Department of Economics and Finance
Chair of Corporate Finance

Central Bank Digital Currencies:
Statistics & Insights into a New Era in Finance

SUPERVISOR:

Prof. Luana Zaccaria

CANDIDATE:

Leonardo Di Folco #276421

Academic Year 2023/2024

ABSTRACT

Central Bank Digital Currencies represent a significant innovation in the realm of finance, promising to revolutionize monetary systems globally. The thesis, titled "Central Bank Digital Currencies: Statistics & Insights into a New Era in Finance", explores the transformative potential of CBDCs through a comprehensive evidence-based analysis. The study investigates the design, implementation strategies, and impacts of CBDCs across different national contexts, providing a comparative analysis to understand the diverse approaches and outcomes.

The research methodology encompasses both quantitative and qualitative techniques, drawing from a wide range of sources, including data analysis from existing implementations, surveys, and interviews with key stakeholders. The findings reveal that, while CBDCs offer substantial benefits such as enhanced financial inclusion, reduced transaction costs, and improved monetary policy effectiveness, they also pose significant challenges related to privacy, cybersecurity, and regulatory frameworks.

The thesis contributes to the existing literature by offering a holistic understanding of CBDCs, covering economic, regulatory, technological, and social dimensions. Different perspectives are integrated, providing a complete analysis of CBDCs' multifaceted implications.
In light of the evidence-based analysis, strategic recommendations for central banks, governments, and financial institutions are offered, aiming to help them navigate the complexities of CBDC implementation. The conclusion underscores the importance of a balanced approach, where technological innovation is aligned with robust regulation and public trust.

Ultimately, the paper aims to equip policymakers and financial institutions with critical insights to make informed, strategic decisions, ensuring that CBDCs contribute to a more inclusive, efficient, and stable global financial system.

TABLE OF CONTENTS

INTRODUCTION……6

CHAPTER 1: LITERATURE REVIEW……..…….....8

- **1.1 Purpose and Objectives…….....9**
- **1.2 CBDCs: an Overview……10**
- **1.3 Theoretical Frameworks…….....16**
- **1.4 Gaps in The Literature……...24**

CHAPTER 2: METHODOLOGY…….……....26

- **2.1 Introduction to Methodology……27**
- **2.2 Research Design…….…28**
- **2.3 Data Collection……..……..29**
- **2.4 Ethical Considerations and Limitations…….……..33**

CHAPTER 3: EVIDENCE-BASED ANALYSIS……34

- **3.1 Overview of Data and Sources……..…….35**
- **3.2 Descriptive Analysis…….……...36**
- **3.3 Current Implementations and Case Studies……..……..40**
- **3.4 Economic Implications……..…….49**
- **3.5 Public and Istitutional Perceptions……...56**
- **3.6 Regulatory and Legal Challenges……..…59**
- **3.7 Synthesis of Findings……..61**

CHAPTER 4: STRATEGIC CONSIDERATIONS AND RECOMMENDATIONS……...…….…...62

- **4.1 Overview and Strategic Focus……...…63**
- **4.2 Strategic Considerations for Central Banks……64**
- **4.3 Policy Recommendations for Governments……70**
- **4.4 Strategic Guidance for Financial Institutions……..74**

CONCLUSION……76

INTRODUCTION

The financial landscape is experiencing a profound transformation driven by the rise and development of digital technologies, reshaping traditional banking and payment systems. The concept of Central Bank Digital Currencies, also known as CBDCs, is among the most revolutionary innovations in this domain. Unlike cryptocurrencies such as Bitcoin and Ethereum, which operate on decentralized networks without central oversight, CBDCs are digital representations of a country's fiat currency, issued and regulated by the National Central Bank. This unique characteristic positions CBDCs as a potential stabilizing force in the digital economy, offering the benefits of digital transactions while maintaining the reliability and oversight of central banking.

Several countries are at the forefront of CBDC development. For instance, China has advanced significantly with its digital yuan, already conducting widespread pilot programs. Sweden is currently testing the e-krona in a variety of services, and the Bahamas has launched the Sand Dollar, one of the first fully operational CBDCs. Meanwhile, the United States and the European Union are still in the research and development phases, carefully considering the implications and design choices of their potential digital currencies. These global efforts signal a pivotal shift in monetary policy and financial infrastructure, suggesting that CBDCs could fundamentally redefine financial systems.

The study of CBDCs is crucial for several reasons. First and foremost, these digital instruments have the potential to significantly enhance financial inclusion. In many regions, a substantial portion of the population remain unbanked or underbanked, lacking access to essential financial services; CBDCs could provide these populations with secure and accessible means of participating in the financial system, thereby promoting economic inclusion and reducing inequality. Additionally, CBDCs can improve payment system efficiencies by lowering transaction costs and processing times. Traditional banking and payment infrastructures are often slow and costly, particularly in cross-border transactions. By leveraging advanced digital technologies, CBDCs can enable faster, cheaper, and more secure transactions, thus benefiting both consumers and businesses.
Furthermore, CBDCs provide central banks with new tools for monetary policy implementation and management. By providing a direct channel for monetary transactions, CBDCs can intensify the transmission of monetary policy, making it more efficient in achieving economic stability. CBDCs also offer central banks real-time data on economic activities, allowing for more responsive and informed policy decisions.
However, alongside these benefits, CBDCs also pose significant challenges. Privacy, cybersecurity, and regulatory oversight are critical issues that must be addressed to ensure successful implementation. Understanding these multifaceted impacts is fundamental for policymakers, financial institutions, and the broader public to navigate the complexities of this emerging technology.

The thesis aims to address several key research questions to provide a comprehensive analysis of CBDCs: how do different countries approach the implementation of CBDCs, and what are the

resulting outcomes? What are the economic impacts of CBDCs on financial inclusion, transaction costs, and monetary policy effectiveness? How do public and institutional perceptions of CBDCs vary across regions and demographics, and what factors influence these perceptions?

The primary objectives of this study are to conduct a comparative analysis of CBDC implementation strategies across various countries, highlighting best practices and lessons learned; to assess the economic impacts of CBDCs on financial systems; to explore public and institutional perceptions of CBDCs, identifying factors that influence these views and how they may affect the adoption and acceptance of CBDCs; and to contribute insights to the existing literature on CBDCs, offering evidence-based recommendations for policymakers, central banks, and financial institutions.

The paper is organized into different key sections to systematically explore the research questions and goals. The starting point is the *Introduction*, that briefly provides the background and context of CBDCs, presents the research questions and objectives, and describes the thesis' structure. The first chapter, *Literature Review*, covers existing research on CBDCs, including key concepts and design features, historical evolution, and potential benefits and risks. It analyses the theoretical frameworks on which CBDCs are rooted, and identifies gaps in the literature that this study aims to fill, thus providing a solid foundation for the comprehensive analysis that follows. The second chapter, *Methodology*, outlines the research design, data collection methods, and analytical techniques used in the study. It explains the selection of case studies and surveys, and the statistical methods employed for data analysis. Ethical considerations and limitations of the study are also discussed. The third chapter, *Evidence-based Analysis*, presents the collected data in a structured format, including descriptive statistics and analytic information. It provides a detailed comparative analysis of CBDC implementations in different countries, assesses the economic impacts of CBDCs, and explores public and institutional perceptions based on official surveys and interviews. The fourth chapter, *Strategic Considerations and Limitations*, builds upon the findings presented in the previous section, and provides tailored recommendations for the key stakeholders involved—central banks, governments, and financial institutions—focusing on how each can navigate the unique economic, technological, and regulatory challenges that CBDCs present. The final part, *Conclusion*, illustrates the key takeaways of the study, highlighting the contributions to the field, and offering suggestions for future research. It emphasizes the importance of a balanced approach to CBDC implementation, ensuring that technological advancements align with robust regulatory measures and public trust.

By following this structured approach, the paper aims to provide a comprehensive and nuanced understanding of CBDCs, their potential benefits and challenges, and their implications for the future of finance.

CHAPTER 1
LITERATURE REVIEW

1.1 PURPOSE AND OBJECTIVES

The ongoing digital transformation of the financial sector has introduced several innovations that challenge traditional banking and payment systems. Among these innovations, Central Bank Digital Currencies[1] stand out as a particularly transformative development. Defined as digital forms of a country's fiat currency[2], CBDCs hold enormous potential to revolutionize financial transactions, enhance economic inclusion, and refine monetary policy mechanisms.
Being managed and overseen by central banks, CBDCs represent the first instance of a centralized cryptocurrency, providing a stable and trustworthy alternative in the digital currency landscape, so far dominated by decentralized cryptocurrencies, which operate without central authority.

The *Literature Review* Chapter reviews the extensive body of literature on CBDCs, aiming to summarize key concepts, theoretical frameworks, and empirical findings. It begins by providing an overview of CBDCs, discussing their essential characteristics and design features, and exploring their potential effects on modern financial systems. The chapter also inspects the theoretical frameworks underpinning CBDC implementation, including foundational economic theories and insights from behavioral economics.
Furthermore, the regulatory and legal challenges associated with the adoption of CBDCs are addressed, emphasizing the need for comprehensive frameworks to manage issues such as privacy, security, and compliance. The review also highlights the potential repercussions of CBDCs on various economic and financial aspects, such as financial disintermediation, the zero-lower bound, and the implications for monetary policy transmission, drawing on key studies that provide critical insights to assess the broad impact of CBDC implementation.
By consolidating the current body of knowledge, the *Literature Review* identifies gaps and areas requiring further investigation, thereby setting the stage for a deeper, evidence-based analysis in the following chapters. The insights gained from this review are instrumental in advancing the understanding of the potential roles CBDCs may play in shaping future financial systems.

The chapter is structured as follows: *Section 1.2* provides an overview of CBDCs, including key concepts, design features, historical evolution, and potential impacts. *Section 1.3* explores the theoretical frameworks on which CBDCs are rooted, from fundamental economic theories to behavioral economics. Finally, *Section 1.4* identifies gaps in the existing literature and outlines how this thesis aims to address these gaps.

---

[1] *Abbr. CBDCs*
[2] *Fiat money is a government-issued currency that is not backed by a commodity such as gold. Most modern paper currencies, such as the U.S. dollar, are fiat currencies.*

1.2 CBDCs: AN OVERVIEW

1.2.1 Definition and Key Concepts

Broadly defined, digital currencies are forms of currency that exist solely in digital form, rather than in physical form, like banknotes and coins. They can be used to conduct transactions over the internet and other digital networks. Digital currencies include a wide array of financial instruments, including cryptocurrencies, stablecoins, and digital representations of fiat currencies.

Cryptocurrencies, such as Bitcoin or Ethereum, are digital currencies that operate on decentralized networks using blockchain technology[3], which ensures transparency, security, and immutability of transactions. These currencies are not controlled by any central authority, distinguishing them from traditional fiat currencies. However, the decentralized nature of cryptocurrencies also leads to challenges, such as high volatility and regulatory concerns.
Stablecoins, on the other hand, are digital currencies whose value is pegged to that of another currency (typically a flat currency like US dollar), commodity (typically gold), or financial instrument. This pegging mechanism is designed to maintain a stable value, reducing the volatility commonly associated with cryptocurrencies. Stablecoins aim to combine the benefits of digital currencies with the stability of traditional assets, making them attractive for various financial applications.
Central Bank Digital Currencies represent a novel and unique form of digital currency issued and regulated by a nation's Central Bank. Differently from decentralized cryptocurrencies and private stablecoins, CBDCs are backed by the trust and authority of the issuing Central Bank, ensuring stability regulatory oversight. The fundamental purpose of CBDCs is to provide a secure, efficient, and inclusive alternative to both cash and private digital currencies, thereby enhancing the overall efficiency and functionality of the financial system.

CBDCs can be categorized into two types: Retail CBDCs and Wholesale CBDCs. Retail CBDCs are designed for public use in everyday transactions; the goal is to provide a digital equivalent to cash, enabling consumers to make payments, store value, and conduct other financial activities seamlessly. They are intended to enhance financial inclusion by providing access to digital financial services for unbanked and underbanked populations. Retail CBDCs can also improve the efficiency and security of payment systems by reducing the reliance on physical cash and mitigating the risks associated with cash handling and counterfeit money.
Wholesale CBDCs are restricted to use by financial institutions and aim to improve the efficiency and security of interbank transfers and settlements. They can streamline the settlement process in financial markets, reducing time and costs associated with cross-border transactions and minimizing counterparty risks[4]. By providing a secure and efficient medium for large-value transactions, wholesale CBDCs can improve the financial system stability.

---

[3] Blockchain is a shared, immutable ledger that facilitates the process of recording transactions and tracking assets in a business network (IBM)
[4] Counterparty risk is the probability that one of the parties involved in an investment, credit, or trading transaction may not fulfill its part of the deal and may default on the contractual obligations

1.2.2 Historical Evolution

The concept of digital currencies has evolved significantly over the past few decades. The journey began with the advent of electronic payment systems and digital banking in the late 20th century, which paved the way for the development of more sophisticated digital financial instruments.
The introduction of cryptocurrencies, particularly Bitcoin in 2009, marked a major milestone in this evolution. Bitcoin's decentralized nature demonstrated the potential for digital currencies to operate independently of traditional financial institutions.
Despite the success of cryptocurrencies, their volatility and lack of regulatory oversight posed significant challenges. Furthermore, evidence shows how, by now, cryptocurrencies are perceived as speculative assets rather than money and, in many cases, they are used to facilitate financial crimes, including money laundering and ransomware attacks[5] *(BIS,2021)*. This led central banks to explore the possibility of developing their own digital currencies that could offer the benefits of digital transactions while maintaining monetary stability and regulatory control. Pilot projects and feasibility studies for CBDCs began to gain momentum in the mid-2010s, with countries like China, Sweden, and the Bahamas leading the way in developing and testing their own versions of CBDCs.

The historical evolution of digital currencies has been closely linked to the decline in the use of cash for daily transactions. As illustrated in the following figure, cash usage has been steadily declining across various countries, driven by the convenience and efficiency of digital payments. The COVID-19 pandemic further accelerated this trend, as people increasingly turned to remote digital payments to minimize physical contact. This shift highlighted the need for robust digital payment systems and provided a strong impetus for the development of CBDCs. *(BIS, 2021)*

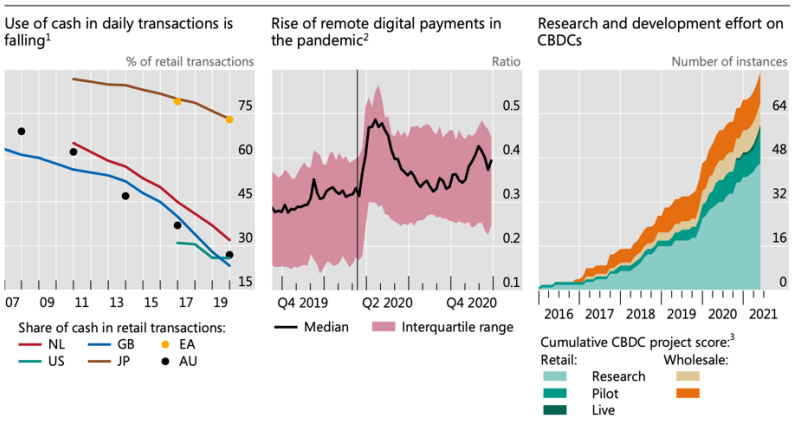

Figure 1

[5] *Ransomware is a tactic used by cybercriminals to hijack a user's computer system. During such an attack, the system is effectively taken hostage, and the user must pay a ransom to regain access; typically, the hacker requests payment in cryptocurrency to maintain anonymity*

In response to those trends, central banks around the world have intensified their research and development efforts on CBDCs, significantly growing the cumulative number of pilot projects. This global momentum reflects the recognition of CBDCs' potential to support economic stability.

