

MASTER IN MONETARY AND FINANCIAL ECONOMICS

MASTER'S FINAL WORK

DISSERTATION

CENTRAL BANK DIGITAL CURRENCIES AND MONETARY POLICY: A THEORETICAL REVIEW OF RISKS AND OPPORTUNITIES

JOÃO PEDRO BOULHOSA MARIANO

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SUPERVISION:
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JUNE – 2025

DISCLAIMER

I disclose that AI tools were employed during the development of this thesis as follows:

1. AI-based research tools were used to assist in literature review and data collection.
2. Generative AI tools were consulted for brainstorming and outlining purposes.

However, all final writing, synthesis, and critical analysis are my own work.

Instances where AI contributions were significant are clearly cited and acknowledged.

Nonetheless, I have ensured that the use of AI tools did not compromise the originality and integrity of my work. All sources of information, whether traditional or AI-assisted, have been appropriately cited in accordance with academic standards. The ethical use of AI in research and writing has been a guiding principle throughout the preparation of this thesis.

I understand the importance of maintaining academic integrity and take full responsibility for the content and originality of this work.

João Pedro Mariano, 30/06/2025

GLOSSARY

CBDC – Central Bank Digital Currency

ELB – Effective Lower Bound

BIS – Bank for International Settlements

IMF – International Monetary Fund

USA – United States

ECB – European Central Bank

ACH – Automated Clearing House

POS – Point of Sale

mCBDC – Multi-Central Bank Digital Currency

ABSTRACT, KEYWORDS AND JEL CODES

The rise of Central Bank Digital Currencies (CBDCs) marks an important development in the modernization of monetary systems worldwide. As economies transition away from physical cash and toward digital payments, central banks face new challenges and opportunities in the conduct of monetary policy. This dissertation reviews the implications of CBDCs for monetary policy design and transmission, and financial stability.

The study begins by addressing the theoretical foundations of money and the evolving role of cash, followed by an analysis of the growing shift toward digital payments. It then explores the role and implications of CBDCs, focusing on how their design can enhance or disrupt monetary policy transmission mechanisms, particularly by relaxing the effective lower bound (ELB). Critical risks are also addressed, including bank disintermediation, financial instability, and international effects. The findings suggest that while CBDCs offer innovative tools for improving monetary transmission and the payment system, their benefits are conditional on careful design and global coordination. Appropriate safeguards, such as tiered remuneration, holding limits, and internationally compatible frameworks, can help mitigate systemic risks and ensure that CBDCs complement rather than undermine the existing financial system.

The dissertation contributes to the growing policy and academic debate by offering a structured synthesis of current knowledge and practical policy recommendations for central banks navigating the transition to a digital monetary system.

Keywords: CBDC, Cash Payments, Monetary Policy Transmission, ELB, Financial Stability, Bank Disintermediation

JEL Codes: E42, E52, E58, F33

RESUMO

O aparecimento de Moedas Digitais dos Bancos Centrais (CBDCs) assinala um desenvolvimento importante na modernização dos sistemas monetários a nível mundial. À medida que as economias se afastam do dinheiro físico e se aproximam dos pagamentos digitais, os bancos centrais enfrentam novos desafios e oportunidades na condução da política monetária. Esta dissertação analisa as implicações dos CBDCs para a conceção e transmissão da política monetária e estabilidade financeira.

O estudo começa por abordar os fundamentos teóricos da moeda e a evolução do papel do dinheiro físico, seguido de uma análise da crescente mudança para os pagamentos digitais. Em seguida, explora o papel e as implicações dos CBDCs, centrando-se na forma como a sua conceção pode melhorar ou perturbar os mecanismos de transmissão da política monetária, em particular através da flexibilização da *effective lower bound* (ELB). Riscos críticos também são abordados, incluindo a desintermediação bancária, a instabilidade financeira e os efeitos internacionais. As conclusões sugerem que, embora os CBDC ofereçam instrumentos inovadores para melhorar a transmissão monetária e o sistema de pagamentos, os seus benefícios dependem de uma conceção cuidadosa e de uma coordenação global. Salvaguardas adequadas, tais como remuneração diferenciada, limites de detenção e quadros compatíveis a nível internacional, podem ajudar a mitigar os riscos sistémicos e garantir que os CBDC complementem, em vez de prejudicarem, o sistema financeiro existente.

A dissertação contribui para o crescente debate político e académico, oferecendo uma síntese estruturada dos conhecimentos atuais e recomendações práticas de política para os bancos centrais que seguem na transição para um sistema monetário digital.

TABLE OF CONTENTS

GLOSSARY	i
ABSTRACT, KEYWORDS AND JEL CODES	ii
RESUMO	iii
TABLE OF CONTENTS	iv
TABLE OF FIGURES	v
ACKNOWLEDGMENTS	vi
1. INTRODUCTION	1
<i>1.1. Research Purpose and Contribution</i>	3
<i>1.2. Methodology</i>	4
<i>1.3. Outline</i>	4
2. MONETARY POLICY IN A DIGITIZING ECONOMY	5
<i>2.1. The Shift to Digital Payments</i>	7
<i>2.2. Policy Concerns</i>	13
3. CBDCs AND THE TRANSFORMATION OF MONETARY POLICY	16
<i>3.1. CBDCs and the Monetary Policy Transmission Mechanism</i>	17
<i>3.2. CBDCs and the Effective Lower Bound</i>	19
4. RISKS AND CHALLENGES IN A CBDC FRAMEWORK	20
<i>4.1. Bank Disintermediation and Credit Contraction</i>	21
<i>4.2. Financial Stability and Systemic Responses</i>	22
<i>4.3. Cross-Border Spillovers</i>	24
5. CONCLUSIONS	28
<i>5.1. Research Limitations</i>	29
<i>5.2. Future Research</i>	30
REFERENCES	32

TABLE OF FIGURES

Figure 1 – Global CBDC Development Map	2
Figure 2 – Cash in Circulation as a Percentage of GDP	7
Figure 3 – Share of Payment Instrument Use for All Payments in the USA	8
Figure 4 – Average Number of In-Person Payments Per Month Under \$25	9
Figure 5 – Share of Cash Usage by Age Group and Year	9
Figure 6 – Share of Payment Instrument Use by Household Income	10
Figure 7 – Share of Payment Instruments Used at the POS in the Euro Area, 2016-24 .	11
Figure 8 – Payments by Value and Instrument	12
Figure 9 – Payments by Age and Instrument	12

