. A retail CBDC, like cash, would not be susceptible to credit risk because it is a liability of the central bank, giving end users more security. Similar to cash, it can serve as a physical conduit between the people and the central bank. Retail CBDCs could enable fees to be set and limits on data usage to be established in line with public interest rather than commercial motives as a central bank-operated system. All authorized payment service providers might have access to a retail CBDC system, which could be built from the ground up or improved upon. This could give public authorities the push they need to make the required adjustments to payment system governance and access policies and mandate a better degree of commitment to security, efficiency and inclusion. A retail CBDC could permit a new class of intermediaries that provide payment services but do not handle client funds in terms of the legal and regulatory environment. Because they have reduced prudential risk, these banks can operate with lower capital requirements and less intense regulatory and supervisory oversight. This might encourage new firms to enter the market for payment services, thus increasing the number of payment service providers (PSP). Retail CBDCs could boost market vitality and innovation by permitting the entry of a new class of PSPs, creating more specialized and alluring value propositions for both payers and payees. Furthermore, the introduction of retail CBDCs could potentially lead to increased competition among existing PSPs, which could result in lower transaction fees and improved services for consumers. This could also lead to the development of new business models and partnerships between PSPs and other industries. In addition, retail CBDC architecture may make it possible to implement strategies that give users control over payment transaction data that could otherwise be reserved for a select few players in crowded markets. To promote access to and use of fundamental transaction instruments, the creation of a retail CBDC would require the activation of the four catalytic pillars described in the PAFI framework. To promote adoption and usage, the central bank would need to design retail CBDC transaction features in a way that is straightforward and practical for even non-sophisticated users. A network of accessible access points would also need to be established in order to provide retail CBDC as a "public utility." The central bank could accomplish this directly or through collaborations with PSPs[54]. Additionally, initiatives must be made to promote public awareness and financial literacy in order to guarantee the widespread adoption of retail CBDC.

[54] World Bank Group. (2021, November). Central Bank Digital Currency Background Technical Note

This will entail educating the general public about the new instrument, its features, and its advantages. To properly implement the retail CBDC, the central bank will need to create educational campaigns and work with stakeholders to offer support and training. Finally, the central bank can promote retail CBDC adoption and usage by utilizing high volume recurring payment streams. For taxes and other recurrent payments, such as social welfare benefits, the government may decide to make retail CBDC the preferred method of payment. This would promote the opening and use of retail CBDC accounts by citizens, increasing utilization. The number of payment products and services would significantly increase with the adoption of retail CBDC technology. Individuals and businesses would be able to interact without difficulty across national boundaries and legal jurisdictions thanks to the creation of a new globally usable digital form of currency. By doing so, customer experience would be improved by getting rid of the obstacles and expenses related to conventional payment methods. Additionally, financial literacy and awareness would receive a big boost thanks to retail CBDC technology. Retail CBDC would elevate the prominence of financial inclusion as a national policy objective by serving as a new form of legal tender and money, which would encourage greater efforts to inform the public about financial management and widen access to financial services. In addition to these advantages, the use of retail CBDC technology would result in substantial improvements in the payment system's efficiency. Furthermore, retail CBDCs would provide a more secure and transparent means of conducting transactions, reducing the risks associated with cash transactions and illegal activities such as money laundering and tax evasion. This would ultimately lead to a more stable financial system and greater economic growth. Transactions would be processed more quickly, cutting down on counterparty risks and settlement periods. This would increase the payment system's overall security and dependability and cut expenses for both businesses and customers. Additionally, retail CBDC technology would foster new chances for innovation and cross-sector cooperation, promoting development and expansion of the economy. Retail CBDC would promote the development of digital trade by offering a safe and effective payment infrastructure, opening up new business opportunities and fostering economic growth.

CONCLUSION

The debate regarding the advantages and disadvantages of CBDC is evolving rapidly. As the debate progresses, stakeholders are gaining a deeper knowledge into the potential advantages of CBDC, such as enhanced resilience, payment efficiency and financial inclusion. This ongoing dialogue aims to foster a comprehensive understanding of CBDCs implications and inform policymakers, regulators and the public on the best approaches for its implementation. After extensive research and analysis, this thesis has explored various facets of CBDCs and their effect on payment systems. The findings of this study are shown in the following lines.

Firstly, wholesale CBDC's programmable features facilitate the incorporation of measures to mitigate risks and provide improved control over transactions, fostering a payment system that is more resilient. At the same time, retail CBDC could improve financial stability by promoting payment resilience and offering essential payment services outside of the commercial banking system. In fact, it is important to maintain a healthy balance between digital and cash-based payment options to ensure a reliable backup option in times of need. Furthermore, offline retail CBDCs could bridge the gap between traditional cash-based transactions and digital payments.