The evolution of CBDCs is also significantly influenced by advancements in technology, particularly in Distributed Ledger Technology[6] and blockchain. DLT is a digital system for recording asset transactions in which details are simultaneously recorded in multiple locations. Unlike traditional databases, it does not rely on central data store or administrative control. Blockchain, a type of DLT, uses cryptographic and algorithmic methods to create a continuously growing data structure – the blockchain – which ensures the integrity and security of data transactions.
Two foundational elements of blockchain technology are transparency and immutability; all transactions are recorded on a public ledger that is visible to all participants, ensuring transparency. Blockchain immutability means that once a transaction is recorded, it cannot be altered or deleted; this feature is crucial for maintaining the integrity and trustworthiness of financial records.
DLT operates on a decentralized network of computers, called nodes. Each node maintains a copy of the ledger, and consensus algorithms are used to agree on the validity of transactions. This innovation streamlines processes, reduces the need for intermediaries, and improves the efficiency of transactions.
While DLT offers numerous benefits, scalability and energy consumption have been significant challenges. Early blockchain systems, like Bitcoin, have faced issues with scalability due to the increasing size of the blockchain and the energy-intensive nature of proof-of-work consensus mechanisms. Recent developments aim to address these challenges through alternative consensus algorithms like proof-of-stake[7], sharding[8], and off-chain solutions. These technological advancements in DLT and blockchain are critical in the development of CBDCs. They provide the underlying infrastructure needed to ensure the security, efficiency, and scalability of digital currencies. Central banks are leveraging these technologies to build robust CBDC systems that can handle large volumes of transactions safely and efficiently. *(Auer et al, 2021)*

In summary, the historical trajectory of digital currencies, characterized by the decline in cash usage and the development in technological infrastructures, has culminated in the emergence of CBDCs. Central banks worldwide are actively investigating and deploying CBDCs to leverage the advantages of digital currencies, while concurrently upholding standards of stability, security, and regulatory compliance.

---

[6] *Abbr. DLT*
[7] *A consensus mechanism is a method for validating entries into a distributed database – the blockchain – and keeping the database secure. Proof-of-Work uses a competitive validation method to confirm transactions and add new blocks to the blockchain; Proof-of-Stake is designed to reduce network congestion and address environmental sustainability concerns surrounding the PoW protocol; it uses randomly selected validators to confirm transactions and create new blocks. (Moralis Ac.)*
[8] *Sharding is a technique used in blockchain to enhance scalability and transaction speed by dividing the network into smaller partitions, called "shards".*

1.2.3 Key Features and Design Principles

The design of Central Bank Digital Currencies is governed by several critical features and principles to ensure their effectiveness, security, and broad acceptance.

One of the primary design considerations is accessibility. CBDCs must be easily accessible to the public, financial institutions, and businesses. This includes developing user-friendly interfaces and ensuring compatibility with existing financial systems and digital devices. The goal is to create a seamless and inclusive digital payment ecosystem that facilitates everyday transactions for all economic participants, including those who are unbanked or underbanked.
Security is another paramount concern in the design of CBDCs. To protect against cyber threats and ensure the integrity of digital transactions, robust security measures must be implemented, including advanced encryption techniques, and multi-factor authentication. The architecture of CBDCs must be resilient against cyberattacks, fraud, and other malicious activities to maintain user trust and system stability.
Balancing privacy with regulatory oversight is a critical challenge in the design of CBDCs. Users expect a certain level of privacy in their financial transactions, but central banks must ensure that CBDCs are not exploited for illicit activities. Privacy-preserving technologies, such as zero-knowledge proofs and differential privacy[9], can help achieve this balance by enabling secure and private transactions while allowing for necessary regulatory scrutiny.
Interoperability is another crucial feature for the successful implementation of CBDCs. To facilitate seamless transactions across different platforms and jurisdictions, CBDCs must be designed to integrate with existing financial systems and international payment networks. This requires collaboration between central banks, financial institutions, and technology providers to develop standardized protocols and frameworks. Ensuring interoperability enhances the utility of CBDCs and supports global trade and cross-border financial activities.

The underlying technology infrastructure of CBDCs, such as Distributed Ledger Technology or blockchain, plays a significant role in determining their efficiency and security. DLT offers transparency and immutability, ensuring that all transactions are recorded and cannot be altered. This is essential to preserve the integrity of financial records. Nevertheless, DLT also presents challenges related to scalability and energy consumption. *(See Section 1.2.2)*
Regulatory compliance is essential for the successful adoption of CBDCs. The development and implementation of CBDCs must comply with existing regulatory frameworks and standards. Central banks need to work closely with regulatory bodies to establish clear guidelines and rules governing the issuance, distribution, and use of CBDCs. Ensuring regulatory compliance is crucial for gaining public trust and promoting the widespread adoption of CBDCs.

[9] *Zero-knowledge proofs are cryptographic protocols that allow one party to prove to another party that they know a value or possess certain information without revealing the actual information itself, thus ensuring that the verifier is convinced of the truth of the assertion. Differential Privacy is a statistical technique used to ensure that the output of a data analysis does not reveal any specific information about any individual in the dataset.*

1.2.4 Potential Benefits and Risks

The implementation of CBDCs offers numerous potential benefits that could significantly transform the financial environment, revolutionizing how transactions are conducted and how monetary policy is implemented. At its core, the adoption of CBDCs represents a significant evolution in the nature of money, transitioning from physical cash and traditional bank deposits to a digital form of central bank liability accessible directly to the public. This transformation has far-reaching implications for payment systems and financial inclusion, but also for the broader economic structure, including how central banks manage liquidity, control inflation, and respond to economic crises. As countries increasingly explore CBDCs, the discourse surrounding these digital currencies is evolving, revealing both the transformative opportunities they present and the intricate challenges they introduce.

One of the most significant advantages of CBDCs is their potential to enhance the payment system efficiency. By reducing reliance on intermediaries and streamlining transaction processes, CBDCs can lower transaction costs and accelerate settlement times. This benefits both consumers and businesses by providing faster and cheaper payment options. According to studies by the Bank for International Settlements[10], the elimination of intermediaries in the transaction process not only reduces the risk of transaction failures but also increases the overall reliability of the payment system. Additionally, CBDCs can facilitate cross-border payments by bypassing traditional correspondent banking networks, thereby reducing costs and increasing transaction speed. *(Bech & Garratt, 2017)*

Another critical benefit of CBDCs is their potential to significantly promote financial inclusion. In many developing regions, part of the population experiences lack of access to traditional banking infrastructure. CBDCs can provide an accessible alternative, enabling these populations to participate in the formal financial system. This inclusion can drive economic growth and reduce poverty by allowing more individuals to save securely, access credit, and engage in digital commerce. For instance, research by the International Monetary Fund[11] suggests that CBDCs delivered through mobile applications could ensure broad accessibility in countries with high mobile phone penetration but low banking access. *(Adrian & Mancini-Griffoli, 2019)*

On top of that, CBDCs can improve monetary policy effectiveness. By providing central banks with more precise tools for managing the money supply and implementing monetary policy measures, CBDCs can improve the transmission mechanism, making policy measures more effective. The real-time data provided by CBDC transactions can enhance central banks' ability to monitor economic activity and adjust policies accordingly, leading to more responsive and informed decision-making. CBDCs could also allow for negative interest rates implementation, as they eliminate the zero-lower bound[12] constraint associated with physical cash, which limits the ability of central banks to reduce nominal interest rates below zero. The ZLB has historically constrained monetary policy during economic downturns, but CBDCs could be designed to allow the imposition of negative interest rates on digital holdings, thereby encouraging spending and investment even when traditional tools are ineffective *(Rogoff, 2017)*. This would enhance the central banks' ability to stimulate economic activity during periods of low inflation and weak demand.

---

[10] *Abbr. BIS*
[11] *Abbr. IMF*
[12] *Abbr. ZLB*

However, the introduction of CBDCs also presents several risks and challenges. Ensuring the security and privacy of digital transactions is a significant concern. Cyber threats and data breaches can undermine trust in the financial system, and central banks must invest in robust cybersecurity measures to protect against these risks.

Additionally, the widespread adoption of CBDCs could disrupt existing financial institutions and payment service providers. Traditional banks might face reduced deposits as consumers and businesses shift their funds into CBDCs, potentially impacting their lending capacities and revenue models. This phenomenon, known as financial disintermediation, could lead to a restructuring of the financial services industry *(Keister & Sanches, 2022).* Payment service providers could also see diminished roles, leading to a restructuring of the financial services industry. This calls for the development of strategies to mitigate negative effects, with frameworks for compensating or integrating these entities into the new financial landscape.

Privacy is another significant issue associated with CBDCs. While the digital nature of CBDCs allows for enhanced tracking and regulation of transactions, it also raises concerns about user privacy and the potential for government surveillance. A successful implementation will need to balance the need for regulatory oversight with the protection of individual privacy.

Regulatory challenges also need to be addressed. Developing legal frameworks to govern the issuance, distribution, and use of CBDCs is essential, with the goal of balancing the need for innovation with the protection of financial stability and consumer rights. Regulatory oversight must make sure that CBDCs are not used for illicit activities, such as money laundering and terrorism financing[13], while maintaining user privacy *(BIS, 2021)*. This involves international cooperation to establish global standards and regulations for CBDCs, ensuring interoperability and compliance across different jurisdictions.

To sum up, while CBDCs offer significant potential benefits in terms of payment system efficiency, financial inclusion, and monetary policy effectiveness, they also pose substantial risks and challenges. Central banks must carefully consider these factors and work collaboratively with regulatory bodies, financial institutions, and technology providers to design and implement CBDCs that are secure, efficient, and compliant with regulatory standards.

[13] *Money Laundering is the processing of assets from criminal activity to obscure their illegal origins; Terrorism Financing involves the raising and processing of funds to supply terrorists with resources. Both activities often exploit the same vulnerabilities in financial systems that allow for an inappropriate level of anonymity and opacity in the execution of financial transactions. (IMF)*

1.3 THEORETICAL FRAMEWORKS

The implementation of CBDCs is rooted in several theoretical frameworks that provide insights into their potential impacts on monetary policy, economic stability, and technological infrastructure. This section explores these frameworks, from monetary theory to behavioral economics, thus establishing a complete understanding of the role and potential effects of CBDCs in modern financial systems.

1.3.1 Monetary Theory and CBDCs

The introduction of CBDCs can be analyzed through the lens of traditional and modern monetary theories, which provide a foundation for comprehending their role in the economy. At its core, monetary theory examines the functions of money—serving as a unit of account, means of payment, medium of exchange, and store of value.
Historically, central banks have fulfilled these functions through the issuance of physical currency and regulation of the money supply. The rise of CBDCs represent a significant extension of these roles into the digital domain, potentially transforming how central banks manage monetary policy and financial stability.

One key theoretical underpinning of CBDCs is the Quantity Theory of Money[14], a framework that posits a direct relationship between money supply and price levels. According to the theory, the quantity of money available grows at the same rate as price levels do in the long run.
It is often expressed by the so-called Equation of Exchange:

$$MV = PQ$$

Where:

- M is the money supply;
- V is the velocity of money[15];
- P is the price level, and
- Q is the real output.

One implication of the theory is that the value of money is determined by the amount of money available in the economy; an increase in the money supply, without a corresponding increase in economic output, can lead to a decrease in the value of money, as the rate of inflation increases.

---

[14] *Abbr. QTM*
[15] *Velocity of money is a measurement of the rate at which money is exchanged in an economy.*

Here is a graph representing the Quantity Theory of Money; it shows the relationship between the money supply (M) and the price level (P), assuming constant velocity of money (V) and constant real output (Q).

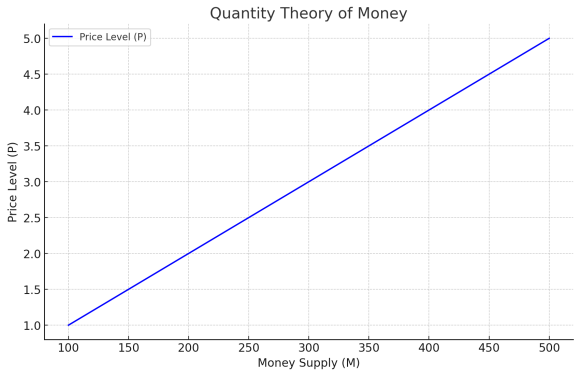

Figure 2

The fundamental relationship established in QTM remains central to understand how CBDCs might influence the money supply; in fact, they could affect the velocity of money by increasing the efficiency of payments and reducing the need for physical currency and commercial bank deposits, thus potentially accelerating transaction speeds. If not carefully managed, this could lead to inflationary pressures, especially if the supply of CBDCs expands without corresponding growth in real output *(Ferrari et al., 2020)*. Central banks will need to carefully calibrate the issuance of CBDCs to ensure that they do not inadvertently fuel inflationary pressures.
The following graph illustrates the potential impact of CBDCs on QTM: the original relationship between money supply M and price level P is shown in blue. The red dashed line represents the altered relationship, assuming that CBDCs increase the velocity of money V. As shown, as velocity increases, the price level grows more rapidly in response to the same increase in money supply, which could potentially lead to higher inflationary pressures.

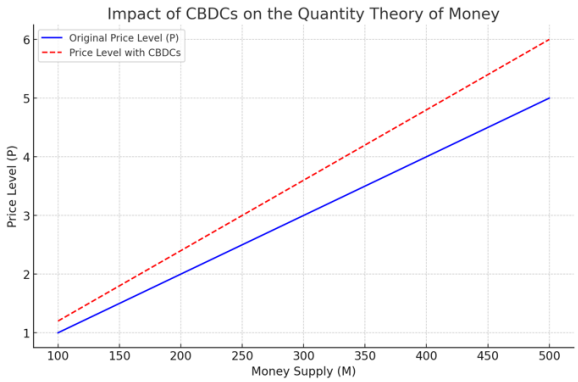

Figure 3

Modern monetary theory[16] also provides a perspective on CBDCs, particularly in terms of government spending and fiscal policy. MMT suggests that governments can create money to finance public spending without necessarily leading to inflation, as long as there is sufficient productive capacity in the economy. The following graph will show the relationship between government spending, economic output, and inflation, and how increased government spending can lead to higher economic output with minimal inflation when there are unused resources. The graph will include a point where the economy reaches full capacity, beyond which further spending would start to cause inflation.

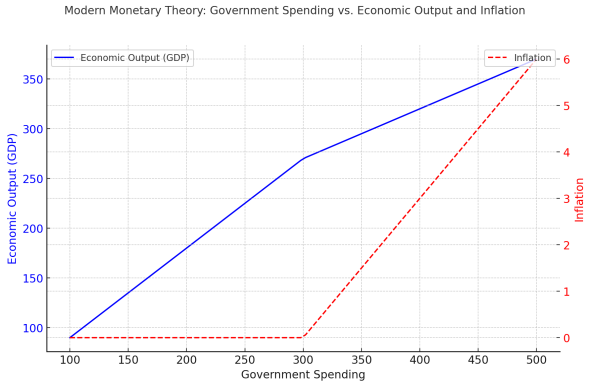

Figure 4

Here, the blue line represents economic output, which increases with government spending. Initially, as spending increases, output rises significantly because there are unused resources in the economy. However, as the economy approaches full capacity, the growth in output starts to slow. The red dashed line represents inflation, which remains low while there are unused resources; but, once full capacity is reached—around 300 units of government spending—, additional spending begins to cause inflation, represented by the sharp increase in the red line.