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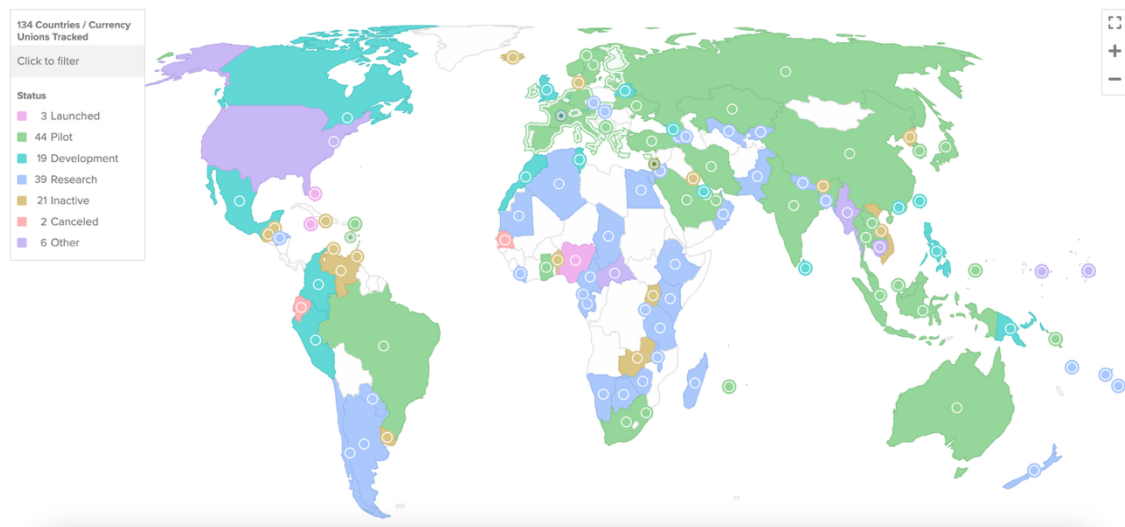
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1. INTRODUCTION

The global financial system is undergoing a transformative shift, driven by technological innovation, declining use of physical cash, and the growing demand for more efficient, secure, and inclusive payment infrastructures (Rogoff, 2017; Auer & Böhme, 2020). In this context, central banks around the world are exploring the introduction of Central Bank Digital Currencies (CBDCs), a new form of digital public money issued and regulated by central banks. CBDCs are digital representations of sovereign currency, which offers the public direct access to central bank liabilities through a secure digital instrument (BIS, 2020; Adrian & Mancini-Griffoli, 2019). Unlike cryptocurrencies or private stablecoins, CBDCs are designed to maintain the core characteristics of traditional fiat currency, namely legal acceptance, price stability, and trust in the issuing authority. Their design can vary across jurisdictions, with models including retail CBDCs (for the public) and wholesale CBDCs (for financial institutions).

CBDC exploration has been driven by several global trends: the decline in cash usage (Rogoff, 2017), the rise of private digital payment providers (Kosse & Mattei, 2021), concerns over monetary sovereignty (Bordo & Levin, 2017), and the need to modernize legacy financial infrastructure. As illustrated in Figure 1, the global interest in CBDCs is no longer hypothetical. According to the most recent data, over 130 countries or currency unions - representing more than 98% of global GDP - are actively researching, developing, or piloting CBDCs (Atlantic Council, 2025). The map shows the diverse stages of development across regions, ranging from research and pilot phases to full-scale launches.

Figure 1 - Global CBDC Development Map

Source: (Atlantic Council, 2025)

This dynamic landscape underscores both the urgency and complexity of designing CBDCs that meet a wide range of national objectives. While some countries pursue them to promote payment efficiency or financial inclusion, others seek to protect monetary sovereignty or prepare for future shifts in international currency usage. However, despite their promise, CBDCs raise major design, operational, and policy challenges. These include potential risks to financial stability, bank disintermediation, data privacy, and cross-border monetary spillovers (Bindseil, 2020; Kiff et al., 2020; Auer & Böhme, 2020). Consequently, the international debate on CBDCs has moved from “if” to “how”. As central banks experiment with technical prototypes and institutional frameworks, there is growing recognition that the design of CBDCs will shape their macroeconomic consequences. Far from being a purely technological project, CBDCs are implanted in the core functions of central banking - trust, financial stability, and public interest.

1.1. Research Purpose and Contribution

This dissertation aims to explore the implications of CBDCs for monetary policy, with a particular focus on how they may reshape traditional transmission mechanisms, affect financial intermediation, and alter the strategic role of central banks in a digitized economy. As the global shift toward digital payments accelerates, central banks are faced with urgent decisions about whether and how to issue CBDCs. While much attention has been given to their technological design, the broader macroeconomic and institutional consequences remain the subject of active debate. The rise of CBDCs touches on foundational questions of how monetary policy is implemented, how money is trusted, and how the financial system transmits central bank decisions to the real economy. That being said, the central research question guiding this work is:

- How can the introduction of CBDCs alter the effectiveness and transmission of monetary policy, and what risks and opportunities must be considered to ensure macro-financial stability?

In addressing this question, the dissertation contributes to the literature in several ways. First, it offers a structured review of the theoretical foundations of money and monetary policy in the context of declining cash use. Second, it examines how different CBDC design features, such as interest-bearing capabilities, holding limits, and cross-border functionality, could affect interest rate pass-through, financial intermediation, and the effective lower bound (ELB). Third, it evaluates key risks, including disintermediation, capital flight, and international spillovers, highlighting how CBDC adoption could either support or undermine financial stability, depending on institutional choices.

1.2. Methodology

This dissertation adopts a qualitative methodology based on a structured and critical literature review. Given the early stage of CBDC implementation and the lack of long-term empirical data, this approach allows for a comprehensive examination of the theoretical debates and policy considerations currently shaping central bank thinking.

The analysis draws from a wide range of sources, including academic research, institutional working papers, and official publications from central banks and multilateral organizations. Emphasis is placed on studies published by the Bank for International Settlements (BIS) and the International Monetary Fund (IMF), which have played a central role in shaping the policy dialogue around CBDCs. Key academic contributions from authors such as Bindseil (2020), Kiff et al. (2020), Auer and Böhme (2020), and Bordo and Levin (2017) offer critical insights into the design choices and macroeconomic consequences of introducing digital central bank money. By comparing findings across these sources, it was possible to identify areas of consensus and divergence regarding CBDC implications for monetary transmission, financial stability, and cross-border spillovers. The methodology focuses not only on summarizing existing knowledge but also on connecting different grounds of the debate to form a cohesive and updated understanding of CBDC developments.

1.3. Outline

Chapter two begins with a review of the theoretical foundations of money and monetary policy, the implications of an increasingly digital economy, and the emerging policy concerns in this context.

Chapter three examines how CBDCs could transform monetary policy. It discusses the features that influence their macroeconomic effects regarding the transmission mechanism and the ELB.

Chapter four turns to systemic and international risks associated with CBDCs, such as bank disintermediation, financial instability, and capital flow volatility. It investigates how CBDCs could create new vulnerabilities in domestic financial systems and generate cross-border spillovers.

Finally, Chapter 5 presents a set of conclusions and policy recommendations. Then it reflects on the research limitations and future research areas.

2. MONETARY POLICY IN A DIGITIZING ECONOMY

The role of money in the economy, particularly within the framework of monetary policy, has been central to macroeconomic theory for decades. At its core, money performs three primary functions: it serves as a medium of exchange, a store of value, and a unit of account. These functions support the effectiveness of monetary policy, as they determine how changes in interest rates or the money supply influence economic behaviour (Berentsen & Schär, 2018).

In traditional monetary systems, where central banks issue physical cash, monetary policy is implemented primarily through controlling short-term interest rates and influencing liquidity conditions in the banking system. The effectiveness of this mechanism revolves around the public's willingness to hold and transact with the central bank's liabilities, notably physical currency and commercial bank deposits. Cash, as the most liquid and widely accepted form of central bank money, has historically played a critical role in anchoring the value of money and in ensuring the transmission of policy signals (Rogoff, 2017; Bindseil, 2020). Moreover, the existence of physical cash imposes

a natural barrier on the central bank's ability to set significantly negative nominal interest rates. This constraint is known as the ELB. If central banks attempt to push interest rates too far below zero, economic agents may choose to hold physical cash instead of low-yielding or negative-yielding bank deposits, and so challenging the transmission of monetary policy (Rogoff, 2017; Meaning et al., 2018).