Secondly, CBDC can make cross border transactions more efficient by reducing all challenges and friction that the system suffers. However, interoperability and consistent standards across different jurisdictions are essential for CBDC issuance, and it is important to consider both wholesale and retail aspects when designing and implementing CBDC arrangements. By introducing multi-CBDC systems, central banks can tackle prevailing obstacles using a novel approach that is not constrained by traditional systems. These arrangements give priority to harmonizing national CBDC designs, establishing consistent access frameworks, and fostering interconnectivity. Consequently, they increase the efficiency of cross-currency and cross-border transactions. There are three models for multi-CBDC arrangements: the “compatible” model, which involves achieving interoperability through the use of common standards, the “interlinked model, which takes interoperability a step further by establishing additional interlinkages between the participating CBDC systems and the “single payment” model which involves a single rulebook and a single participation set, enabling all participating companies to use the same CBDC system. These three multi-CBDC arrangements can provide inspiration for policymakers to develop the most efficient system, allowing for greater efficiency of cross border payment services.

Thirdly, retail CBDC can help promote financial inclusion by providing a safe, convenient, and affordable payment infrastructure, lowering the cost of electronic payments, and enabling

access to digital payments for remote communities. In addition, retail CBDCs can accelerate the adoption of digital payments by providing a public, open-access digital payment system, lowering entry barriers, and stimulating economic growth. Retail CBDC can also ensure a greater level of both security in pursuing financial transactions, leading to an overall increased trust in the financial system. Finally, retail CBDCs can also provide a greater degree of transparency and protection to those who may have previously been victims of financial prejudice or exploitation and impose a higher responsibility on central banks to ensure direct access to them.

In conclusion, the implementation of CBDCs and their impact on the payment systems presents a transformative opportunity for central banks to address existing challenges and enhance the efficiency of the payment systems. However, policymakers have to carefully evaluate all the potential risks associated with such implementation and heavily regulate such technology with the fundamental aim of protecting households and firms which are the ultimate users of payment systems.

GLOSSARY

Clearing system: a set of rules and procedures whereby financial institutions present and exchange data and/or documents relating to transfers of funds or securities to other financial institutions at a single location.

Network effects: value or utility a user derives from a good or service depends on the number of users of compatible products.

Settlement account: an account containing money and/or assets that is held with a central bank, central securities depository, central counterparty or any other institution acting as a settlement agent.

Transaction account: it is an account that you use on a day-to-day basis which your wage and other payments can be paid into.

BIBLIOGRAPHY

Ahnert, T., Assenmacher, K., Hoffmann, P., Leonello, A., Monnet, C., & Porcellacchia, D. (2022). The economics of central bank digital currency. ECB Working Paper Series No. 2713.

Aurer, R., & Bohme, R. (2021). Central bank digital currency: The quest for minimally invasive technology. BIS Working Papers No. 948.

Alberola, E., & Mattei, I. (2022). Central bank digital currencies in Africa. Bank of International Settlements.Monetary and Economic Department.

Auer, R., Banka, H., Boakye-Adjei, N. Y., Faragallah, A., Frost, J., Natarajan, H., & Prenio, J. (2022). Central bank digital currencies: A new tool in the financial inclusion toolkit? FSI Insights on policy implementation, No. 41. Bank for International Settlements.

Auer, R., Boar, C., Cornelli, G., Frost, J., Holden, H., & Wehrli, A. (2021). CBDCs beyond borders: Results from a survey of central banks. BIS Papers No. 116. Bank for International Settlements, Monetary and Economic Department.

Aurer, R., Frost, J., Gambacorta, L., Monnet, C., Rice, T., & S, H. S. (2021). Central Bank Digital Currencies: motives, economic implications and the research frontier. BIS Working Papers No 976. Bank for International Settlements, Monetary and Economic Department.

Aurer, Haene, & Holden. (2021). Multi-CBDC arrangements and the future of cross-border payments. Monetary and Economic Department. Bank for International Settlements.

Bank of England (2020), Central Bank Digital Currency: opportunities, challenges and design.

Bank for International Settlements. (2018). Cross-border retail payments. Committee on Payments and Market Infrastructures.

Bank for International Settlements. (2020). Payment aspects of financial inclusion: application tools. Committee on Payments and Market Infrastructures, World Bank Group.
Bech, M., Faruqui, U., & Shirakami, T. (2020). Payments without borders. Bank for International Settlements.

Bech, M. L., & Hancock, J. (2020). Innovations in payments. BIS Quarterly Review.