In this context, CBDCs could serve as a tool for direct monetary intervention, enabling central banks to inject liquidity into the economy in a more efficient way with respect to traditional methods. This could be particularly useful during economic crises, especially when traditional monetary policy tools, such as interest rate adjustments, have lost their effectiveness due to constraints such as ZLB.
However, as shown in the next figure, the introduction of CBDCs may accelerate inflationary pressures at an earlier stage, particularly in economies operating near full capacity, where increased government spending facilitated by CBDCs may quickly outstrip available resources *(Andolfatto, 2018)*.

[16] *Abbr. MMT*

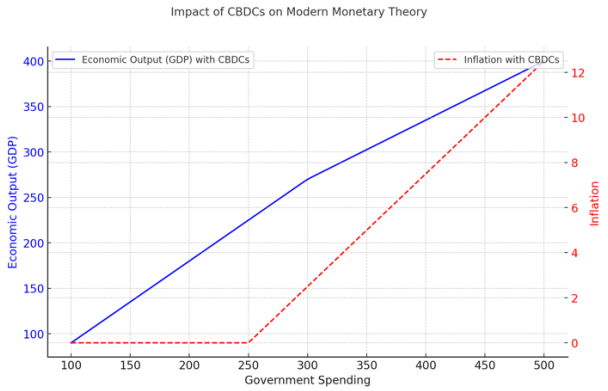

Figure 5

Here is the graph illustrating the effect of CBDCs on MMT; the blue line shows the economic output with the introduction of CBDCs. The output increases as government spending increases, but the curve becomes steeper at full capacity due to the potential increase in money velocity caused by CBDCs.
The red dashed line represents inflation with CBDCs. Inflation begins earlier, starting around 250 units of spending, and rises more sharply, reflecting the accelerated impact of government spending on prices when CBDCs are in play.

The introduction of CBDCs also raises questions about the central banks' role in the financial system, introducing new dimensions to monetary policy transmission mechanisms. Traditionally, central banks have influenced the money supply indirectly through tools such as open market operations and setting reserve requirements[17]. However, by providing central banks with real-time data on economic transactions, CBDCs enable more precise money supply management and better-targeted monetary interventions *(Bindseil, 2020)*. This real-time oversight of money flows could improve the central bank's ability to manage money supply and react to economic changes quickly. However, the direct issuance of digital currency could also diminish the role of commercial banks in the financial system, leading to disintermediation—where banks lose their traditional role of intermediaries between savers and borrowers. To address this phenomenon, central banks may need to establish mechanisms to ensure that banks continue to play a vital role in credit intermediation, such as setting limits on CBDC holdings or providing incentives for commercial banks to maintain sufficient liquidity. *(Niepelt, 2020)*

[17] *Open Market Operations are central banks' actions of buying or selling government securities to control the money supply and interest rates. Reserve Requirements are regulations that determine the minimum amount of reserves that banks must hold against their deposits, influencing their capacity to lend. (Federal Reserve)*

1.3.2 Technological Considerations

This section addresses the key technological frameworks that influence the design, security, and operational efficiency of CBDCs. The adoption of blockchain technology, cybersecurity measures, and digital infrastructure is crucial in ensuring the functionality and resilience of CBDCs in modern financial systems.

At the heart of many CBDC proposals is blockchain technology, a Distributed Ledger Technology that allows for secure and transparent transactions, with no need for a central authority. Blockchain ensures immutability—meaning once a transaction is recorded, it cannot be altered or deleted—and transparency, as all participants in the network can access the ledger.
A critical challenge in decentralized systems like blockchain is achieving consensus among all participants, especially when there is a possibility of faulty or malicious behavior. One of the primary theoretical problems in this context is the Byzantine Generals' Problem, introduced by Lamport, Shostak, and Pease in 1982. The problem describes a situation in which a group of generals, each commanding a portion of an army, must agree on a coordinated plan of action. However, the generals are separated and can only communicate through messengers. Some of the generals may be traitors, sending false or contradictory messages to confuse the others. The problem lies in reaching a consensus where all loyal generals agree on the same plan, even if some others are trying to disrupt the process. This challenge is central to blockchain consensus algorithms, highlighting the difficulty of achieving consensus across a distributed network, where some participants might behave maliciously or fail to communicate properly. By solving this problem, blockchain enables the secure and reliable operation of CBDCs without the need for a central authority.
However, the scalability and energy efficiency of blockchain remain significant challenges, particularly as the volume of transactions increases. As previously discussed, early blockchain implementations demonstrated limitations in terms of transaction throughput. Bitcoin, for instance, can only process about seven transactions per second, which is far below the thousands of transactions processed by traditional payment systems such as Visa *(Garratt et al., 2020)*. The low scalability of blockchain-based systems, primarily those using Proof of Work[18], has been a key obstacle to large-scale adoption for systems like CBDCs.
PoW, originally used by Bitcoin, is the consensus mechanism in which network participants, called miners, compete to solve cryptographic puzzles that require significant computational knowledge. The first miner to solve the puzzle validates the next block of transactions and is rewarded with newly created cryptocurrency. While PoW is secure and decentralized, it is also extremely energy-intensive and has been criticized for its inefficiency. The high energy consumption results from the constant computational effort required to solve increasingly difficult puzzles as more miners join the network *(Narayanan et al., 2016).*
Given its environmental impact, PoW is not considered an ideal mechanism for CBDCs, especially as central banks look for more energy-efficient and scalable solutions. In response to PoW criticisms, newer energy-efficient consensus mechanisms like Proof of Stake[19] have been developed. In PoS, instead of relying on computational work, validators confirm transactions based on the number of tokens they hold, making the mechanism less resource-intensive compared to PoW. PoS enhances scalability by significantly reducing the energy required to maintain the

[18] *Abbr. PoW*
[19] *Abbr. PoS*

network. It also encourages long-term participation and commitment from validators since their stakes are at risk if they act dishonestly *(Saleh, 2021)*.
Newer blockchain systems, like Ethereum, have gradually transitioned to PoS due to its scalability and environmental benefits, making it a more attractive option for CBDCs. By leveraging PoS or similar consensus mechanisms, central banks can ensure that CBDCs operate on secure and sustainable networks while accommodating a high transaction volume.

Cybersecurity is another critical concern in the development of CBDCs. The digital nature of CBDCs makes them vulnerable to cyberattacks, including hacking, data breaches, and fraud. Theoretical frameworks in cybersecurity, such as the CIA Triad[20] provide a foundation to design secure CBDC systems. Ensuring the confidentiality of transactions, the integrity of the digital ledger, and the availability of the system under all conditions are paramount to maintain trust in the new currency. In addition to traditional cybersecurity measures, central banks must also address the growing threat posed by advancements in quantum computing. Quantum computers have the potential to break current cryptographic systems, which could jeopardize the security of blockchain networks. In anticipation of this, there is growing interest in quantum-resistant cryptography, which aims to develop encryption algorithms that can withstand quantum attacks *(Bernstein et al., 2017)*. The development and adoption of such cryptographic techniques will be crucial with regard to CBDCs long-term security.
The success of CBDCs also hinges on the robustness and inclusiveness of the digital infrastructure that supports them. Theories of network externalities, which refer to the phenomenon where the value of a product increases as more people use it, and Metcalfe's Law, which further illustrates this concept stating that the value of a network increases exponentially with the number of users, suggest that the widespread adoption of CBDCs will depend on the robustness and accessibility of the underlying digital infrastructure. For CBDCs to be widely adopted, countries must ensure that adequate digital infrastructure is in place, including reliable internet access, secure digital wallets, and integration with existing payment systems *(Ferrari et al., 2020)*.

[20] *The CIA Triad refers to Confidentiality, Integrity and Availability, describing a model designed to guide policies for information security within an organization. Confidentiality is a set of high-level rules that limits access to all types of data and information, Integrity is the assurance that the information is trustworthy and accurate, and Availability is a form of risk management to guarantee reliable access to that information by authorized people.*

1.3.3 Behavioral Economics

Behavioral economics offers valuable insights into how individuals and businesses might react to the introduction and use of CBDCs. Unlike traditional economic models that assume rational behavior, behavioral economics considers the psychological, social, and cognitive factors that influence decision-making. Understanding these factors is crucial to predict the adoption and usage patterns of CBDCs.

One of the key concepts in behavioral economics is trust, which plays a central role in the acceptance of new financial technologies. The successful adoption of CBDCs will depend largely on the public's trust in the issuing Central Bank and the perceived security and stability of the digital currency. Studies show that trust in financial institutions is directly correlated with the adoption of digital financial services *(Boel, 2021)*. In particular, cognitive biases, such as the status quo bias[21], may cause individuals to prefer existing financial instruments over a new and unfamiliar instrument, even if the latter offers clear benefits. Overcoming these biases may require targeted public awareness campaigns and gradual implementation strategies that build confidence in CBDCs over time.

The concept of loss aversion, which suggests that people tend to prefer avoiding losses rather than acquiring equivalent gains, is also relevant. This bias may manifest in hesitation toward CBDCs if individuals perceive potential risks. Research on digital payment systems suggests that these concerns can slow down adoption unless addressed through clear communication and robust security frameworks *(Schwartz et al., 2021)*. In fact, studies show that perceived security is a significant barrier to the adoption of digital financial systems, underscoring the importance of transparency and user protection in the design of CBDCs *(BIS, 2020)*. If individuals perceive that using CBDCs could expose them to higher risks—such as potential cyberattacks or privacy breaches—they may be hesitant to adopt the new currency, even if it offers convenience and lower transaction costs. Addressing these concerns through robust security measures and clear communication about the protections in place could help mitigate the impact of loss aversion on CBDC adoption.

Another significant aspect is herding behavior, where individuals follow the actions of a larger group instead of relying on their own analysis. In the context of CBDCs, if early adopters—particularly influential groups or institutions—begin using the digital currency, others may follow them, leading to a faster adoption rate. Conversely, if key stakeholders resist adopting CBDCs, this could slow down the uptake among the broader population. Empirical studies on financial innovations suggest that social dynamics play a crucial role in whether new technologies gain traction *(Chen et al., 2010)*.

Mental accounting is a critical behavioral concept that could influence how people manage their finances with the introduction of CBDCs. It describes how individuals organize, evaluate, and track their financial activities by categorizing money into different "accounts" in their minds; this mental process influences how people spend, save, and perceive their financial resources. Individuals may mentally categorize money held in CBDCs differently from traditional bank deposits or cash, affecting their spending and saving behaviors. Central banks should be aware that people may use CBDCs differently than they use cash or existing digital currencies due to this mental categorization.

---

[21] *Status quo bias is evident when people prefer things to stay the same by doing nothing or by sticking with a decision made previously. (Behavioral Economics)*

Behavioral economics also emphasizes the importance of user experience in determining the success of new financial technologies. Factors such as ease of use, accessibility, and seamless integration with existing payment systems can heavily influence adoption rates. Studies indicate that the usability and design of a digital currency can significantly impact user satisfaction and, consequently, widespread use *(ECB, 2020)*. Poorly designed systems that introduce frictions into transactions are likely to experience lower adoption, while systems that prioritize user-friendly interfaces are more likely to succeed.

Incorporating behavioral economics into the CBDCs analysis offers a nuanced understanding of how human behavior, psychological factors, and social influences may affect adoption. By acknowledging and addressing these factors, central banks can design and implement CBDCs in ways that maximize their potential benefits while minimizing resistance and unintended consequences. The successful rollout of CBDCs will depend not only on technical infrastructure but also on addressing the human factors that influence financial decision-making.

1.4 GAPS IN THE LITERATURE

The study of CBDCs is an emerging field, with a rapidly growing body of literature that explores various aspects of their design, implementation, and impact. However, despite the significant progress in research, there remain several areas where current studies are either lacking or insufficient. Identifying these gaps is crucial to advance the understanding of CBDCs and ensure that future research addresses the most pressing questions.

1.4.1 Identified Research Gaps

One of the most prominent gaps in the current literature on CBDCs is the lack of comprehensive empirical data on their long-term economic impacts. While several studies have modeled the potential effects of CBDCs on monetary policy, financial stability, and transaction costs, much of this work is theoretical or based on pilot programs that have not yet reached full implementation. As a result, there is a need for more extensive empirical research that examines the real-world impacts of CBDCs over an extended period, particularly in different economic contexts. This includes understanding how CBDCs affect consumer behavior, savings rates, and the broader financial ecosystem in both advanced and emerging economies.

Another important gap in the literature is the limited exploration of the social and behavioral aspects of CBDC adoption. While technological and economic analyses dominate the current research landscape, there is relative shortage of studies examining how social factors, such as trust in government institutions, digital literacy, and cultural attitudes toward money, influence public acceptance and CBDCs usage. Understanding these social dynamics is critical for designing CBDCs that are not only technically sound but also widely accepted and used by the population.

The regulatory and legal challenges associated with CBDCs represent another area where further research is needed. Although there has been considerable discussion about the potential regulatory frameworks for CBDCs, particularly in terms of data privacy, cybersecurity, and financial stability, there is still a lack of consensus on how best to address these challenges. Moreover, the legal implications of CBDCs, particularly in relation to cross-border transactions and international law, are not yet fully understood. More research is needed to develop robust legal frameworks that can support the safe and effective deployment of CBDCs in a global context.

Finally, a partial gap in understanding the potential unintended consequences of CBDC implementation can be observed. While much of the existing research highlights the benefits of CBDCs, less attention has been paid to the possible negative outcomes. These could include the disintermediation of the banking sector, increased systemic risk due to cybersecurity threats, and the erosion of financial privacy. Addressing these potential risks requires a more lucid and rational approach to CBDC research, one that considers both the benefits and the drawbacks of digital currency adoption.

1.4.2 Contribution to Existing Literature

The thesis aims to contribute to the existing literature on CBDCs by providing a unique and comprehensive analysis that integrates various perspectives, data sources, and case studies to assess the impact of CBDCs across different economic, social, and regulatory contexts. Rather than introducing new primary data, the research draws upon existing studies and interviews, which often focus on specific aspects of CBDCs, synthesizes empirical data from multiple countries, and integrates them to provide a more complete and multifaceted analysis.

A key feature of the thesis is its comparative approach. By incorporating case studies from diverse economic environments, including both advanced economies and developing countries, the research allows for a broad, cross-national analysis of CBDC implementation. This enables to highlight how the economic effects of CBDCs vary depending on the specific economic structure, institutional framework, and socio-political context of each country.
Another significant focus of the research is the exploration of social and behavioral factors that influence public acceptance of CBDCs. The paper will investigate how trust in government institutions, levels of digital literacy, and cultural attitudes toward money affect the willingness of populations to adopt and use CBDCs. By examining these factors, the research will identify strategies that could increase public engagement with CBDCs.
Further, regulatory and legal frameworks surrounding CBDCs are evaluated in a global context, with particular attention paid to how different nations address issues like data privacy, cybersecurity, and cross-border transaction complexities. By analyzing both existing and proposed frameworks, the research will explore how these frameworks can be developed or refined to support the safe and effective CBDC implementation. This will involve considering the unique challenges posed by CBDCs and proposing solutions that can be integrated into the global financial system while addressing the specific needs of different countries.

Finally, a critical approach will persist throughout the paper, assessing the potential unintended consequences of CBDC implementation. This includes exploring the risks associated with the disintermediation of the banking sector, increased systemic risk due to cybersecurity threats, and the erosion of financial privacy. As a result, the thesis contributes to the literature by offering a complete, 360-degree analysis of CBDCs, drawing meaningful comparisons across different contexts to provide a nuanced understanding of their global implications.