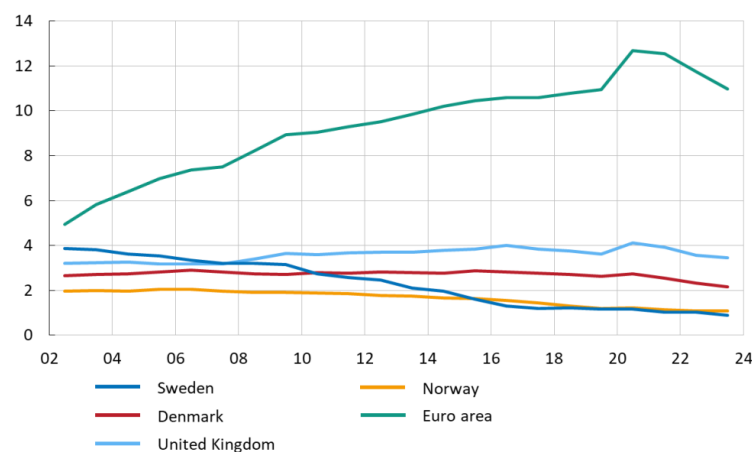
In addition to its implications for interest rate policy, cash plays a role in maintaining financial privacy and resilience. Physical money functions independently of digital infrastructure, offering a certain degree of independence and being safer during times of systemic disruptions, such as power outages or cyberattacks (Fabris, 2019). However, the increasing digitalization of financial systems, combined with a growing preference for electronic payments, has triggered debates about the continued relevance of cash in modern economies. Several advanced economies have observed a sharp decline in cash usage, prompting concerns about the long-term viability of cash-based monetary policy frameworks (Costa & De Grauwe, 2001). From a theoretical standpoint, the diminishing role of cash calls into question the traditional assumptions underlying monetary models. If physical money no longer plays a significant role in economic transactions, models must adapt to reflect a world in which central bank liabilities exist only in digital form. This shift has profound implications for the formulation, implementation, and effectiveness of monetary policy.

In sum, understanding the theoretical foundations of money and its traditional functions is essential to analysing the implications of its digital transformation. Cash has not only served as a tool for exchange but also as an institutional anchor for central banking. As economies move toward digital alternatives, these foundations must be re-evaluated to ensure that monetary policy remains effective and credible.

2.1. The Shift to Digital Payments

The global trend toward digitalization has significantly transformed the way individuals and businesses interact with money. In recent years, the use of physical cash has declined sharply in many advanced and emerging economies, driven by technological innovation, changes in consumer preferences regarding payment methods, and supportive policy environments (Fabris, 2019). In countries such as Sweden and Norway, cash usage has dropped to historically low levels, to the point where almost all payments are digital. In Sweden, for instance, around 90% of purchases are now conducted electronically, and several major retailers no longer accept cash at all (Sveriges Riksbank, 2025).

Figure 2 - Cash in Circulation as a Percentage of GDP



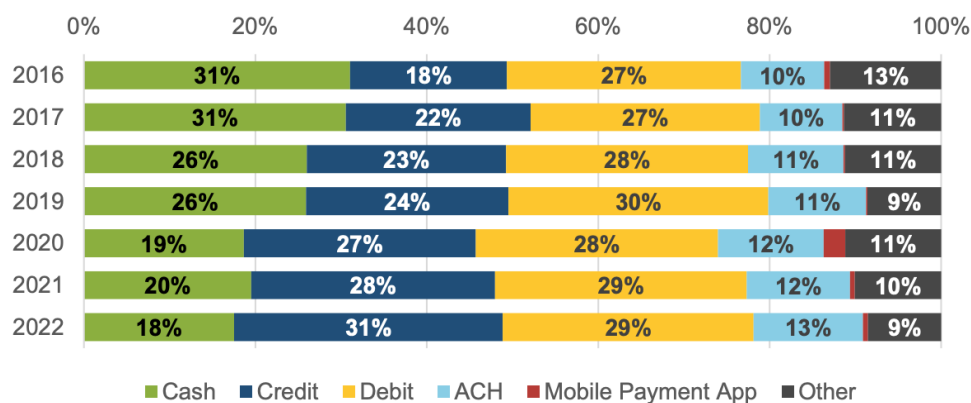
Source: Sveriges Riksbank (2025)

As Figure 2 shows, comparing cash in circulation as a percentage of GDP, cash circulation in Sweden and Norway is close to fading. In Denmark and in the United Kingdom, cash in circulation is only slightly higher, with a similar trend. In the Euro Area, there has been a decline since 2020.

On that note, the COVID-19 pandemic has further reinforced this trend by raising public awareness of hygiene issues associated with cash and accelerating the adoption of

contactless payment technologies (Kosse & Mattei, 2021). Additionally, the expansion of mobile banking, e-wallets, and fintech solutions has expanded access to digital financial services, particularly in urban areas. However, the speed and scope of the shift away from cash vary significantly across jurisdictions. In the Euro Area and the United States (USA), cash usage is dropping but it still plays a significant role in small-value transactions and in segments of the population that are less digitally included (Bindseil, 2020). Looking into the USA, as shown in Figure 3, cash usage has dropped close to half from 2016 to 2022, but still representing an 18% share of all payments in 2022 (Cubides & O'Brien, 2023). Conversely, credit card payments increased from 18% in 2016 to 31% in 2022. Debit card payments and automated clearing house (ACH) payments, an electronic transfer of money in the USA, have slightly increased, while other types of payments have slightly decreased.

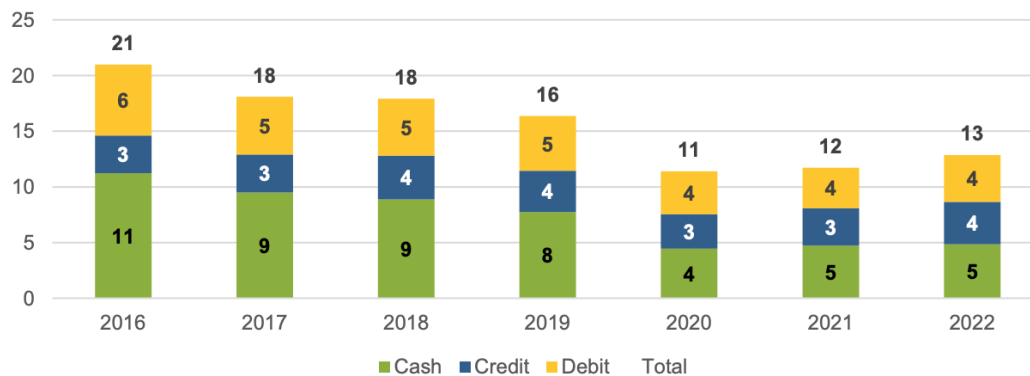
Figure 3 - Share of Payment Instrument Use for All Payments in the USA



Source: Cubides & O'Brien (2023)

Regarding the significance of small-value transactions in the USA, Figure 4 ahead shows that, in 2022, the share of cash usage for these payments (in person) stabilized since 2020, still being the highest (Cubides & O'Brien, 2023).