Blumenstock, J., Callen, M., & Ghani, T. (2017). Why do defaults affect behavior? Experimental evidence from Afghanistan. NBER Working Paper Series, Working Paper 23590.

Bindseil, U., Panetta, F., & Terol, I. (2021). Central Bank Digital Currency: functional scope, pricing and controls. ECB Occasional Paper, (2021/286).

Bindseil, U., & Pantelopoulos, G. (2022). Towards the holy grail of cross-border payments. European Central Bank.

Boar C. and Wehrli A. (2021) "Ready, steady, go? Results of the third BIS survey on central bank digital currency", BIS Papers, no 114.

Bordo, M. D., & Levin, A. T. (2017, August). Central Bank Digital Currency and the Future of Monetary Policy. NBER Working Paper Series, No. 23711. National Bureau of Economic.

Brunnermeier, M. K., James, H., & Landau, J. P. (2019). The digitalization of money. National Bureau of Economic Research Working Paper Series, 26300.

Chen, S., Goes, T., Qiu, H., & Shim, I. (2022). CBDCs in emerging market economies. BIS Papers No. 123. Bank for International Settlements, Monetary and Economic Department..

Cipollone, P. (Deputy Governor of Banca d'Italia). (2020, October 28). The Implementation of CBDCs by Central Banks: Challenges, Risks and Opportunities. Banca d'Italia.

Committee on Payments and Market Infrastructures Markets Committee. (2018). Central Bank Digital Currencies. BIS Papers No. 87. Bank for International Settlements.

Committee on Payments and Market Infrastructures. (2020, July). Enhancing cross-border payments: Building blocks of a global roadmap. Stage 2 report to the G20. Bank for International Settlements.

Demirgüç-Kunt, A., Klapper, L., Singer, D., & Ansar, S. (2021). The Global Findex Database 2021: Financial Inclusion, Digital Payments, and Resilience in the Age of COVID-19.

European Central Bank, Bank of Japan, Sveriges Riksbank, Swiss National Bank, Bank of England, Board of Governors of the Federal Reserve System, Bank for International Settlements, & Bank of Canada. (2021). Central bank digital currencies: Foundational principles and core features. Report No. 1 in a series of collaborations from a group of central banks.

Federal Reserve. (2022). Money and Payments: The U.S. Dollar in the Age of Digital Transformation. The Federal Reserve.

G20 Roadmap for Enhancing Cross-border Payments: Priority Actions for Achieving the G20 Targets.(2023). Financial Stability Board

G20 (2021). Central bank digital currencies for cross-border payments. Report to the G20. July 2021.

House of Lords Economic Affairs Committee. (2022). Central bank digital currencies: a solution in search of a problem? (3rd Report of Session 2021–22)

Infante, Sebastian, Kyungmin Kim, Anna Orlik, Andr´e F. Silva, and Robert J. Tetlow (2022). "The Macroeconomic Implications of CBDC: A Review of the Literature," Finance and Economics Discussion Series 2022-076. Washington: Board of Governors of the Federal Reserve System,

International Monetary Fund. (2022). The Money Revolution: Crypto, CBDCs, and the Future of Finance. Finance and Development.

Kaligis, N. V. B., Tewal, B., Maramis, J. B., & Mangantar, M. (2018). Financial inclusion profile: Determinants and barriers. International Journal of Economics and Financial Issues.

Panetta, F. (2018). 21st Century Cash: Central Banking, Technological Innovation, and Digital Currencies. SUERF/BAFFI CAREFIN Centre Conference.

Sarmiento, A. (2022). Seven lessons from the e-Peso pilot plan: The possibility of a Central Bank Digital Currency. Latin American Journal of Central Banking.

Shaddady, A., & Moore, T. (2019). Investigation of the effects of financial regulation and supervision on bank stability: The application of CAMELS-DEA to quantile regressions. Journal of International Financial Markets, Institutions and Money.

Soderberg, G., Bechara, M., Boss, W., Che, N. X., Davidovic, S., Kiff, J., Lukong, I., Mancini Griffoli, T., Sun, T., & Yoshinaga, A. (2022). Behind the Scenes of Central Bank Digital Currency: Emerging Trends, Insights, and Policy Lessons. International Monetary Fund.

Tan, B. J. (2023). Central Bank Digital Currency and Financial Inclusion. International Monetary Fund.

World Bank Group. (2021). Central Bank Digital Currency: A Payments Perspective.

World Bank Group. (2021, November). Central Bank Digital Currency Background Technical Note.

Wright, A., McKenzie, S. C., Bodie, L. R., & Belle, C. L. (2022). Financial Inclusion and Central Bank Digital Currency in The Bahamas. Research Department, Central Bank of The Bahamas.