CHAPTER 2
METHODOLOGY

2.1 INTRODUCTION TO METHODOLOGY

The *Methodology* chapter of a research study serves as the foundation upon which the entire analysis is built, detailing the systematic approach taken to address the research questions and objectives. In this study, methodology is particularly crucial given the multifaceted nature of the subject, which spans from economic theory and technological innovation to regulatory frameworks and social acceptance. A robust methodology ensures that the research is both rigorous and credible, allowing for the generation of meaningful insights that can contribute to the broader discourse on CBDCs.
The purpose of this chapter is to outline the research design, data collection methods, and analytical techniques to examine these sources comprehensively.

The chapter begins by detailing the research design in *Section 2.2*, explaining the rationale behind an evidence-based, mixed-methods approach and how it aligns with the study's goals.
Following this, *Section 2.3* describes the data collection process, detailing the types of secondary data used, the selection criteria for studies, and the used sources. The analytical techniques, applied to synthesize and interpret this data, are discussed, ensuring that the analysis remains relevant to the research questions.
Additionally, *Section 2.4* covers the ethical considerations, ensuring that all data collection and analysis processes adhere to the highest standards of integrity and confidentiality. Any limitations stemming from the reliance on existing data sources are also acknowledged, providing transparency about the potential challenges and constraints encountered.

In essence, the *Methodology* Chapter lays the groundwork for the subsequent analysis, ensuring that the research is conducted in a systematic, ethical, and transparent manner. By clearly outlining the research design, data collection, and analysis methods, this chapter provides a roadmap for understanding how the study's findings were derived and how they contribute to the ongoing exploration of CBDCs.

2.2 RESEARCH DESIGN

The research design is a critical component of any study, as it provides the blueprint for how the research will be conducted, guiding the collection and analysis of data. This section outlines the research design employed in this study, justifying the chosen approach and explaining how it aligns with the overall research goals.

Given the complexity and interdisciplinary nature of CBDCs, this study adopts a mixed-methods research design, integrating both quantitative and qualitative approaches. The mixed-methods design is particularly well-suited for this research because it allows for a comprehensive exploration of the topic from multiple perspectives. While quantitative methods provide the means to analyze numerical data and identify patterns or correlations, qualitative methods offer deeper insights into the perceptions, experiences, and motivations of various stakeholders involved in or affected by CBDCs.

The quantitative component of the research focuses on analyzing existing data related to CBDCs, such as economic indicators, transaction volumes, and adoption rates in countries where CBDCs have been implemented or piloted. This analysis is crucial to understand the broader economic impacts of CBDCs, including their effects on monetary policy, financial stability, and transaction costs. Data for this component is sourced from central banks' reports, academic studies, and financial databases. The quantitative analysis will employ statistical techniques such as regression analysis and time-series analysis to identify trends and relationships within the data.

The qualitative component of the research involves gathering insights through existing interviews and surveys with key stakeholders, including central banks' officials, financial institution representatives, and consumers. This approach is essential to capture the perspectives and experiences that cannot be fully understood through quantitative data alone. The qualitative data will be analyzed using thematic analysis, allowing the research to identify common themes, concerns, and expectations regarding the implementation and impact of CBDCs.

The choice of a mixed-methods design is justified by the need to address both the macro-level economic impacts of CBDCs and the micro-level behavioral and institutional factors that influence their adoption and success. By combining them, this research can provide a more holistic understanding of CBDCs, offering insights that are both empirically grounded and contextually rich.

2.3 DATA COLLECTION

Data collection is a pivotal aspect of the research process, as it forms the foundation upon which the analysis and conclusions of the study are built. Here, the data collection process is carefully designed to ensure that the data gathered is relevant, reliable, and comprehensive, enabling a thorough exploration of the research questions. This section outlines the methods and sources of data collection, and discusses the strategies employed to ensure the accuracy and integrity of the data.

2.3.1 Methods and Sources

The data collection process for this research draws on a combination of existing surveys, reports, academic literature, and industry publications, tailored specifically to address the research questions of the study.

Surveys conducted by central banks, research institutions, and international organizations are utilized to capture public perceptions and behaviors related to CBDCs. These surveys provide valuable insights into the level of public trust, concerns about privacy and security, and the factors influencing the adoption of CBDCs. The data from these surveys is essential to understand how different demographic groups perceive digital currencies and what might drive or hinder their widespread use.
The research also incorporates insights from interviews and expert opinions that have been published in various reports and industry analyses. These interviews often involve key stakeholders such as central banks' officials, financial regulators, and digital currency experts. By analyzing these interviews, the research gains in-depth perspectives on the motivations, challenges, and expectations associated with the development and implementation of CBDCs.
Case studies are analyzed, focusing on specific countries that have advanced in the development or implementation of CBDCs, such as China, Sweden, and The Bahamas. These case studies involve collecting detailed information about the processes, challenges, and outcomes associated with CBDC initiatives in these countries. Data for the case studies is obtained through a combination of surveys together with document and reports analysis.
The data collected through these methods is crucial to understand the real-world dynamics of CBDC adoption and implementation. It provides context to the analysis and helps identifying factors that influence the success or failure of CBDC projects.

On top of that, a wide set of financial publications is inspected, encompassing a wide range of information from published reports, academic literature, industry publications, and financial databases.
Reports from central banks and industry publications are critical to understand the technical and regulatory frameworks surrounding CBDCs. These documents provide detailed information on the progress and outcomes of CBDC projects in different regions, including pilot programs,

technological implementations, and the regulatory landscape. This data is crucial to analyze the practical aspects of CBDC deployment and identifying best practices.
A substantial portion of the research is grounded in academic literature, which offers both theoretical and empirical analyses of CBDCs. Peer-reviewed journal articles provide a scholarly foundation to capture the economic, social, and technological implications of digital currencies.
Finally, industry publications and financial databases provide additional data on market trends, technological developments, and regulatory changes related to CBDCs. These sources are particularly useful to understand the broader context in which CBDCs are being developed and implemented.

The combination of these various methods and sources allows for a comprehensive and multidimensional analysis of CBDCs. By leveraging existing data from diverse and reputable sources, the research is well-equipped to explore the complexities of CBDC adoption, implementation, and impact.

2.3.2 Data Selection and Analysis

In this section, the approach to data selection and the analytical techniques employed are discussed, emphasizing the rigorous processes undertaken to ensure that the research is both comprehensive and methodologically sound.

The selection of data sources is guided by a stringent set of criteria designed to ensure that the information used is relevant, reliable, and comprehensive. The research prioritizes data from authoritative sources that are widely recognized for their credibility in the field of economics, finance, and digital technology.
One of the primary criteria for data selection is relevance. The study focuses on data that directly relate to the key research questions, including the adoption, implementation, and impact of CBDCs. For instance, data on transaction volumes, public perception surveys, and regulatory frameworks are considered highly relevant because they provide insights into how CBDCs are being integrated into different economies and how they are perceived by various stakeholders. In contrast, data that is tangential or not directly linked to the core objectives of the research is excluded to maintain focus and coherence.
Reliability is another crucial criterion. The research relies on data from sources that have a proven track record of accuracy and reliability. Central banks, such as the European Central Bank[22] and the People's Bank of China[23], are key providers of reliable data on CBDC initiatives because of their central role in developing and implementing these digital currencies. Similarly, academic journals that undergo a rigorous peer-review process, such as those published by the Journal of Financial Economics or the International Journal of Central Banking, are prioritized because they ensure that the research findings are scrutinized and validated by experts in the field.
Comprehensiveness of the data is also considered. The research aims to provide a holistic view of CBDCs by incorporating data that covers various aspects of the currencies. This includes economic data, such as the effects of CBDCs on monetary policy and financial stability, as well as social data, such as public trust and acceptance. By using a wide range of data sources, the research ensures that all relevant dimensions of CBDCs are explored, allowing for a well-rounded analysis.

Once the data has been selected, the next step involves applying appropriate analytical techniques to extract meaningful insights.
The research employs a combination of quantitative and qualitative analysis methods to address the research questions effectively. For quantitative analysis, statistical methods are used to analyze numerical data from surveys, reports, and financial databases. Techniques such as regression analysis, time-series analysis, and comparative analysis are employed to identify trends, correlations, and causal relationships within the data. For instance, regression analysis may be used to examine the relationship between the adoption of CBDCs and various economic indicators, such as inflation rates or financial inclusion metrics. Time-series analysis is particularly useful to assess the impact of CBDCs over time, allowing to track changes in key variables before and after the introduction of a CBDC in a particular country.
Comparative analysis plays a significant role in the research, especially when evaluating the experiences of different countries with CBDCs. By comparing data from multiple jurisdictions, such as China, Sweden, and The Bahamas, it is possible to identify similarities and differences in

[22] *Abbr. ECB*
[23] *Abbr. PBOC*

their approaches to CBDC implementation. This comparative approach helps to draw broader conclusions about the factors that contribute to the success or challenges of CBDCs across different economic and regulatory environments.

In addition to quantitative methods, the research employs qualitative analysis to interpret non-numerical data from interviews, reports, and academic literature. Thematic analysis is used to identify and explore recurring themes and patterns in the qualitative data, such as concerns about privacy, the role of CBDCs in enhancing financial inclusion, or the regulatory challenges faced by central banks. This technique allows the research to delve into the underlying issues and motivations that drive stakeholder perspectives on CBDCs, providing a richer understanding of the qualitative dimensions of the topic.

Content analysis is another used qualitative technique. This method involves systematically examining documents, reports, and publications to identify key concepts, trends, and narratives related to CBDCs. This is particularly useful for analyzing the language and discourse surrounding CBDCs, helping to reveal how different stakeholders frame the benefits and risks of digital currencies.

The final stage of the data analysis process involves the synthesis of quantitative and qualitative findings to draw exhautive conclusions, achieved through an integrative approach that combines the numerical insights gained from statistical analysis with the contextual understanding provided by qualitative analysis.

For instance, quantitative data may show a correlation between the introduction of a CBDC and increased financial inclusion in a particular country. However, qualitative data from interviews and reports may reveal the specific mechanisms through which this effect is achieved, such as targeted government policies or public education campaigns. By combining these insights, the research can offer more nuanced and actionable recommendations for policymakers and financial institutions.

2.4 ETHICAL CONSIDERATIONS AND LIMITATIONS

Ethical considerations are integral to the research process, particularly when dealing with data that involves sensitive financial information, stakeholder opinions, and public perceptions. Although this study relies on existing data rather than collecting new data directly, it still adheres to strict ethical guidelines to ensure the integrity of the research.

One of the key ethical considerations is the responsible use of data. All data sources have been collected and published in compliance with ethical standards. For instance, surveys and interviews used in the research have been conducted with informed consent from participants, and the data must be anonymized to protect individuals' privacy. This is particularly important when analyzing public opinion surveys, where respondents' personal views on CBDCs may be sensitive.
In addition, the research adheres to principles of academic integrity by ensuring that all data is properly cited and that the original authors and institutions are credited for their work. This not only respects the intellectual property rights of the data providers but also enhances the credibility of the research.
The study also considers the potential biases and limitations inherent in the data. Since the research relies on pre-existing data, there is a risk that the original data collection methods or the perspectives of the original researchers may introduce biases. To mitigate this risk, the research employs a triangulation approach, cross-referencing data from multiple sources to validate findings and ensure that the conclusions drawn are robust and reliable.

Despite these precautions, there are inherent limitations in relying solely on existing data. One significant limitation is the potential outdatedness of some data, particularly in a fast-evolving field like CBDCs, where new developments occur rapidly. To address this, the research prioritizes the use of the most recent data available and acknowledges any temporal limitations in the analysis.
Another limitation is the scope and generalizability of the findings. Since the study is based on data from specific countries and contexts, the findings may not be universally applicable to all regions or economic environments. The research addresses this limitation by carefully selecting case studies that represent a diverse range of CBDC experiences and by clearly delineating the scope of the conclusions.

In conclusion, while the reliance on existing data presents certain challenges, these are carefully managed through rigorous data selection, ethical adherence, and critical analysis. By addressing these ethical considerations and limitations, the research ensures that the findings are both credible and valuable for the ongoing discourse on the implementation and impact of CBDCs.

CHAPTER 3
EVIDENCE-BASED ANALYSIS

3.1 OVERVIEW OF DATA AND SOURCES

Having established the methodological framework of this research, including the design, data collection methods, and analytical techniques, the study now transitions to the *Evidence-based Analysis* phase, where the application of the previously discussed methods to actual data aims to test hypotheses, explore relationships, and derive insights that contribute to a broader understanding of the subject. This transition marks a critical point in the research process, where theoretical considerations and methodological planning give way to the practical analysis of real-world data.
The purpose of this section is to provide an overview of the key datasets and information that will be analyzed, focusing on how these data contribute to understand the adoption, economic impacts, public perceptions, and regulatory challenges associated with CBDCs.

A central aspect of the analysis involves examining adoption rates and demographic trends related to CBDCs. This includes data on how quickly and widely these digital currencies are being adopted across different demographic groups, with particular attention to differences based on factors such as age, income level, and geographic location. Insights from national reports and surveys provide critical information on user adoption and engagement with CBDCs, offering a precise understanding of who is using these currencies and why.
In addition to adoption metrics, the analysis considers a range of economic indicators, such as changes in transaction costs, inflation rates, and financial inclusion metrics, following the implementation of CBDCs. These economic data points are essential for the evaluation of the broader macroeconomic CBDCs effects, helping to clarify their impact on both national and global economies. By analyzing these indicators, the research seeks to understand how CBDCs influence economic stability and monetary policy effectiveness.
Public perceptions and levels of trust in CBDCs are also examined, drawing on survey data that assess attitudes towards these digital currencies. The analysis also includes a detailed examination of the regulatory approaches and legal frameworks developed by different countries to govern the use of CBDCs. This involves comparing how various jurisdictions have addressed challenges related to data privacy, cybersecurity, and financial stability. The effectiveness of these regulatory frameworks is analyzed to identify best practices and common challenges that could inform future CBDC developments.

The *Evidence-based Analysis* Chapter will systematically analyze these data points, applying the quantitative and qualitative techniques outlined in the *Methodology* Chapter. The analysis will provide a comprehensive examination of the empirical evidence surrounding CBDCs, offering valuable insights into their impacts, challenges, and opportunities in the evolving landscape of digital currencies.

3.2 DESCRIPTIVE ANALYSIS

The descriptive analysis aims to provide a detailed overview of the current state of CBDCs across various countries, focusing on global trends, adoption rates, and the progress of key case studies. This analysis serves as a foundation to acknowledge the broader context in which CBDCs are being developed and implemented, setting the stage for more in-depth exploration of their economic impacts, public perceptions, and regulatory challenges.

3.2.1 Global Trends in CBDC Development

Over the past decade, the exploration and development of CBDCs have accelerated at an unprecedented rate, with over 130 countries actively engaged in some form of CBDC research, development, or pilot testing by 2024. According to a 2023 report by the Bank for International Settlements, approximately 93% of central banks are either in the research phase, conducting pilots, or moving towards full-scale CBDC implementation. This surge in activity reflects the growing recognition of CBDCs as a transformative tool in the global financial system, driven by the need to modernize payment infrastructures, enhance financial inclusion, and maintain monetary sovereignty in an increasingly digital economy.