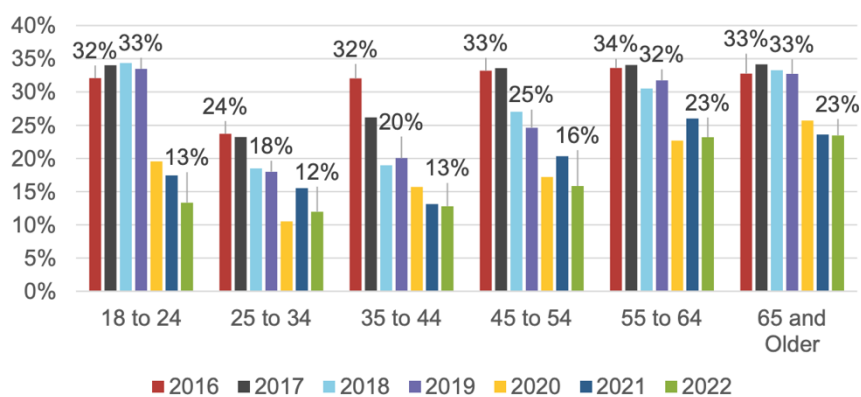
Figure 4 - Average Number of In-Person Payments Per Month Under \$25



Source: Cubides & O'Brien (2023)

When it comes to less included population in digital payments, older consumers tend to stick more to cash usage than younger consumers. Looking into Figure 5, consumers aged 55 and older in 2022, in the USA, have on average 23% of payments using cash (Cubides & O'Brien, 2023). This is higher than the average 18% of the country and even higher than the 12%-13% share of the consumers aged from 18 to 44 years old. However, regardless of the age group, cash usage has dropped significantly since 2016 until 2022.

Figure 5 - Share of Cash Usage by Age Group and Year

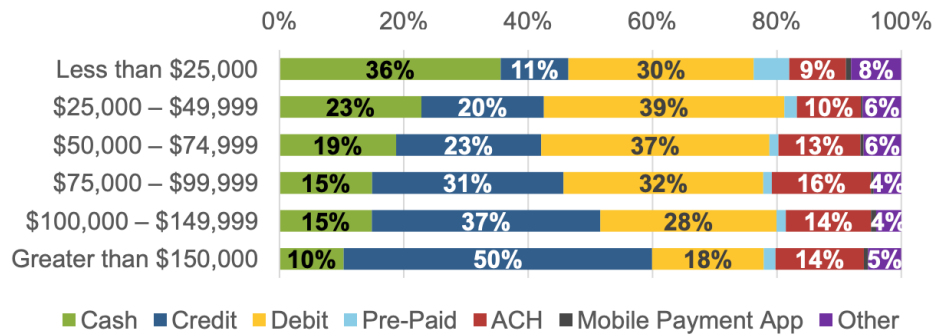


Source: Cubides & O'Brien (2023)

The income of the household also has a correlation with cash usage. As explicit in Figure 6, the lower the income, the bigger the share of cash payments. In the USA, in

2022, with a household income of less than \$25,000, the share of cash payments is 36%. With a household income greater than \$150,000, the average share of cash payments is 10% (Cubides & O'Brien, 2023).

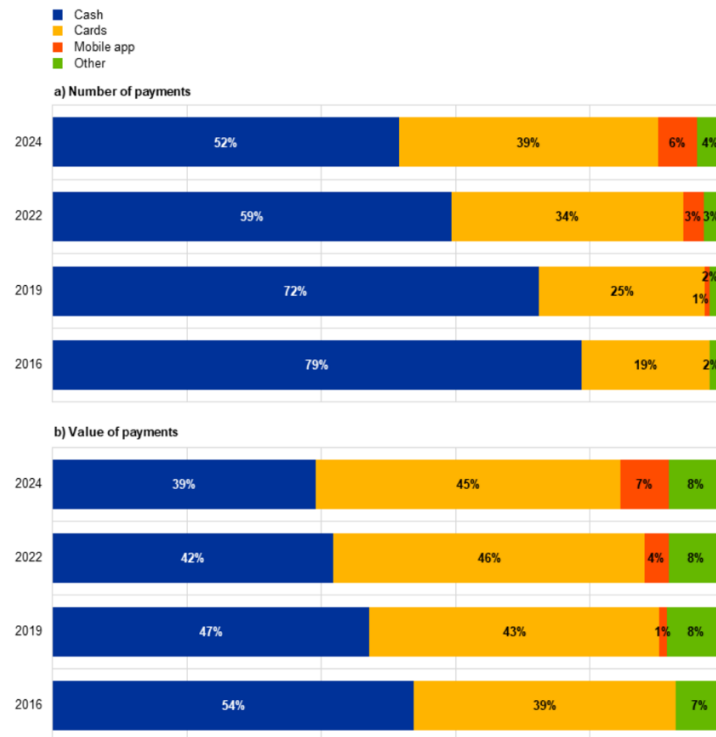
Figure 6 - Share of Payment Instrument Use by Household Income



Source: Cubides & O'Brien (2023)

Looking into the Euro Area, Figure 7 shows the share of payment instruments (2016-24) used to purchase goods or services in physical locations - point of sale (POS) transactions. Regarding the number of payments, the share of cash payments decreased from 79% in 2016 to 52% in 2024. Regarding the value of payments, the share of cash decreased from 54% in 2016 to 39% in 2024 (ECB, 2024). This demonstrates that, although the portion of cash transactions in the Euro Area is declining, it still represents a significant amount.

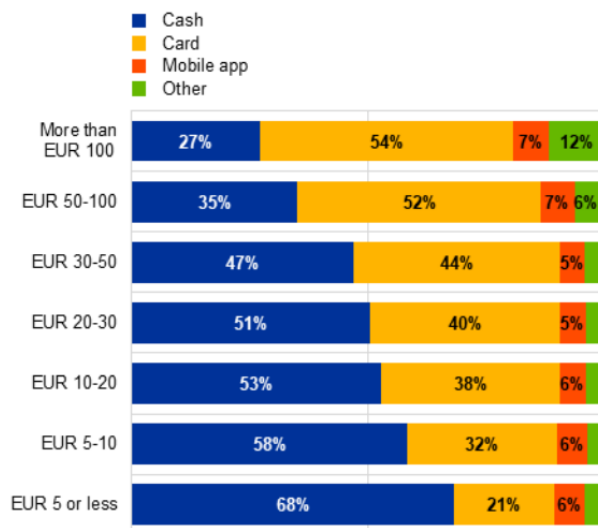
Figure 7 - Share of Payment Instruments Used at the POS in the Euro Area, 2016-24



Source: ECB (2024)

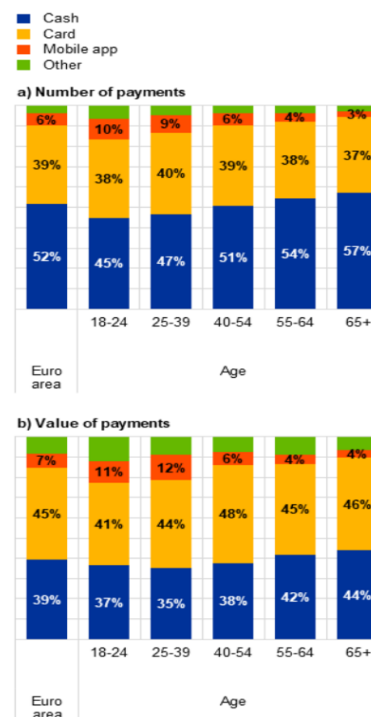
The Euro Area has similarities to the USA in small-value transactions and payments by age group, where smaller transactions and older consumers have larger cash representation. Figure 8 shows the breakdown of POS payments by value and payment instrument for 2024, in the Euro Area. Cash transactions represent 68% of payments of 5€ or less and more than half of the payments with a value between 5€ and 30€. Figure 9 is a breakdown of the share of payment instruments used at the POS by age, separated by number of payments and value of payments. The use of cash increases with age, representing more than half of the payments of consumers aged above 40, and reaching 57% at the age of 65 or older (ECB, 2024).