One of the most significant global trends is the move towards full-scale CBDC implementation in countries with advanced digital payment infrastructures. For instance, China has been a global leader with its digital yuan, which has been in pilot stages since 2020. The People's Bank of China reported that by the end of 2022, over 261 million digital yuan wallets had been opened, facilitating transactions totaling over 100 billion yuan[24]. By mid-2023, the digital yuan was being tested in over 23 major cities *(PBOC, 2023)*. These figures underscore China's strategic push to integrate the digital yuan into everyday transactions, not only for domestic use but potentially for cross-border trade as well.

Sweden, another forerunner in the digital payments space, has advanced its e-krona project, reflecting the country's move towards a cashless society. With cash usage in Sweden dropping to less than 10% of all transactions by 2023, the Riksbank has focused on ensuring that the e-krona can provide a safe and accessible alternative to cash. The ongoing pilot projects are testing the integration of the e-krona with existing payment systems and evaluating its impact on financial stability and monetary policy. Sweden's approach highlights the trend among advanced economies to use CBDCs as a means of modernizing payment systems and reducing the reliance on physical cash. *(Riksbank, 2023)*

[24] *Approximately $14.5 billion*

In emerging markets, the motivations for developing CBDCs often center around improving financial inclusion. For example, The Bahamas' Sand Dollar, launched in October 2020, was designed to address the unique challenges of a nation with dispersed population. By 2023, the Sand Dollar had become widely used across the Bahamas, particularly in remote areas where traditional banking infrastructure is limited. The Central Bank of The Bahamas reported a significant increase in digital transactions, particularly in the Family Islands, where the Sand Dollar has enabled residents to access financial services that were previously unavailable. The Sand Dollar success highlights the potential of CBDCs to bridge financial inclusion gaps in regions with challenging geographies and underdeveloped financial infrastructures *(Central Bank of The Bahamas, 2023).* Additionally, a common theme across various countries is the strategic use of CBDCs to enhance monetary sovereignty. In a global financial landscape increasingly influenced by private digital currencies and cross-border digital transactions, central banks are exploring CBDCs as means to retain control over their national monetary systems and mitigate risks posed by the proliferation of private digital currencies and stablecoins. For instance, the ECB has positioned the digital euro as a potential tool to ensure that European citizens have access to a central bank-backed digital currency that complements existing payment solutions. The ECB's focus on privacy and security in the design of the digital euro reflects the broader trend among central banks to ensure that CBDCs can co-exist with private digital currencies while maintaining public trust and financial stability. *(ECB, 2023)*

These global trends indicate that while the motivations and approaches to CBDC development vary across countries, there is a shared recognition of the need to adapt to the rapidly changing digital landscape. Whether driven by the need to modernize payment systems, promote financial inclusion, or safeguard monetary sovereignty, the push towards CBDCs is reshaping global finance, with significant implications for the future of money and payments.

3.2.2 Adoption Rates and Demographic Trends

CBDCs adoption varies significantly across different regions and demographic groups, influenced by a complex set of factors including digital literacy, trust in government institutions, availability of existing digital payment options, and broader socio-economic conditions. This section delves into these factors, using quantitative data and analytical insights to understand global adoption trends and the demographic patterns that characterize the uptake of CBDCs.

The adoption of CBDCs has been notably uneven across the globe, reflecting the different economic, technological, and social environments in which these digital currencies are being introduced. In China, for instance, the digital yuan has seen relatively high adoption rates. This widespread adoption can be attributed to several factors, including China's high smartphone penetration rate, which stood at approximately 78% in 2023, and the government's strategic push to integrate the digital yuan into existing digital ecosystems. *(China Academy of Information and Communications Technology, 2023)*
In contrast, the adoption of CBDCs in Europe and North America has been more measured and cautious. In 2022, ECB-conducted surveys revealed that while there is interest in the digital euro, significant concerns persist among the public regarding privacy, security, and the potential for government surveillance. Approximately 54% of respondents in the Eurozone expressed concerns about privacy, while 39% were worried about cybersecurity risks. These concerns are particularly pronounced among older demographics, with individuals over 50 years old being less likely to express enthusiasm for digital currencies compared to younger age groups. In North America, similar trends are observed, with a 2023 Federal Reserve survey indicating that only 36% of U.S. adults were familiar with CBDCs, and of those, a majority expressed reservations about the potential for government overreach.

Demographic factors play a crucial role in shaping the adoption of CBDCs. Younger populations, particularly those aged 18-35, are generally more receptive to digital currencies. They are more likely to engage with digital platforms for a wide range of activities, such as banking, shopping, and entertainment. A 2023 survey by Deloitte found that 67% of Millennials and Gen Z in developed markets expressed interest in using CBDCs, compared to only 29% of Baby Boomers[25]. The younger demographic's familiarity with technology and digital payments, combined with their openness to innovation, makes them a key target for CBDC adoption.
Conversely, older populations tend to be more resistant to adopting CBDCs, preferring traditional forms of money such as cash and bank deposits. This reluctance is often driven by a lack of digital literacy and a stronger attachment to conventional financial practices. For example, in Sweden, where the Riksbank has been piloting the e-krona, surveys indicate that individuals over 60 are significantly less likely to use digital payments and express concerns about the potential loss of privacy and security with the adoption of a CBDC *(Riksbank, 2023)*. This demographic trend underscores the importance of targeted educational campaigns to address the concerns of older populations and encourage broader adoption across all age groups.

---

[25] *Baby Boomer is a title given to people born in the years following the Second World War, precisely between 1946 and 1964. Generation Y, or Millennials, is given by people born roughly between 1981 and 1994, while Generation Z is the youngest generation in today's workforce, including people born between 1995 and 2009.*

In emerging markets, the focus on financial inclusion is a primary driver of CBDC adoption, particularly among underbanked populations. For instance, as of 2023, the Central Bank of The Bahamas reported that the Sand Dollar had been adopted by approximately 95% of the population. The success of the Sand Dollar is largely attributed to its accessibility via mobile applications, which allow individuals without traditional bank accounts to participate in the formal financial system.

The global trends and adoption patterns observed in the deployment of CBDCs have significant implications for the future of these digital currencies. The varied approaches to CBDC development reflect differences not only in economic and technological environments but also in strategic priorities. For instance, the rapid adoption in China and the Caribbean contrasts sharply with the more cautious approaches observed in Europe and North America, underscoring the need for context-specific strategies in the implementation of CBDCs.

As more countries move forward with CBDC initiatives, these early experiences offer valuable lessons in how to design, implement, and manage digital currencies in ways that maximize their benefits while mitigating potential risks.

3.3 CURRENT IMPLEMENTATIONS AND CASE STUDIES

Central banks across the globe have accelerated their exploration and development of CBDCs as a strategic response to evolving financial landscapes. As of 2024, 134 countries and currency unions, representing 98% of global GDP, are exploring a CBDC; in May 2020, that number was only 35. *(BIS, 2024)*
This section reviews the current state of CBDC initiatives globally and provides detailed case studies of several projects. It also presents a comparative analysis of different countries' approaches, highlighting best practices and lessons learned from their experiences.

3.3.1 Global CBDC Initiatives

The exploration of CBDCs has rapidly transitioned from theoretical discussions to practical implementations, with numerous central banks worldwide actively engaging in research, pilot projects, and, in some cases, full-scale rollouts of digital currencies. The motivations behind these initiatives vary by country but generally include the desire to modernize payment systems, enhance financial inclusion, increase the efficiency of cross-border payments, and maintain monetary sovereignty in the face of the growing influence of private digital currencies like Bitcoin and stablecoins.

As CBDCs move closer to reality, the experiences of pioneering countries offer valuable insights into the opportunities and challenges presented by digital currencies.
In this section, a detailed analysis of three prominent CBDC projects will be provided: China's digital yuan, Sweden's e-krona, and the Bahamas' Sand Dollar. These case studies will illustrate different approaches to CBDC development, from the highly centralized model of China, designed to assert control and drive economic policy, to Sweden's exploratory and gradual approach aimed at complementing an increasingly cashless society, and finally to the Bahamas' focus on financial inclusion in a geographically dispersed nation.

By examining these three diverse implementations, it is possible to understand the varying objectives, methodologies, and outcomes associated with CBDCs. This analysis will also highlight the broader implications of CBDCs for the global financial system, providing lessons for other countries that are considering the adoption of digital currencies.

3.3.2 China's Digital Yuan

China's digital yuan, officially known as the Digital Currency Electronic Payment[26] or e-CNY, represents one of the most advanced and ambitious CBDC initiatives globally. The People's Bank of China has spearheaded this development with objectives that include modernizing the financial system, enhancing monetary sovereignty, and maintaining control over the rapidly evolving digital payments landscape. Since its inception, the PBOC has steadily expanded the reach and capabilities of the e-CNY, with significant progress and challenges observed in recent years, particularly in 2023 and 2024.

China's journey toward a digital currency began in 2014 when the PBOC established a research institute to explore the feasibility and implications of issuing a digital yuan. This early initiative was driven by several factors, including the declining use of physical cash, the dominance of private mobile payment platforms such as WeChat Pay and Alipay, and the strategic need to assert the yuan's position in global finance. The Central Bank's concern over the potential loss of monetary control to these private platforms, which handled nearly 90% of all retail payments in China by 2020 *(China Academy of Information and Communications Technology, 2020)*, was a key motivator in developing a state-backed digital currency.
The PBOC's research and development efforts culminated in the launch of pilot programs in 2020, initially in cities like Shenzhen, Suzhou, and Chengdu, and later expanding to Beijing, Shanghai, and other major urban centers. These pilots tested various use cases, including retail payments, government subsidies, and public transportation, to assess the digital yuan's functionality and integration with existing financial systems. By the end of 2023, the digital yuan had been used in over 70 million transactions, with a total transaction volume of approximately 1.8 trillion yuan[27], underscoring its growing role in China's digital economy. *(PBOC, 2023)*
Despite these impressive numbers, the digital yuan still accounts for only about 0.16% of China's total monetary base *(PBOC, 2023)*, indicating that while adoption is advancing, it remains modest relative to the broader economy. This modest share highlights the significant growth potential as the PBOC continues to push for wider acceptance, particularly in rural areas and among the older population, where digital literacy may be lower.

The digital yuan is distinguished by several features that set it apart from both traditional currencies and other digital payment methods. At the core of the e-CNY is its centralized control, with the PBOC overseeing issuance, distribution, and transaction monitoring. This centralized oversight aligns the digital currency with national monetary policy objectives, enabling the PBOC to track transactions in real time and enhance its ability to combat financial crimes, such as tax evasion.
The digital yuan operates on a two-tier system. In the first tier, the PBOC issues the digital currency to commercial banks and other financial institutions. These institutions then distribute the digital yuan to the public in the second tier. This system is designed to leverage the existing banking infrastructure, facilitating a smooth transition from traditional to digital currency while minimizing disruption to the financial system.
Another innovative feature of the digital yuan is its offline payment capability, which allows users to conduct transactions without an internet connection through near-field communication

[26] *Abbr. DCEP*
[27] *Approximately $250 billion*

technology[28] *(PBOC, 2023)*. This feature is particularly valuable in rural areas, enhancing the currency's utility across a variety of scenarios. Furthermore, a key technological advancement associated with the digital yuan is its programmability, which enables the automation of certain financial processes. For instance, the PBOC has experimented with programmable money that can be set to expire or be used only for specific purposes, such as government aid or subsidies. This feature not only enhances the precision of monetary policy implementation but also reduces the risk of funds being misused.

The pilot programs for the digital yuan have been extensive and ambitious. In 2023, the PBOC rolled out the digital yuan across 29 cities, involving millions of users and thousands of businesses. For instance, in Shenzhen, the PBOC distributed millions of digital yuan to residents through lotteries, allowing them to spend the currency at participating merchants. In Suzhou, the local government used the digital yuan to distribute subsidies to workers as part of the pilot program, demonstrating the efficiency and transparency of government disbursements using CBDCs. Additionally, the digital yuan has been integrated into Beijing's public transportation system, enabling users to pay for subway rides using the digital currency. E-commerce has also been a significant focus, with major platforms like JD.com participating in the pilots, highlighting the importance of digital payments in China's economy.

The e-CNY infrastructure continues to evolve, with the PBOC testing the currency's ability to handle significant transaction volumes. During the 2022 Beijing Winter Olympics, the e-CNY system demonstrated a transaction processing capability of 10,000 transactions per second[29], with plans to scale up to 300,000 TPS *(PBOC, 2022)*. However, this is still lower than existing private payment platforms like Alipay, which can process up to 544,000 TPS during peak events. *(Alipay, 2022)*

In 2024, the PBOC shifted part of its focus towards institutional and wholesale uses of the e-CNY, particularly in cross-border transactions. Through initiatives like Project mBridge, the PBOC has been collaborating with central banks in Thailand, the UAE, and Hong Kong to explore the use of the digital yuan in cross-border settlements. Although this project has shown promise in facilitating faster and more efficient international payments, challenges related to capital controls and international acceptance persist, highlighting the complexities of integrating the digital yuan into the global financial system. *(BIS, 2024)*

The centralized nature of the digital yuan has raised concerns regarding privacy and potential government surveillance. All transactions are monitored by the PBOC, which has led to debates about the trade-offs between security and individual privacy. Moreover, the global implications of the digital yuan's expansion are significant, particularly as China seeks to reduce its dependence on the US dollar and promote the yuan as an international currency. However, skepticism from other nations and existing capital controls pose challenges to these ambitions.

China's digital yuan represents a bold step towards modernizing the country's financial infrastructure and asserting its monetary sovereignty in the digital age. Its broader adoption and global influence will depend on overcoming significant challenges related to competition, privacy concerns, and international acceptance; the next few years will be critical in determining whether the e-CNY can achieve its ambitious goals of domestic dominance and international relevance.

---

[28] *Abbr. NFC, Near-field communication is a short-range wireless connectivity technology that lets NFC-enabled devices communicate with each other.*

[29] *Abbr. TPS*

3.3.3 Sweden's e-Krona

Sweden's e-krona project represents one of the most advanced explorations of a CBDC in a developed economy, particularly in a context where cash usage is rapidly declining. The e-krona is designed as a digital complement to physical cash, intended to ensure that central bank money remains accessible to the public even as the nation moves toward a cashless society. As of 2024, the e-krona project has made significant progresses, with ongoing pilots and research aimed at addressing the challenges and opportunities presented by the new digital currency.
Sweden has been leading the global transition towards a cashless society, with cash transactions accounting for less than 9% of all payments in the country by 2023, down from 39% in 2010 *(Riksbank, 2023)*. This dramatic decline has raised concerns about the continued availability of central bank money for the public, prompting the Riksbank, Sweden's Central Bank, to explore the concept of a digital currency. The idea of the e-krona was first proposed in 2017, with the goal of providing a state-backed digital payment option that could be used by the public for everyday transactions.