Figure 8 - Payments by Value and Instrument



Source: ECB (2024)

Figure 9 – Payments by Age and Instrument



Source: ECB (2024)

The observed decline in cash usage overall has direct implications for monetary policy. A reduced demand for cash weakens the ELB constraint and opens the door to new policy instruments, such as CBDCs, which can operate more effectively in a predominantly digital environment (Rogoff, 2017; Meaning et al., 2018). Furthermore, as the use of digital payments increases, central banks face new challenges in ensuring payment system stability, protecting consumer data, and avoiding excessive dependence on private financial infrastructure (Adrian & Mancini-Griffoli, 2019). Ultimately, the observed decline in cash usage serves as both a motivation and a constraint for the development of CBDCs. On one hand, it reflects a natural evolution of payment preferences that central banks must adapt to. On the other hand, it raises fundamental

questions about access to public money, economic inclusion, and the transmission channels of monetary policy.

2.2. Policy Concerns

As economies transition toward digital means of payment, the phasing out of physical cash raises multiple policy concerns that extend beyond the technical operation of payment systems. One of the most pressing issues is financial inclusion that was briefly addressed in the previous section. While digital payments are convenient for many, certain segments of population, such as the elderly, low-income individuals, and residents in rural areas, often lack access to the necessary infrastructure (e.g. smartphones, internet connectivity, or digital literacy) (Fabris, 2019; IMF, 2020). Figures 5 and 6 from the previous section show how rigid the elderly and low-income individuals can particularly be to the shift from cash payments to digital. The removal of cash risks marginalizing these excluded groups, thereby exacerbating social and economic inequalities. Ensuring that future payment systems remain accessible and inclusive is therefore critical to preserving the universal function of money and preventing a split in monetary access.

Another core concern is privacy. Physical cash provides a level of privacy that is not inherently present in digital payment systems. CBDCs, depending on their design, could allow authorities to track individual transactions, raising fears about surveillance, data security, and civil freedom (Kosse & Mattei, 2021). Central banks, like the ECB, have asserted that privacy-preserving design features will be prioritized. As mentioned in the ECB (2020) Report on a Digital Euro, privacy is a key concern for the public and will be given the highest consideration in the digital euro design. Despite the acknowledgement of central banks, public trust in government and financial institutions will always play a

critical role in the acceptance of digital currencies. Without robust and credible guarantees of privacy, the adoption of CBDCs could be significantly hurt.

Additionally, the disappearance of cash could impact resilience and operational security. In times of crisis (like natural disasters, cyberattacks, or power outages), cash serves as a fail-safe method of transaction, ensuring continuity when digital systems fail. A purely digital monetary system would depend heavily on the reliability of technological infrastructure, which may not always be guaranteed, especially in vulnerable regions. This dependency increases the exposure of the payment ecosystem to systemic risks and operational disruptions. Without the physical characteristic that cash has, even short-lived technical failures could have disproportionately large economic and social consequences (Bordo & Levin, 2017; Bindseil, 2020). Therefore, the removal of cash raises questions not only about efficiency but also about the robustness and reliability of national payment systems in the face of external shocks.

There are also concerns regarding monetary sovereignty and competition. In jurisdictions where foreign digital currencies (such as global stablecoins) gain a firm position, domestic monetary policy could be undermined. When individuals and firms increasingly transact and save in foreign-issued digital currencies, the central bank's ability to control the unit of account and implement effective monetary policy diminishes. This can lead to a loss of seigniorage revenue and reduced capacity to influence credit conditions or respond to economic shocks. The challenge is particularly acute in small or highly open economies, where capital mobility is high and trust in local institutions may be weaker (Adrian & Mancini-Griffoli, 2019; IMF, 2020). In such scenarios, domestic currencies risk being displaced by more stable or widely used foreign digital alternatives, thereby weakening national monetary autonomy and financial stability. This form of

digital currency substitution highlights the importance of policy coordination and timely regulatory responses.

Finally, the removal of cash can challenge public trust in money itself. Physical cash serves not only as a medium of exchange but also as a tangible symbol of central bank authority and reliability. It represents a direct claim on the central bank and is widely trusted as a safe store of value, especially in times of financial uncertainty or institutional instability. Transitioning entirely to digital forms of money may weaken this psychological and institutional link, particularly among segments of the population who associate physical currency with monetary sovereignty and financial reassurance. Without the visible and familiar presence of cash, individuals may become more skeptical about the abstract nature of digital money, especially if concerns over cybersecurity, privacy, or access are not adequately addressed. This shift could damage the confidence in the monetary system and complicate the transmission of monetary policy, especially during periods of crisis when trust is essential (Costa & De Grauwe, 2001).

Taken together, these concerns underscore that the shift away from cash is not merely a technical evolution but constitutes a significant socio-political and institutional transformation. The use of physical cash has historically been a public tool that guarantees accessibility, anonymity, and universal acceptability, independent of infrastructure or third-party approval (Fabris, 2019; IMF, 2020). Moving toward a predominantly digital monetary system risks redefining the relationship between citizens, financial institutions, and the state. As Bordo and Levin (2017) argue, the widespread adoption of digital currencies could concentrate control over transactions and data flows in the hands of central banks or other digital intermediaries, raising questions about surveillance, democratic accountability, and the neutrality of public money. Moreover, digital payment

systems often depend on private infrastructure and regulatory discretion, which can shift the institutional balance between public and private actors in the financial system (Kosse & Mattei, 2021). This transition therefore goes beyond innovation. It touches on issues of civil freedom, inclusiveness, and the perceived legitimacy of monetary authority. As such, any effort to reduce the role of cash must be guided by a careful and transparent balancing act, ensuring that inclusivity, privacy, resilience, and sovereignty are not compromised in the process.

3. CBDCs AND THE TRANSFORMATION OF MONETARY POLICY

Another crucial design element of CBDCs, not yet addressed in this research, is whether the CBDC is interest-bearing or not. An interest-bearing CBDC could function as a monetary policy tool, enabling the central bank to influence demand for money more precisely. However, it also raises concerns about competition with commercial bank deposits, potentially altering the structure of the financial system (Meaning et al., 2018; Kiff et al., 2020). CBDCs may also be designed with usage limits, tiered remuneration (different interest rates for different amounts of CBDCs), or time-based incentives (benefits for holding or spending CBDCs). This would be to manage risks such as capital flight (money leaving a country quickly), disintermediation (banks stop being used to hold money), or hoarding (accumulating CBDCs). These design choices aim to balance policy objectives like monetary control, financial stability, and consumer adoption (Bindseil, 2020; Mancini-Griffoli et al., 2018).