The Riksbank's exploration of the e-krona has been characterized by a cautious and measured approach. The Central Bank has emphasized the importance of ensuring that the e-krona is designed to complement, rather than replace, existing private payment systems. The Riksbank's approach has involved extensive research, stakeholder consultations, and pilot programs aimed at testing the technical and legal feasibility of the e-krona.
The first phase of the pilot, launched in 2020, focused on developing a technical solution for the e-krona. This phase involved creating a DLT-based platform capable of supporting the issuance, distribution, and management of the digital currency. The use of DLT, specifically a permissioned blockchain, was chosen to ensure a secure, scalable, and resilient infrastructure. By the end of the first phase, the Riksbank had successfully demonstrated the e-krona's potential to operate within Sweden's existing financial system. *(Riksbank, 2021)*
In 2021, the project moved into its second phase, which involved testing the e-krona in a simulated real-world environment. This phase included simulations of everyday transactions, such as payments for goods and services, as well as the integration of the e-krona with existing payment systems, including mobile payment platforms like Swish, which is used by over 80% of the Swedish population *(Riksbank, 2021)*. The pilot also explored the potential for offline payments, ensuring that the e-krona could be used in areas with limited internet connectivity. By 2023, the Riksbank had expanded the pilot to include additional use cases and stakeholders, involving commercial banks and technology companies in the testing process.
As of mid-2023, the e-krona had been tested in over 1.5 million transactions, with a transaction volume exceeding 1 billion SEK[30] *(Riksbank, 2023)*. Although still in the pilot phase, these figures indicate significant public interest and engagement with the digital currency. The Riksbank has also explored the e-krona's potential for cross-border payments within the European Union, collaborating with other central banks to test its interoperability with different digital currency systems. This initiative is particularly important as Sweden continues to play a leading role in the European discussion on digital currencies, potentially paving the way for broader adoption of CBDCs across the region.

[30] *Approximately $95 million*

The pilot's focus on retail environments has been especially informative, with the e-krona being tested in various settings, from small businesses to large retail chains. The feedback from these trials has highlighted both the strengths and challenges of integrating the e-krona into everyday transactions. For instance, while the e-krona's compatibility with existing payment systems was well-received, concerns were raised about the speed of transaction processing compared to private-sector digital payments. The Riksbank has responded by emphasizing the necessity of further technological refinements to ensure that the e-krona can compete effectively with established digital payment platforms.

Public trust in the e-krona is critical to its potential adoption. The Riksbank has placed significant emphasis on ensuring that the e-krona offers a high degree of privacy, while still allowing for regulatory oversight. Surveys conducted in 2023 indicated that approximately 65% of Swedes were open to using the e-krona, with privacy and security being the most important factors influencing their decision *(Riksbank, 2023)*. The Riksbank's transparency in its approach, including regular public consultations and detailed reports on the progress of the e-krona, has been key in maintaining public confidence.

Another important aspect of the e-krona project is its focus on legal and regulatory considerations. The Riksbank has been working closely with the Swedish government to ensure that the e-krona complies with existing financial regulations, while also exploring the need for new legislation to support the use of digital currencies. This includes considerations around consumer protection, data privacy, and the potential impact of the e-krona on financial stability. The Riksbank has also been proactive in engaging with international regulatory bodies, recognizing the need for coordinated efforts to address the cross-border implications of digital currencies.

The e-krona project has been characterized by a strong focus on technological innovation. The Riksbank has partnered with Accenture[31] to develop the technological infrastructure for the e-krona, with a particular emphasis on scalability and security. The use of DLT has been a key aspect of this development, providing a decentralized platform that can support the issuance and management of the e-krona. *(Accenture, 2022)*

Sweden's e-krona project represents a thoughtful and measured approach to the development of a Central Bank Digital Currency. As of 2024, the project has made significant progress, with ongoing pilot programs and research aimed at addressing the challenges and opportunities presented by a digital currency. The e-krona is designed to complement existing payment systems, providing a state-backed digital payment option that can be used by the public for everyday transactions; its progress to date suggests that Sweden is well-positioned to lead the way in the future of digital currencies.

[31] *Accenture plc is an Irish-American company specialized in information technology services and consulting*

3.3.4 The Bahamas' Sand Dollar

The Bahamas' Sand Dollar is a pioneering CBDC that stands as one of the first fully operational digital currencies issued by a central bank. Launched in October 2020 by the Central Bank of The Bahamas, the Sand Dollar was designed to address specific financial inclusion challenges faced by the country, particularly in its geographically dispersed and often underbanked communities. Nowadays, the Sand Dollar continues to evolve, offering valuable insights into the practical implementation and adoption of a national digital currency.

The Bahamas, an archipelago consisting of over 700 islands and cays, faces unique challenges in providing financial services to its population. Many of the smaller islands, known as the Family Islands, have limited access to traditional banking services due to the high costs associated with maintaining physical branches in remote locations. As a result, a significant portion of the population has historically relied heavily on cash transactions. As of 2018, before the introduction of the Sand Dollar, approximately 20% of the Bahamian population was unbanked, with many residents in remote areas lacking access to basic banking services. *(Central Bank of The Bahamas, 2018)*
To address these challenges, the Central Bank of The Bahamas began exploring the concept of a digital currency in 2018, with the goal of creating an efficient and inclusive payment system that could reach all residents, regardless of their location. The Sand Dollar was developed as a digital equivalent of the Bahamian dollar[32], with each Sand Dollar holding the same value as one BSD. The currency is designed to be easily accessible through digital wallets, which can be managed via smartphones or physical payment cards for those without access to mobile devices. As of mid-2023, there were over 50,000 Sand Dollar wallets in circulation, representing approximately 10% of the Bahamian population. *(Central Bank of The Bahamas, 2023)*

One of the key features of the Sand Dollar is its seamless integration with existing financial infrastructure. The Central Bank has partnered with various financial institutions and payment service providers to ensure that the Sand Dollar can be used for everyday transactions. This includes partnerships with commercial banks, credit unions, and non-bank financial institutions, enabling users to transfer funds, pay bills, and make purchases using the Sand Dollar across a range of platforms. By the end of 2023, over 2,000 merchants nationwide accepted the Sand Dollar, including major retailers, utilities, and government agencies.
The Sand Dollar's design prioritizes accessibility and inclusivity. For instance, the Central Bank has made it a requirement that all commercial banks in The Bahamas support Sand Dollar wallets, ensuring that customers can easily convert between physical Bahamian dollars and Sand Dollars. Moreover, the Sand Dollar can be used both online and offline, a critical feature for residents in remote areas with unreliable internet connectivity. The use of digital wallets has been instrumental in this regard, allowing even those without access to traditional banking services to use digital economy services.

The Sand Dollar is underpinned by a robust regulatory and security framework. The Central Bank of The Bahamas monitors all transactions, ensuring compliance with anti-money laundering[33] and

[32] *Abbr. BSD*
[33] *Abbr. AML*

counter-terrorism financing[34] regulations. The Sand Dollar also incorporates strong data privacy protections, with advanced encryption and cybersecurity measures in place to protect against fraud and hacking. The multi-layered security framework includes real-time transaction monitoring and regular security audits, reflecting the Central Bank's commitment to maintain the integrity of the digital currency.

The technological infrastructure supporting the Sand Dollar is based on Distributed Ledger Technology, ensuring that transactions are secure, transparent, and immutable. The DLT platform was selected for its scalability and resilience, which are critical as adoption of the Sand Dollar grows. By mid-2023, the Sand Dollar had facilitated over 1.3 million transactions, with a total transaction volume exceeding 50 million BSD *(Central Bank of The Bahamas, 2023)*. The Central Bank has continued to enhance the Sand Dollar's infrastructure, focusing on increasing transaction processing capacity to accommodate future growth.

In 2023, the Central Bank announced plans to integrate the Sand Dollar with regional payment systems in the Caribbean, facilitating cross-border transactions and enhancing the currency's utility for international payments. This initiative aims to position the Sand Dollar as a model for other small island nations exploring digital currencies, showcasing its potential to improve financial inclusion and economic resilience in similar contexts. This regional integration is expected to significantly increase the adoption of the Sand Dollar, not only within The Bahamas but also across the Caribbean region.

Public trust in the Sand Dollar has been a central focus for the Central Bank of The Bahamas. Recognizing the importance of privacy and data security, the Central Bank has implemented stringent measures to protect users' personal information and transaction data. These measures include advanced encryption, anonymization of transactions, and strict access controls to prevent unauthorized use of personal data. *(Central Bank of The Bahamas, 2023)*

The Central Bank has also engaged in public education efforts to build trust in the Sand Dollar, including community outreach programs, educational campaigns, and partnerships with local organizations to promote the adoption and use of the Sand Dollar. As of 2024, these initiatives have led to steady growth in the usage of the Sand Dollar, with adoption rates expected to increase further as the currency becomes widely accepted across the country.

The Bahamas' Sand Dollar is a pioneering example of a digital currency designed to address the specific challenges of financial inclusion in a geographically dispersed nation. Its successful implementation offers valuable lessons for other countries exploring the potential of CBDCs, particularly in similar contexts where traditional banking services are limited or inaccessible. The Sand Dollar's development, marked by robust technological infrastructure, strong regulatory frameworks, and proactive public engagement, positions it as a model for future digital currencies in small island nations. The next phase of the Sand Dollar's development will likely focus on expanding its adoption, enhancing its technological capabilities, and exploring new use cases, both domestically and regionally.

[34] *Abbr. CTF*

3.3.5 Comparative Analysis

The exploration and implementation of CBDCs by China, Sweden, and The Bahamas reflect distinct approaches shaped by each country's unique economic context, technological infrastructure, and policy objectives. This comparative analysis examines the key differences in development strategies, supported by quantitative data and empirical insights, to highlight the valuable lessons that these case studies offer for future CBDC initiatives worldwide.

Firstly, the level of centralization plays a critical role in shaping the design and functionality of a CBDC. China's digital yuan is characterized by a highly centralized approach that aligns with the country's broader economic and political strategies, spanning various sectors, including retail payments, government subsidies, and public transportation, reflecting the currency's deep penetration into the national economy. However, this centralization comes with significant privacy concerns. The PBOC's ability to track and regulate transactions in real-time enhances its capacity to combat financial crimes. Yet, this also raises the potential for increased government surveillance, which could undermine individual financial autonomy. According to a survey conducted in 2022, around 52% of Chinese citizens expressed concerns about privacy in relation to the e-CNY *(PBOC, 2022)*, highlighting the trade-offs between security and personal freedom in a highly centralized digital currency model.
In contrast, Sweden's e-krona project embodies a more decentralized and cautious approach. The Riksbank's primary goal is to ensure that central bank money remains accessible in a society where cash usage has plummeted. The e-krona's development has been methodical, with extensive pilot programs and stakeholder consultations aimed at addressing technical, legal, and social challenges before a full-scale rollout. This careful approach reflects Sweden's commitment to maintain financial stability and public trust during the transition to digital currency.
The Bahamas' Sand Dollar stands out for its strong emphasis on financial inclusion, particularly in a small island nation with a geographically dispersed population. The Sand Dollar's success is rooted in its accessibility and integration with existing financial infrastructure. The Central Bank's focus on inclusivity has made the Sand Dollar a model for other small island nations exploring CBDCs, showcasing how digital currencies can be tailored to address specific socioeconomic challenges.

Another key difference lies in the technological strategies employed by each country, reflecting their distinct priorities. China has invested heavily in developing a robust infrastructure capable of handling large transaction volumes, with a focus on scalability and integration with other digital payment platforms. Sweden, on the other hand, has prioritized security and privacy, exploring the use of DLT to support the e-krona while ensuring compliance with European regulations. The use of a permissioned blockchain provides a secure, scalable platform for the e-krona, with the Riksbank focusing on integrating the digital currency into the existing financial ecosystem without disrupting established financial institutions.
The Bahamas has taken a more pragmatic approach, focusing on the resilience and accessibility of the Sand Dollar's infrastructure to meet the needs of its diverse population. The Central Bank continues to enhance the Sand Dollar's infrastructure, particularly in terms of scalability and regional integration.
All three countries have emphasized the importance of strong regulatory frameworks and security measures to ensure the integrity of their CBDCs. Compliance with AML and CFT regulations, as

well as robust cybersecurity, are critical to maintain the security and stability of a CBDC, particularly as it becomes more widely adopted. The centralized model of the e-CNY allows for close monitoring of transactions, but also raises concerns about excessive government control. In contrast, Sweden's approach seeks to balance security with privacy, offering a higher degree of financial autonomy to users. The Bahamas has implemented a multi-layered security framework for the Sand Dollar, including advanced encryption, real-time transaction monitoring, and regular security audits to protect against fraud and hacking.

The experiences of China, Sweden, and The Bahamas highlight the value of international collaboration, particularly with regard to cross-border payments. China's participation in the mBridge project and Sweden's exploration of cross-border use cases for the e-krona demonstrate the potential for CBDCs to facilitate more efficient and secure international transactions. However, these initiatives also underscore the challenges of integrating digital currencies into the global financial system.

These differences underscore the importance of tailoring CBDC initiatives to the specific economic, technological, and regulatory environments of each country. While China's approach may be suited to its highly controlled economy, Sweden's emphasis on public trust and financial stability reflects the priorities of a mature, cashless society. The Bahamas' focus on financial inclusion provides a valuable example of how digital currencies can be used to address the unique challenges of smaller economies.

In conclusion, the experiences of China, Sweden, and The Bahamas offer valuable lessons for other countries considering the implementation of CBDCs. Each country's approach reflects its unique circumstances and priorities, demonstrating that there is no one-size-fits-all solution to digital currency adoption. As more countries explore the potential of CBDCs, these case studies will serve as important references for navigating the complex challenges and opportunities associated with digital currencies.

3.4 ECONOMIC IMPLICATIONS

As discussed, CBDCs have the potential to significantly impact various aspects of the economy, especially financial inclusion, efficiency of payment systems, and transmission of monetary policy. This section will explore in detail the economic implications of CBDCs, drawing on existing studies, empirical evidence, and case studies to provide an exhaustive overview.

3.4.1 Financial Inclusion

Throughout the paper, one of the most frequently cited benefits of CBDCs is their potential to enhance financial inclusion. Several studies have highlighted how CBDCs present promising solution to this challenge, offering the potential to provide secure, accessible, and cost-effective financial services to underserved populations.

Financial inclusion is defined as the individuals and businesses' equality of opportunities to access financial services that meet their needs, regardless of their income level or geographic location.
Research by the World Bank shows how around 1.7 billion adults globally remain unbanked, meaning they do not have an account at a financial institution or through a mobile money provider *(World Bank, 2020)*. This can limit economic opportunities and perpetuate poverty.
CBDCs have the potential to address many of the barriers to financial inclusion. Traditional financial services often require access to physical bank branches, which may be scarce or non-existent in rural or remote areas. CBDCs, however, can be distributed and accessed digitally, eliminating the need for physical infrastructure. By leveraging mobile technology, individuals can access CBDCs through digital wallets on their smartphones or other digital devices, enabling them to participate in the formal financial system regardless of their location.
In developing economies, where the penetration of mobile phones often far exceeds that of traditional banking services, CBDCs can be particularly transformative. For example, the use of mobile money services in sub-Saharan Africa has already demonstrated the potential of digital financial services to reach underserved populations. CBDCs can build on this success by providing a state-backed digital currency that is universally accepted and integrated into the national financial system, thereby enhancing the security and reliability of digital payments. *(BIS, 2021)*

The Bahamas' Sand Dollar project is a leading example of how CBDCs can enhance financial inclusion in a developing country. According to the Central Bank of The Bahamas, the Sand Dollar has successfully extended financial services to remote and unbanked communities, allowing residents to participate in the formal economy by enabling digital transactions for everyday purchases, bill payments, and peer-to-peer transfers.
Similarly, China's digital yuan pilot programs have highlighted the potential of CBDCs to promote financial inclusion in a rapidly digitalizing economy. While China's financial infrastructure is more developed than that of many other countries, there are still significant gaps in access to financial services, especially in rural areas. The digital yuan has been integrated into mobile

payment platforms which are already widely used across the country, thus bringing more people into the digital financial ecosystem.
In addition to these case studies, research by the BIS suggests that CBDCs could reduce the costs associated with cash distribution and maintenance, which are often significant in countries with large, dispersed populations. By reducing these costs, central banks can make financial services more affordable and accessible to all citizens. The BIS also highlights that CBDCs can improve the security of financial transactions, reducing fraud and theft risks, often associated with cash-based economies. *(BIS, 2021)*

The potential benefits of CBDCs for financial inclusion are significant, but drawbacks that need to be addressed, too. One of the primary challenges is ensuring that CBDCs are designed to be accessible to all members of society, including those who may not have access to digital devices or the internet. This requires careful consideration of the technological infrastructure needed to support CBDC adoption, as well as campaigns to ensure that individuals who are not digitally literate are not excluded from the financial system.
Another challenge is the potential for banking sector "disintermediation", resulting in higher funding costs for banks, as they may need to offer more attractive interest rates on deposits. Additionally, if the demand for loans remains high but banks have fewer deposits to lend out, this could lead to a tightening of credit conditions, potentially stifling economic growth. *(BIS, 2021)*
Central banks must carefully consider the potential impact of CBDCs on the broader financial system and ensure that they are introduced in a way that complements, rather than undermines, existing financial services.