On the macroeconomic level, CBDCs have the potential to transform the monetary transmission mechanism. By providing a direct connection between the central bank and the public, CBDCs can improve the passage of policy rates and reduce the reliance on intermediary banks (Adrian & Mancini-Griffoli, 2019). At the same time, widespread

CBDC adoption could lead to reduced deposit bases for commercial banks, affecting their ability to extend credit and increasing their dependence on central bank funding (Kumhof & Noone, 2018). Furthermore, CBDCs could enhance payment system efficiency and competition, lower transaction costs, and promote financial inclusion. However, they also introduce new risks, including cybersecurity vulnerabilities, operational challenges, and geopolitical tensions in cross-border settings (Auer & Böhme, 2020; BIS, 2020).

In summary, the design of CBDCs involves complex trade-offs between monetary policy effectiveness, financial system stability, and individual user needs. As central banks explore the introduction of CBDCs, careful attention must be given to these topics and their broader economic implications.

3.1. CBDCs and the Monetary Policy Transmission Mechanism

The effectiveness of monetary policy depends significantly on the central bank's ability to influence aggregate demand through various transmission channels. Traditionally, this influence is applied through interest rate adjustments, which affect borrowing costs, consumption, investment, and exchange rates. However, the rise of CBDCs introduces new dynamics into this framework and offers the potential to enhance monetary transmission while presenting new risks (Kumhof & Noone, 2018; Mancini-Griffoli et al., 2018). One of the primary ways CBDCs can improve transmission is by enhancing the interest rate channel (changes in interest rate influence consumption and investment). By providing a direct instrument that holds an interest itself and is accessible to the public, CBDCs could increase the responsiveness of households and businesses to changes in the central bank's policy rate. This is particularly relevant in environments where traditional monetary tools are constrained, such as when interest rates are near the ELB (Meaning et al., 2018; Rogoff, 2017).

CBDCs could also strengthen the bank lending and credit channels (changes in monetary policy affect the amount of bank loans). A well designed CBDC framework might encourage greater transparency and efficiency in credit allocation, while simultaneously exerting competitive pressure on commercial banks to improve services and reduce lending rates. However, this is dependent on CBDC design choices that avoid excessive disintermediation and maintain a complementary role for banks in the financial system (Bindseil, 2020; Kiff et al., 2020).

In addition, CBDCs can support the portfolio rebalancing channel (changes in interest rate or monetary policy can cause investors to shift their asset holdings). CBDCs could allow central banks to influence the relative returns on various financial assets more directly. As CBDCs become a viable store of value, shifts in interest rates could induce greater movement between digital money, bank deposits, and other assets, thereby amplifying the impact of monetary interventions (Kumhof & Noone, 2018).

The exchange rate channel (changes in interest rates influence the value of a country's currency, which then affects exports and imports) may also be affected. If CBDCs are used in cross-border transactions, they could facilitate faster capital flows and impact exchange rates more directly. This could strengthen or complicate the international transmission of monetary policy, depending on how easily CBDCs can integrate and function with existing financial systems (Adrian & Mancini-Griffoli, 2019).

Nevertheless, the impact of CBDCs on transmission mechanisms depends heavily on adoption levels and behavioural responses. If its development is limited due to privacy concerns or accessibility barriers, the potential benefits of transmission will be contained. Furthermore, excessive reliance on CBDCs could increase financial system fragility if it leads to a reduction in bank intermediation or bank runs during periods of stress (Bordo

& Levin, 2017; BIS, 2020). We can conclude that CBDCs present a promising tool to enhance the transmission of monetary policy. They offer a more direct and potentially more efficient means for central banks to influence economic activity. However, realizing these benefits requires thoughtful design and proactive risk management to maintain financial stability and public confidence.

3.2. CBDCs and the Effective Lower Bound

One of the most widely discussed benefits of introducing CBDCs is their potential to relax or even eliminate the constraints imposed by the ELB on nominal interest rates. The ELB is the point at which interest rates can't be lowered further without people switching to cash, which still earns zero interest. It limits how much central banks can cut rates to stimulate the economy. Since cash carries a nominal return of zero, it effectively sets a floor for how negative central banks can push interest rates (Rogoff, 2017). In a world where cash plays a diminishing role or is replaced by digital alternatives, this constraint can be lifted or modified. A CBDC that is interest-bearing and not a perfect substitute for cash provides a mechanism through which central banks could implement significantly negative policy rates without triggering mass conversions into physical money (Bindseil, 2020; Meaning et al., 2018). This is important for monetary policy. This flexibility on how low interest rates can reach is particularly appealing in environments characterized by long-term stagnation, low inflation, and diminished monetary policy space, which are conditions that have persisted in many advanced economies since the global financial crisis. With an interest-bearing CBDC, central banks would have a greater capacity to stimulate demand in downturns without relying only on unconventional tools such as quantitative easing (Rogoff, 2017). Several policy proposals have emerged to put this idea in practice. Rogoff (2017) advocates a gradual phasing out of cash and the introduction

of an electronic currency with adjustable interest rates. Bindseil (2020) suggests a tiered remuneration system for CBDCs, where holdings above a certain threshold bear a negative interest rate, while smaller balances are exempt, thus preserving inclusion while enhancing policy effectiveness.

However, implementing negative rates through CBDCs has challenges. Public acceptance of negative returns on digital balances may be low, especially if CBDCs are positioned as substitutes for traditional money. Also, the credibility of monetary policy could be undermined if such a regime is viewed as punitive or strict (Fabris, 2019; Bordo & Levin, 2017). There are also technological and legal considerations. The infrastructure must be capable of enforcing negative interest rates securely and efficiently, while legal frameworks need to be updated to accommodate non-cash monetary instruments that deviate from traditional norms (Kosse & Mattei, 2021). Despite these concerns, the use of CBDCs to overcome the ELB remains one of the most compelling and interesting arguments in favour of their adoption. If designed and implemented thoughtfully and carefully, CBDCs could offer central banks a powerful new tool for stabilizing output and inflation in a low-rate environment.

4. RISKS AND CHALLENGES IN A CBDC FRAMEWORK

This chapter examines the main systemic risks and challenges that may arise with the introduction of CBDCs. It outlines how CBDCs could affect the traditional banking sector through disintermediation, influence financial stability during times of stress, and generate international spillovers that may complicate cross-border monetary policy coordination. By exploring these matters, this section sets up a balanced discussion of how risks can be mitigated through thoughtful design and policy measures.

4.1. Bank Disintermediation and Credit Contraction

One of the most frequently cited risks associated with the introduction of CBDCs is the potential for bank disintermediation. In a conventional monetary system, commercial banks play a central role in financial intermediation by accepting deposits and extending credit. If households and firms shift a substantial portion of their deposits to CBDC accounts, this could reduce banks' funding base and hurt their ability to provide loans (Kumhof & Noone, 2018; Kiff et al., 2020). This risk is especially higher during periods of financial stress, when depositors might seek to move funds from commercial banks to CBDCs backed by central banks, perceived as safer. Such shifts could aggravate bank runs and destabilize the financial system, unless mitigated through proper policy and technical design (Bindseil, 2020; Mancini-Griffoli et al., 2018).