3.4.2 Transaction Costs and Efficiency

Another significant economic impact of CBDCs is their potential to reduce transaction costs and improve the efficiency of payment systems. CBDCs promise to streamline these processes, offering faster, cheaper, and more transparent transactions.

To understand the potential benefits of CBDCs, it is essential first to examine the cost structure of traditional payment systems, that typically involve multiple intermediaries, including correspondent banks, payment processors, and clearinghouses. Each of these intermediaries adds a layer of complexity and cost to the transaction process. Fees can accumulate at various stages, including foreign exchange fees, transaction fees, and charges for regulatory compliance and anti-money laundering measures.
Research by the World Bank estimates that the average cost of sending remittances globally in Q1 2024 is 6.35% of the total transaction amount, with some corridors experiencing costs as high as 10% or more *(World Bank, 2024)*. These high costs can significantly impact individuals who rely on remittances for their livelihoods, as well as businesses engaged in international trade. Additionally, the time required to complete cross-border transactions can vary widely, ranging from a few hours to several days, depending on the complexity of the transaction and the number of intermediaries involved.
As shown in the following chart, in Q1 2024, the global average cost for digital remittances was 4.96%, approaching the 3% SDG target, against the 6.94% for non-digital remittances, proving the advantages granted by digital forms of payment. *(World Bank, 2024)*

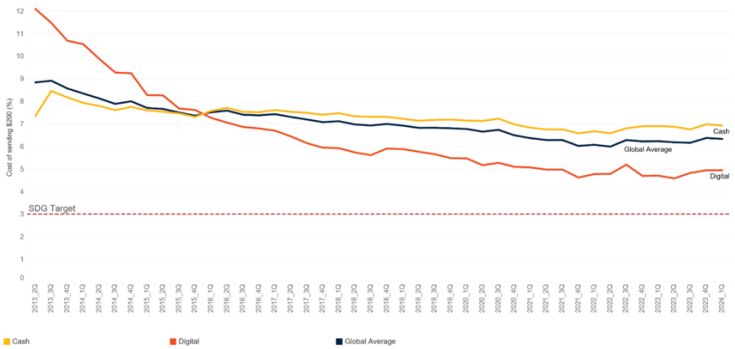

Figure 6

CBDCs have the potential to dramatically reduce transaction costs by streamlining the payment process and eliminating the need for multiple intermediaries. They enable direct transfers between digital wallets, allowing central banks to bypass the traditional banking infrastructure and facilitate faster, more efficient payments. This direct transfer mechanism not only reduces the time required for transactions but also minimizes the fees associated with intermediary services.
Research conducted by the International Monetary Fund highlights that CBDCs could significantly lower the costs of cross-border payments. By enabling direct, peer-to-peer transfers between digital wallets, CBDCs eliminate the need for correspondent banking relationships, reducing both the time and cost associated with international transactions. *(IMF, 2022)*

The case study of China's digital yuan pilot programs provides empirical evidence of the cost-saving potential of CBDCs in domestic transactions as well. According to the People's Bank of China, the digital yuan has reduced the time required for processing payments and lowered the costs associated with traditional banking transactions, particularly for small businesses and consumers who benefit from the lower fees and faster settlement times. *(PBOC, 2023)*
In addition to reducing the costs of domestic and cross-border payments, CBDCs can improve overall financial system efficiency by enhancing the transparency and traceability of transactions. The ability of central banks to monitor transactions in real-time allows for more effective enforcement of regulations. This increased efficiency and security can lead to greater trust in the financial system, encouraging widespread adoption of digital payments and reducing the reliance on cash.

The efficiency gains offered by CBDCs extend beyond cost reduction to include improvements in the speed and reliability of payment systems. Traditional payment systems often suffer from delays due to the need for manual processing at various stages of the transaction. These delays can be particularly problematic in cross-border transactions, where differences in time zones, regulatory environments, and banking practices can further complicate the process.
CBDCs, by contrast, enable near-instantaneous settlement of transactions, reducing the time required for payments to be processed and clearing out the inefficiency often associated with traditional systems. This is particularly important in the context of real-time payments, which are increasingly demanded by consumers and businesses alike. The ability to settle transactions in real-time can improve liquidity management for businesses, reduce the risk of payment delays, and enhance overall economic efficiency.
Furthermore, the programmability of CBDCs offers additional opportunities to improve the efficiency of payment systems. For example, programmable CBDCs could be used to automate complex financial processes, such as the execution of smart contracts[35] *(IMF, 2022)*. This level of automation can also help minimizing errors and reducing the costs associated with processing and reconciling transactions.

Once again, there are also challenges that must be addressed. One of them is ensuring that the technological infrastructure supporting CBDCs is robust, scalable, and resilient. As the volume of transactions increases, the underlying systems must be capable of handling large transaction volumes without compromising speed or security.
Another significant risk associated with CBDCs is the potential for capital flight, particularly in the context of cross-border usage. Capital flight occurs when investors move their assets out of a country due to concerns about economic instability, unfavorable regulations, or better opportunities elsewhere. CBDCs could exacerbate this risk by making it easier and faster for individuals and businesses to transfer large sums of money across borders. For instance, if a country's economic conditions deteriorate, residents could quickly convert their local CBDC into a foreign CBDC or another stable digital asset, leading to a rapid outflow of capital. This could put additional pressure on the country's currency and financial stability, potentially leading to a Balance of Payments crisis.
The potential for capital flight is closely related to the Triffin Dilemma, a concept introduced by economist Robert Triffin. The Triffin Dilemma arises when a country's currency is used as a global

[35] *Smart contracts are digital contracts stored on a blockchain that are automatically executed when predetermined terms and conditions are met. (IBM)*

reserve currency. To meet the global demand for its currency, the issuing country must run a current account deficit[36], which can undermine confidence in the currency over time. In the context of CBDCs, the dilemma could become more pronounced if a particular CBDC, such as a digital dollar or euro, becomes widely adopted internationally. Countries issuing such a globally dominant CBDC might face increased pressure to maintain large amounts of liquidity to satisfy global demand, potentially compromising their domestic monetary policy objectives. *(IMF, 2022)* Moreover, as CBDCs are adopted globally, the coordination among central banks becomes increasingly important to manage these risks. Without careful coordination, the widespread use of a few dominant CBDCs could lead to imbalances in the global financial system. Countries with less widely used CBDCs might experience reduced monetary sovereignty as their ability to control domestic monetary policy becomes constrained by the influence of dominant foreign CBDCs. This could lead to a situation where the global financial system becomes more dependent on the policies of a few central banks, increasing systemic risks and reducing the ability of smaller countries to respond effectively to economic shocks.

[36] *A current account deficit occurs when the expenditure on imported goods and services exceeds the value of exports (Forbes)*

3.4.3 Monetary Policy and Economic Stability

The last significant potential implication of CBDCs lies in their ability to improve monetary policy transmission. Traditional monetary policy tools influence economic activity indirectly through the banking system, relying on the intermediation of commercial banks to pass on changes in policy rates to consumers and businesses. However, this transmission can be weakened by factors such as liquidity traps, where interest rates are close to zero, or by banks choosing not to fully pass on rate changes to their customers.

Traditionally, central banks influence economic activity by setting interest rates, which in turn affect borrowing, saving, and spending behaviors. However, particularly during periods of economic downturn, central banks may implement negative interest rates, a tool designed to stimulate economic activity by encouraging spending and investment rather than saving.
Negative interest rates occur when central banks set nominal interest rates below zero, effectively charging depositors for holding money in savings accounts. In practice, however, the implementation of negative interest rates has been constrained by the availability of physical cash. When interest rates drop below zero, people and businesses might prefer to hold cash, which does not incur a negative rate, rather than keeping their money in bank accounts that do. This limits the effectiveness of negative interest rate policies and can obstruct efforts to revive economic activity. CBDCs offer a potential solution to this problem by enabling central banks to more effectively enforce negative interest rates. Unlike physical cash, which can be stored outside the banking system, CBDCs are digital and can be directly managed by central banks. This allows central banks to impose negative interest rates on CBDC holdings, thereby ensuring that the policy affects all money held within the financial system. By doing so, central banks could reduce the attractiveness of holding money in digital form, encouraging greater spending and investment during periods of economic stagnation. This ability to apply negative interest rates more effectively could also help central banks avoid liquidity traps, where traditional monetary policy tools become ineffective.
A deeper understanding of liquidity traps further illustrates the potential advantages of CBDCs in managing economic downturns. A liquidity trap occurs when individuals and businesses prefer to hold onto cash rather than spend or invest it, despite the central bank's efforts to inject liquidity into the economy. In a liquidity trap, traditional monetary policy tools, become ineffective because the public's demand for liquidity remains high regardless of the cost of borrowing. This situation can lead to prolonged periods of economic stagnation, as seen in Japan during the 1990s and early 2000s, where near-zero interest rates failed to stimulate sufficient economic activity *(IMF, 2022)*. CBDCs could help central banks avoid or mitigate the effects of liquidity traps by providing a more direct and controllable monetary tool.

A study by the ECB highlights that the programmability of CBDCs could also allow for more targeted monetary policy interventions. For instance, central banks could implement tiered interest rates on CBDC accounts, offering higher rates for savings or lower rates for transactional accounts *(ECB, 2022)*. This flexibility would enable central banks to tailor monetary policy to specific economic conditions, amplifying its effectiveness in managing inflation, unemployment, and economic growth.
In addition to interest rate policy, CBDCs could also support the implementation of more direct fiscal policy measures. For example, central banks could use CBDCs to distribute stimulus

checks[37] or social benefits directly to citizens' digital wallets, ensuring that the funds are used for intended purposes and reach the target population quickly and efficiently *(BIS, 2021)*.

CBDCs also have the potential to contribute to economic stability by providing a more resilient and secure payment system. Traditional payment systems, particularly those dominated by private sector entities, can be vulnerable to disruptions caused by financial crises, technological failures, or cybersecurity threats. By providing a state-backed digital payment option, CBDCs could reduce reliance on private payment systems, ensuring that the payment infrastructure remains stable and operational during periods of economic stress.

The BIS emphasizes that CBDCs could enhance financial stability by reducing the risk of bank runs. In a crisis scenario, depositors might be more inclined to withdraw their funds from commercial banks and hold them in CBDC accounts, which are perceived as safer since they are directly issued and guaranteed by the Central Bank *(BIS, 2021)*. This could prevent the kind of bank runs that exacerbated the financial crises of the past, thereby stabilizing the banking system and preventing broader economic contagion.

Moreover, CBDCs could improve the effectiveness of central banks' lender-of-last-resort functions. In a financial crisis, central banks could provide liquidity directly to the market through CBDCs, ensuring that financial institutions and payment systems continue to function smoothly. This direct provision of liquidity could help to prevent the freezing of credit markets, which often occurs during financial crises, and could support the overall stability of the financial system.

[37] *Stimulus checks are payments sent by the government to taxpayers to boost their spending power and spur economic activity.*

3.5 PUBLIC AND INSTITUTIONAL PERCEPTIONS

The success of CBDCs hinges not only on their technical and economic benefits but also on how they are perceived by the public and key institutional stakeholders. Public and institutional perceptions of CBDCs are critical in determining the level of trust, adoption, and eventual integration of digital currencies into the broader financial system.
This section examines the current state of public opinion regarding CBDCs, as well as the perspectives of financial institutions, banks, and other key stakeholders.

3.5.1 Surveys and Public Opinion Studies

Central banks worldwide have conducted surveys and studies to gauge public sentiment and understand the factors that influence acceptance and trust in digital currencies. These surveys reveal a complex landscape where public opinion varies significantly depending on factors such as geographic location, economic status, and familiarity with digital payments.

A survey conducted by the ECB in 2022 found that most respondents across the Eurozone supported the introduction of a digital euro, citing convenience, security, and the ability to make payments without an internet connection as key advantages. Nonetheless, concerns about privacy, data security, and the potential for government surveillance were also highlighted as significant barriers to widespread adoption. The survey results indicated that public acceptance of a digital euro would likely depend on how well these concerns are addressed in the design and implementation of the CBDC. *(ECB, 2022)*
In contrast, public opinion surveys conducted in the United States by the Federal Reserve reveal a more cautious attitude toward CBDCs. While there is recognition of the potential benefits of a digital dollar, such as improved financial inclusion and reduced transaction costs, many respondents were skeptical about the impact of CBDCs on financial privacy and the potential for increased government control over personal finances. This skepticism is particularly pronounced among older demographics and individuals with lower levels of digital literacy, who are less likely to trust digital financial solutions. *(Federal Reserve, 2022)*
In developing economies, where access to traditional banking services is limited, public opinion toward CBDCs tends to be more favorable. For instance, a survey conducted in Kenya found that a significant majority of respondents were open to the idea of a digital currency, particularly as a means of enhancing financial inclusion and reducing reliance on cash. However, concerns about the stability and security of digital currencies remain, particularly in regions with weaker regulatory frameworks and less robust cybersecurity. *(Central Bank of Kenya, 2022)*

Across these surveys, several factors consistently influence public acceptance and trust in CBDCs; a major factor influencing public opinion is the level of privacy associated with CBDCs. Many respondents expressed concerns that CBDCs could lead to increased government surveillance of financial transactions. Addressing these concerns through strong data protection measures and

ensuring that CBDCs offer a level of privacy comparable to or exceeding that of current digital payment systems will be crucial for gaining public trust.

Additionally, the perceived security and stability of CBDCs are also critical to their acceptance. Public confidence in the digital currency's resilience against cyber threats, as well as its ability to maintain value stability, will heavily influence its adoption. Central banks will need to implement robust security protocols and clear communication strategies to build and maintain public trust in CBDCs.

Furthermore, public familiarity and comfort with existing digital payment systems significantly affect perceptions of CBDCs. In regions where mobile payments and digital banking are already widespread, the transition to CBDCs may be smoother, with less resistance from the public. Conversely, in areas where digital literacy is low, there may be greater apprehension and a need for extensive education and outreach efforts.

Finally, public trust in central banks and government institutions plays a crucial role in shaping perceptions of CBDCs. In countries where trust in these institutions is high, the public is more likely to view CBDCs favorably; but, in regions where trust in government or financial institutions is low, skepticism toward CBDCs may be more pronounced, necessitating targeted efforts to build confidence.

3.5.2 Institutional Perspectives

Financial institutions, banks, and other key stakeholders also have significant perspectives on the adoption and implementation of CBDCs. These institutions are essential in the financial ecosystem, and their support or opposition to CBDCs can have a significant impact on the success of digital currencies.