To address these concerns, central banks have proposed several design features aimed at limiting disintermediation. One approach involves setting limits on the amount of CBDC that individuals or firms can hold, helping to reduce the risk of large-scale deposit outflows from commercial banks. Another strategy is the use of tiered remuneration, in which holdings above a certain threshold would earn lower or even negative interest rates, discouraging excessive accumulation. Additionally, by issuing non-interest-bearing CBDCs, central banks can reduce the incentive to shift funds away from traditional bank deposits. These mechanisms are intended to safeguard the central role of commercial banks in credit creation, while still delivering the potential benefits of digital public money (Bindseil, 2020).

Empirical simulations suggest that moderate CBDC adoption might not necessarily result in a net contraction of credit. Instead, the impact depends on the overall demand for CBDC and how banks respond by adjusting funding strategies or offering more

competitive products (Kiff et al., 2020; BIS, 2021). Moreover, some authors argue that increased competition from CBDCs could improve the banking sector by encouraging efficiency and innovation. Commercial banks may be compelled to lower fees, improve customer service, and accelerate digital transformation, which can enhance financial system performance overall (Berentsen & Schär, 2018; Auer & Böhme, 2020). On that note, policymakers must be aware that even well set CBDCs could alter the dynamics of monetary transmission and private credit intermediation. The challenge lies in designing a CBDC that supports monetary policy and public trust without undermining the traditional banking sector's capacity to support investment and economic growth.

4.2. Financial Stability and Systemic Responses

In addition to concerns about disintermediation, the introduction of CBDCs also brings up broader financial stability risks. The most notable of these is the risk of digital bank runs. In times of market stress or declining confidence in the banking system, depositors might rapidly transfer funds from commercial bank accounts into CBDC holdings, exacerbating liquidity shortages and increasing the likelihood of systemic crises (Bindseil, 2020; Kiff et al., 2020). Unlike traditional bank runs that are constrained by physical access or transaction limits, CBDC-based withdrawals could occur instantaneously, amplifying effects across financial institutions. This issue is particularly critical in countries with highly digitalized financial ecosystems or weak banking sectors, where the speed and ease of digital transactions could intensify disintermediation and credit contraction (Auer & Böhme, 2020; BIS, 2021). For instance, Sweden, one of the most cashless societies, as seen before, has raised concerns that a fast switch from commercial bank deposits to a CBDC could put strain on banks' liquidity during times of stress. Similarly, the Bahamas and Nigeria, both early adopters of CBDCs, have

implemented measures to address this issue given the vulnerabilities of their banking sectors and digital infrastructures. These examples highlight how the risk of swift, large-scale fund transfers is particularly concerning in settings where digital infrastructures enable smooth transfers with minimal delay, or where confidence in the banking sector is fragile.

To counter these risks, several central banks have explored technical safeguards and institutional responses. For example, the ECB has advocated for holding limits and tiered remuneration mechanisms, where balances above a certain threshold earn lower or even negative interest rates, discouraging excessive migration from commercial bank deposits (Bindseil, 2020). The People's Bank of China (PBoC) has implemented user and wallet-level caps, as well as daily transaction limits, to manage usage patterns and prevent sudden surges of demand during periods of financial stress (BIS, 2021). These types of safeguards aim to replicate the friction that exists in traditional systems, slowing down the pace of digital outflows. Additionally, delays in payment processes or limits on transaction speed have been considered, providing central banks with more time to respond to market pressures. Emergency liquidity/lending measures also remain a crucial tool to support solvent banks facing temporary funding pressure, helping to preserve financial stability in a digital currency environment.

Another financial stability concern is the reduction of credit intermediation capacity, particularly if CBDCs lead to persistent deposit outflows. This could make economic downturns even worse and strain credit availability for households and firms. To mitigate this, proposals suggest maintaining a dual-layer system, in which commercial banks continue to operate as intermediaries even within a CBDC-based architecture (Kumhof & Noone, 2018; Mancini-Griffoli et al., 2018). There are also concerns regarding

operational resilience and cybersecurity. A CBDC system would need to maintain uninterrupted availability, integrity, and resistance to cyber threats. A failure or breach in such a system could have widespread consequences for trust in public institutions and financial stability (Auer & Böhme, 2020; BIS, 2020).

Despite these risks, CBDCs are still viewed to strengthen the overall resilience of the financial system. The BIS (2020) notes that CBDCs can serve as a complementary payment option that ensures continuity during disruptions to private payment systems. The IMF (2020) also highlights that CBDCs could play a stabilizing role by enhancing payment system reliability and reducing reliance on private intermediaries, particularly in jurisdictions with less robust financial infrastructures. Similarly, the Swedish Riksbank has underlined that a CBDC could ensure continued access to central bank money in an increasingly cashless society, reinforcing trust in the monetary system and strengthening financial inclusion and system continuity (Sveriges Riksbank, 2025). By offering a state-guaranteed digital payment method, CBDCs can lower dependence on potentially fragile private payment networks and encourage greater competition and innovation in essential financial services (Adrian & Mancini-Griffoli, 2019). This can be especially beneficial during periods of crisis or technological failure, where access to a trustworthy and publicly backed form of digital money can support confidence and liquidity. Overall, while CBDCs pose certain financial stability challenges, these are not unmanageable. With careful design and implementation, CBDCs can coexist with the traditional banking system and potentially enhance its strength.

4.3. Cross-Border Spillovers

The introduction of CBDCs has the potential to generate significant international implications, particularly in the areas of exchange rate volatility, capital flows, and

monetary sovereignty. As countries explore or begin issuing CBDCs, the interactions between domestic and foreign digital currencies could reshape cross-border payment systems and global financial stability (Adrian & Mancini-Griffoli, 2019; BIS, 2020). One of the most discussed areas on this matter relates to exchange rates and currency substitution. In jurisdictions with unstable monetary systems or weak institutions, foreign CBDCs (especially those issued by major central banks) could become more attractive than domestic currencies. This could lead to partial or full replacement of the local currency by a foreign digital currency, reducing the effectiveness of domestic monetary policy (Bordo & Levin, 2017; IMF, 2020). Additionally, the ease and speed of cross-border payments enabled by CBDCs could intensify capital flow volatility. CBDCs compatible with other countries' systems could allow investors and households to reallocate funds across jurisdictions rapidly, bypassing traditional capital controls. This could complicate macroeconomic management and financial regulation in smaller and emerging market economies (Kosse & Mattei, 2021; Auer et al., 2021). On the positive side, CBDCs offer the opportunity to modernize and enhance the efficiency of international payment systems. Today's cross-border transactions are often costly and slow. CBDCs designed with international compatibility standards could reduce frictions, lower transfer costs, and promote financial inclusion on a global scale (BIS, 2021).

In response, several international joint initiatives have been launched to coordinate CBDC development and explore their cross-border potential. The mCBDC Bridge (a collaborative effort between the BIS Innovation Hub and the central banks of Hong Kong, Thailand, China, and the United Arab Emirates) aims to test the viability of real-time, peer-to-peer cross-border payments and foreign exchange operations using multiple CBDCs on a single distributed ledger (record of transactions). The project explores the

technical feasibility of reducing settlement times from days to seconds while enhancing transparency and reducing operational costs for participating jurisdictions (BIS, 2022). Project Dunbar (also led by the BIS in partnership with central banks from Australia, Singapore, Malaysia, and South Africa) goes a step further by testing direct transactions between financial institutions using CBDCs issued by different central banks on a shared platform. Instead of relying on correspondent banking or intermediaries, participating banks in different jurisdictions could settle international payments directly. This could significantly reduce costs and risks associated with existing systems, especially for smaller economies (BIS, 2022). These initiatives demonstrate how multilateral CBDC frameworks can improve payment efficiency and security across borders, as well as decrease transaction costs. At the same time, they aim to ensure that technological innovation remains anchored in robust regulatory standards and institutional cooperation, thus balancing progress with stability (BIS, 2022).

Nonetheless, unresolved issues remain around data governance, monetary control, and geopolitical competition. The strategic deployment of CBDCs by major economies could give rise to new forms of influence or financial dependency, particularly if certain CBDCs become dominant in international trade or reserves (Fabris, 2019; Kiff et al., 2020). Ultimately, the global adoption of CBDCs could reinforce the need for enhanced international cooperation among central banks and regulatory bodies. In turn, a lack of coordination could increase global financial fragmentation, while effective collaboration could lead to a more inclusive, secure, and integrated monetary order.

CBDCs potentially have an impact on the composition of foreign exchange reserves. If CBDCs, issued by major economies, gain widespread use in cross-border transactions and international trade settlements, they could start to be held as reserve assets by other

central banks, alongside or even in place of traditional reserve currencies. CBDCs could be more attractive for their accessibility and new settlement features (Adrian & Mancini-Griffoli, 2019; IMF, 2020). CBDCs could improve settlement efficiency by allowing faster, more transparent cross-border payments and with less operational costs, since their users can send money on secure digital systems, directly and without delays from intermediaries (IMF, 2020). However, if a widely trusted CBDC becomes more attractive and easier to access internationally, it could reinforce or shift global currency hierarchies. This could make it harder for smaller or emerging economies to maintain demand for their domestic currency in global trade and reserves (Bordo & Levin, 2017). Furthermore, if businesses and households in countries with unstable currencies find it easier to use a foreign CBDC that they trust more, they may switch away from the local currency for savings and payments. This can weaken monetary policy effectiveness and reduce a country's control over its own money supply, especially for smaller economies that already face capital flight and low institutional trust (IMF, 2020).

CBDCs, as direct liabilities of the central bank, do not require a separate reserve backing in the way that commercial bank deposits do. Instead, they are inherently supported by the central bank's existing asset base, such as government securities, gold reserves, and foreign currency holdings, which hold the credibility of all monetary liabilities, including physical cash (Kumhof & Noone, 2018; Meaning et al., 2018; Bindseil, 2020; BIS, 2020). However, widespread adoption of CBDCs could affect the composition of the central bank's balance sheet. Therefore, while no rigid reserve ratio is required for CBDC issuance itself, its design and scale could have important implications for liquidity management, collateral needs, and the operational framework of monetary

policy, implying the need for careful management of the central bank's reserves (Adrian & Mancini-Griffoli, 2019).

5. CONCLUSIONS

CBDCs have the potential to enhance the effectiveness and transmission of monetary policy by providing a more direct and flexible tool for influencing interest rates, strengthening the pass-through to households and businesses, and potentially overcoming constraints such as the ELB. There are opportunities in strengthening the resilience of payment systems, promoting financial inclusion, and enhancing monetary sovereignty, with the right design safeguards, privacy measures, and international coordination. However, there are risks of bank disintermediation, digital bank runs, cross-border spillovers, and operational vulnerabilities, which could amplify systemic stress if not properly addressed. Therefore, the analysis of CBDCs reveals a complex combination of innovation, monetary policy effectiveness, and financial stability.

Several policy recommendations can be made to guide the design and implementation of CBDCs. First, CBDCs should be designed to complement, not replace, bank intermediation. CBDCs should be carefully structured to avoid disintermediation of the banking sector. Instruments such as tiered remuneration, holding limits, and non-interest-bearing balances can mitigate potential outflows from commercial bank deposits (Bindseil, 2020; Kiff et al., 2020). Additionally, financial stability should be ensured through cautious measures. Central banks should develop strong risk precautions and safeguards against digital bank runs. These may include delayed settlements, real-time surveillance systems, and emergency lending to support banks during stress scenarios (Auer & Böhme, 2020; BIS, 2020). On a similar note, privacy, cybersecurity, and public trust should be highly prioritized. Public confidence is essential for CBDC adoption.

Ensuring strong data protection, privacy-preserving architectures, and transparent governance will be vital to maintain legitimacy and user trust (Kosse & Mattei, 2021). Furthermore, international coordination and compatibility should be promoted. To avoid monetary fragmentation and currency substitution, central banks must coordinate internationally on standards, regulations, and settlement protocols. Initiatives like mCBDC Bridge and Project Dunbar provide valuable testing grounds (BIS, 2022; Auer et al., 2021). At last, CBDCs should be evaluated as an important tool for policy innovation. This is a compelling aspect of this new digital currency. CBDCs could expand the monetary policy toolkit, especially in low-interest environments. Their potential to bypass the ELB should be explored further with a focus on design features that enable effective transmission without hurting public confidence (Rogoff, 2017; Bordo & Levin, 2017).

In conclusion, CBDCs represent a significant evolution for money and monetary policy. While they hold great promise for improving payment systems and enhancing policy transmission, their implementation must be approached with caution. The risks, from financial disintermediation to systemic instability, are serious, but manageable with appropriate institutional design and international coordination. The transition to a digital monetary system will require balancing innovation with carefulness, inclusiveness with efficiency, and national autonomy with global cooperation. If successful, CBDCs could lead to a more adaptable, transparent, and resilient framework for monetary policy in the digital era.

5.1. Research Limitations

While this dissertation provides a comprehensive review of the current literature, the study relies exclusively on theoretical and policy-oriented sources, given that CBDCs are

still in the early stages of development and large scale empirical evidence remains limited. This means that many conclusions about transmission channels, disintermediation risks, and cross-border effects are based on simulations or hypothetical scenarios rather than real-world implementation data. Additionally, the focus on advanced economies may not fully capture the specific institutional, technological, and regulatory contexts of emerging markets, where the impact of CBDCs could be substantially different. Finally, the fast-evolving nature of CBDC research means that new developments, whether technical pilots, policy experiments, or international coordination efforts, could quickly outdate some of the findings presented here. These constraints highlight the need for ongoing empirical monitoring and comparative analysis as more CBDCs move from pilot phases to actual deployment.

5.2. Future Research

Building on the insights and limitations identified in this study, as more pilot projects and early stage implementations emerge, there is a need for empirical studies that assess how CBDCs actually influence monetary policy transmission, financial intermediation, and consumer behaviour in practice. Furthermore, future research could benefit from comparative analyses across jurisdictions, especially to understand how different legal and institutional frameworks shape CBDC adoption and mitigate systemic risks such as digital bank runs or cross-border currency substitution. In addition, the technological design of CBDCs, such as privacy safeguards, programmable features, and protection against cyber threats, should be explored further to promote trust, security, and integration into existing financial systems. Lastly, given the growing importance of international spillovers, further work is needed to examine how multilateral frameworks, such as projects like mCBDC Bridge or Project Dunbar, can be operationalized to enhance cross-

border payment efficiency while preserving monetary sovereignty and regulatory standards. Advancing these research areas will be essential to inform policymakers and ensure that CBDCs contribute positively to the stability and effectiveness of the global monetary system.

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