From commercial banks' perspective, the introduction of CBDCs presents both opportunities and challenges. On one hand, CBDCs could lead to greater efficiency in payment systems, reducing transaction costs and enabling faster, more secure settlements. Banks could benefit from the integration of CBDCs into existing digital payment infrastructures, allowing them to offer enhanced services to their customers and compete more effectively in a rapidly digitalizing financial landscape.
On the other hand, as already discussed, banks also face potential risks from the widespread adoption of CBDCs. Potential disintermediation and disruption of existing business models are the primary concerns. Banks and payment service providers may need to adapt by developing new products and services that leverage CBDCs while maintaining their competitive edge. This could include offering innovative financial products that integrate CBDCs with other digital assets or developing enhanced security features for CBDC transactions.

Despite these challenges, many financial institutions recognize the potential benefits of CBDCs, particularly in terms of enhancing financial inclusion and improving the efficiency of cross-border payments. For instance, cross-border payment providers and remittance companies see CBDCs as an opportunity to reduce the costs and complexities associated with international transactions, thereby expanding their customer base and increasing profitability. *(BIS, 2021)*
Moreover, central banks and regulatory authorities emphasize the potential of CBDCs to enhance financial stability. CBDCs could reduce reliance on cryptocurrencies and other private digital payment systems, which are often seen as more prone to speculative risks and less secure.

Ultimately, the perspectives of financial institutions on CBDCs are shaped by a complex interplay of potential benefits and risks. While CBDCs offer opportunities for greater efficiency, financial inclusion, and enhanced stability, they also present challenges that require careful consideration and management. To ensure the successful implementation of CBDCs, central banks will need to address these concerns through robust design, clear communication, and strategic collaboration with key stakeholders.

3.6 REGULATORY AND LEGAL CHALLENGES

This section explores the regulatory frameworks and legal implications surrounding CBDCs, emphasizing the importance of establishing robust structures to ensure that digital currencies function effectively and securely within the existing financial system.

3.6.1 Regulatory Frameworks

The development and implementation of CBDCs present a host of regulatory challenges that need to be addressed to ensure their success. Regulatory frameworks for CBDCs are still in their infancy, as central banks and regulatory bodies worldwide deal with the complexities of integrating digital currencies into the traditional financial system.

One of the main challenges in establishing a regulatory framework for CBDCs is balancing innovation with risk management. On one hand, CBDCs offer the potential to enlarge financial inclusion, reduce transaction costs, and improve the efficiency of payment systems. On the other hand, they introduce new risks related to cybersecurity, privacy, and the potential for disintermediation of the banking sector. Regulatory frameworks must, therefore, strike a balance between promoting innovation and ensuring that these risks are adequately managed.

Currently, regulatory approaches to CBDCs vary widely across different jurisdictions. In some countries, such as China, the regulatory framework for CBDCs is highly centralized, with the PBOC exercising strict control over the issuance, distribution, and monitoring of the digital yuan. In contrast, the ECB is adopting a more cautious and collaborative approach to developing a regulatory framework for the digital euro. The ECB has emphasized the importance of engaging with a wide range of stakeholders, including commercial banks, payment service providers, and the public, to ensure that the digital euro is designed and regulated in a way that complements existing financial systems and respects fundamental rights such as privacy and data protection. *(ECB, 2022)*

The regulatory framework for CBDCs must also address the issue of cross-border payments and interoperability. As more countries explore the potential of CBDCs, there is a growing need for international cooperation to establish common standards and protocols that allow for seamless integration of digital currencies across borders. The BIS has been actively involved in fostering this cooperation, working with central banks to develop guidelines and best practices for the regulation of cross-border CBDC transactions. *(BIS, 2021)*

In addition to these challenges, regulators must also consider the potential impact of CBDCs on financial stability. Regulators will need to carefully monitor these developments and adapt their frameworks as necessary to ensure that the introduction of CBDCs does not undermine financial stability or disrupt the broader economy.

3.6.2 Legal Implications

The legal implications of CBDCs are equally complex, involving a range of issues related to privacy, security, and compliance. One of the primary legal concerns surrounding CBDCs is the issue of privacy. Unlike cash, which allows for anonymous transactions, CBDCs are inherently digital and, therefore, leave a traceable record of every transaction. This raises significant concerns about the potential for government surveillance and the erosion of financial privacy.

To address these concerns, legal frameworks for CBDCs must include robust data protection measures that safeguard users' privacy while still allowing for the necessary oversight to prevent illicit activities.
The European General Data Protection Regulation[38] provides a potential model for such a framework, emphasizing the importance of transparency, accountability, and the protection of individual rights in the handling of personal data. *(ECB, 2022)*
Another critical legal issue is the security of CBDCs. The digital nature of CBDCs makes them vulnerable to cyberattacks, fraud, and other forms of digital crime. Legal frameworks must, therefore, include provisions for cybersecurity, ensuring that CBDCs are designed and operated in a way that protects against these risks. This may involve establishing minimum security standards for the technology used to issue and distribute CBDCs, as well as creating mechanisms to detect and respond to cyber threats in real-time.
Compliance with existing financial regulations is another significant legal challenge for CBDCs. Central banks and financial institutions must ensure that CBDCs comply with AML and CTF regulations, developing new compliance tools and procedures, as well as updates to existing legal frameworks to accommodate the unique characteristics of digital currencies.
Moreover, the legal status of CBDCs must be clearly defined. This refers to determining whether CBDCs will be considered legal tender and how they will be treated under different areas of law. In many jurisdictions, existing legal frameworks may need to be updated or expanded to address these issues and ensure that CBDCs can operate effectively within the broader legal system.
Finally, the legal implications of cross-border CBDC transactions must also be considered. As CBDCs are adopted by more countries, there will be a need for international legal agreements and frameworks to govern cross-border transactions. This may involve the development of new treaties or the adaptation of existing ones to address the unique challenges posed by digital currencies.

The regulatory and legal challenges associated with CBDCs are both significant and multifaceted. Establishing robust regulatory frameworks and addressing the legal implications of CBDCs will be critical to their success. These frameworks must balance the need for innovation with the urgency to manage risks, protect privacy, ensure security, and maintain compliance with existing financial regulations. As central banks and regulatory bodies continue to develop and refine these frameworks, international cooperation and collaboration will be essential to address the global nature of digital currencies and ensure their successful integration into the financial system.

[38] *Abbr. GDPR*

3.7 SYNTHESIS OF FINDINGS

The final section encapsulates the *Evidence-based Analysis* conducted throughout the chapter, providing a nuanced understanding of CBDCs and their multifaceted impacts across various domains. The chapter methodically explores the motivations behind CBDC development, patterns of adoption, economic implications, public and institutional perceptions, and the regulatory and legal challenges that have emerged in different national contexts.

The analysis reveals that the motivations driving CBDC initiatives are as different as the countries implementing them. Nations such as China, Sweden, and The Bahamas have launched their CBDC projects with distinct objectives, reflecting their unique economic, technological, and social contexts.
Adoption patterns of CBDCs have shown significant variation across regions and demographic groups. The digital yuan has seen widespread adoption among younger users in China, while adoption in Sweden and The Bahamas has been shaped by different factors, including public concerns over privacy and the need to reach underbanked populations. The data suggests that demographic factors, particularly age and digital literacy, play a crucial role in shaping public acceptance of CBDCs, with younger populations generally more open to digital currencies.

Economically, CBDCs have the potential to improve financial inclusion, streamline payment systems, and enhance monetary policy effectiveness. However, the analysis also underscores the potential risks associated with CBDC implementation, such as the disintermediation of commercial banks and the challenges of enforcing negative interest rates in a digital currency environment. These economic implications highlight the need for careful policy design to balance the benefits of CBDCs with the stability of the broader financial system.

Public and institutional perceptions of CBDCs, as explored in the chapter, are critical to their successful implementation. Surveys and studies reveal a complex landscape where trust in government institutions, concerns over privacy, and the degree of digital literacy significantly influence public acceptance. Financial institutions, while recognizing the potential efficiency gains from CBDCs, also express concerns about the potential disruption to traditional banking models. The chapter's findings emphasize the importance of building public trust and ensuring that CBDC designs address privacy and security concerns to facilitate broader adoption.

The regulatory and legal challenges associated with CBDCs are multifaceted, involving the need for robust frameworks that address issues of privacy, security, and compliance with existing financial regulations. The experiences of China, Sweden, and The Bahamas highlight the different approaches to regulation, with varying degrees of centralization and public consultation. The chapter concludes that the successful implementation of CBDCs will require not only strong regulatory oversight but also international cooperation to address the global nature of digital currencies.

CHAPTER 4
STRATEGIC CONSIDERATIONS & RECOMMENDATIONS

4.1 OVERVIEW AND STRATEGIC FOCUS

The evolution of CBDCs has generated significant interest among policymakers, financial institutions, and international regulatory bodies. As demonstrated in the previous chapters, the motivations behind CBDC development, along with patterns of adoption and regulatory responses, differ significantly across national contexts. In light of these findings, it is essential to move beyond analysis and into the field of strategic recommendations.
The *Strategic Considerations & Recommendations* Chapter focuses on providing actionable insights for central banks, governments, and financial institutions, offering a roadmap for navigating the complexities of CBDC implementation.

The evidence-based analysis in Chapter 3 highlighted the diverse objectives driving CBDC initiatives—from China's pursuit of monetary sovereignty to Sweden's emphasis on maintaining access to central bank money in a cashless society, and The Bahamas' focus on financial inclusion. These varied motivations necessitate tailored strategies that address the specific economic, technological, and social environments in which CBDCs are introduced.
The aim of this chapter is to provide strategic recommendations that build upon the insights gathered from the case studies and data analysis presented earlier. These recommendations are designed to guide central banks, policymakers, and other stakeholders as they navigate the challenges and opportunities posed by CBDC implementation. By addressing both the potential benefits and risks, the chapter offers a comprehensive framework for ensuring that CBDCs can deliver on their promise of enhancing financial inclusion, improving payment systems, and supporting monetary policy objectives while maintaining financial stability.

The chapter is structured in the following way: *Section 4.2* focuses on the strategic considerations for central banks, offering recommendations on CBDC design, infrastructure choices, and balancing privacy with regulatory oversight; this section will also provide insights into managing the risks of disintermediation while maximizing the economic benefits of CBDCs. *Section 4.3* outlines policy recommendations for governments, addressing the need for updated regulatory and legal frameworks. This section will also emphasize the importance of public engagement and education campaigns to foster greater understanding and trust in digital currencies. Finally, *Section 4.4* provides strategic guidance for financial institutions, suggesting ways to integrate CBDCs into existing systems while adapting to new business models and maintaining competitiveness in the digital financial ecosystem.
Through these focused discussions, the chapter aims to provide a comprehensive framework for implementing CBDCs in a way that balances innovation with financial stability and fosters public trust. By addressing both the potential benefits and risks, this chapter offers a strategic guide for navigating the challenges of CBDC adoption.

4.2 STRATEGIC CONSIDERATIONS FOR CENTRAL BANKS

The role of central banks in the successful implementation of CBDCs is paramount. As primary institutions responsible for these digital currencies' issuance and regulation, central banks must carefully consider a range of strategic considerations. These include decisions on the design and infrastructure of CBDCs, balancing privacy and regulatory requirements, and managing the potential risks of disintermediation. The following recommendations are aimed at ensuring that CBDCs are implemented in a manner that supports financial stability, enhances payment systems, and maintains public trust.

4.2.1 Design and Infrastructure Considerations

The design and infrastructure choices for CBDCs are fundamental to their success, with significant implications for security, scalability, and public adoption. Central banks face crucial decisions regarding the architecture of CBDCs, particularly in selecting between centralized and decentralized models, incorporating offline functionality, and ensuring seamless integration with existing financial systems. Each choice carries potential trade-offs that must be carefully considered in light of the specific economic and technological context of each country.

One of the most important design choices is whether to adopt a centralized infrastructure, or a decentralized one. For central banks operating in highly regulated environments with strong oversight mechanisms, such as China, a centralized CBDC model is recommended. This approach allows for greater control and direct intervention in the economy. China's digital yuan has shown that centralized models enable real-time transaction monitoring and provide tools to implement national monetary policy more effectively. Central banks in similar contexts should consider the benefits of retaining this level of control, especially if maintaining monetary sovereignty is a priority. However, they must also address the growing concerns about financial privacy, incorporating privacy-enhancing technologies, such as zero-knowledge proofs, to alleviate public fears of financial surveillance, while ensuring compliance with AML and CTF regulations.
In contrast, for smaller economies or those with limited infrastructure, a decentralized model may offer more flexibility. The success of the Bahamian Sand Dollar lies in its DLT-based platform, which allows for increased security and transparency without requiring centralized control. For countries with a dispersed population or underdeveloped banking sectors, adopting a decentralized model allows for smoother integration with private payment systems and can leverage blockchain technology to maintain security and transparency at a lower cost.
When planning the infrastructure of a CBDC, central banks should always prioritize scalability and security. A critical lesson from China's digital yuan pilot is the importance of building for future capacity, not just present needs. Central banks in large economies or countries with high transaction volumes, like India or Brazil, should prepare their CBDC infrastructure to handle millions of transactions per second from the outset. Therefore, it is recommended to invest in high-

speed processing infrastructure from the very beginning, ensuring that the currency can compete with existing digital payment solutions.
In countries with more modest transaction volumes, scalability should still be a priority, but the strategy should be incremental scaling. A central bank in a smaller economy can begin with lower TPS capacity and scale up as adoption grows, focusing first on sectors like retail and then expanding to cross-border transactions. A gradual approach allows central banks to avoid high upfront costs while ensuring future expansion.
In terms of security, conducting regular cybersecurity audits, and maintaining real-time transaction monitoring to safeguard the system, are recommended practices. As seen with CBDC pilots worldwide, especially in large economies, the risk of cyberattacks and fraud increases with the digitization of currencies *(IMF, 2022)*. Central banks must integrate encryption technologies and collaborate with cybersecurity firms to protect both the CBDC infrastructure and its users.

For countries with low internet penetration or geographically isolated populations, such as The Bahamas or parts of sub-Saharan Africa, offline functionality is essential to a CBDC's success. In areas where internet access is limited or unreliable, the lack of digital payment options can worsen financial exclusion. Central banks in such contexts should design CBDCs with offline capabilities from the start; this can be achieved using technologies like Near-Field Communication, which allows peer-to-peer transactions even without an internet connection. Central banks should work closely with telecommunications companies to explore innovative solutions for offline payment systems that can still ensure secure and verifiable transactions once connectivity is restored.
For central banks in emerging economies, especially those in developing regions, implementing tiered access to offline functionalities may be the best approach. This means that offline capabilities should first be targeted toward areas that are most disconnected from the traditional banking system. Once these populations are integrated, central banks can phase in offline options in more connected urban areas to broaden CBDC usage.
When considering the design of CBDCs, central banks should not operate in isolation from existing financial systems. One of the most important recommendations is to collaborate with commercial banks and fintech companies from the outset. In Sweden, for example, the e-krona project emphasized the importance of creating a CBDC that complements existing payment platforms like Swish. Thus, a cooperative approach is recommended, inviting input from commercial banks, payment service providers, and technology firms to ensure that the new digital currency integrates smoothly with the current financial landscape.
Moreover, interoperability must be a central concern. Central banks should focus on ensuring that CBDCs can work seamlessly with traditional banking systems and cross-border platforms, particularly in countries heavily reliant on remittances or international trade. The adoption of global standards for interoperability is advised, such as those advocated by the BIS. This will not only encourage domestic adoption but will also facilitate smoother cross-border transactions.
Finally, for central banks in countries where private mobile payment platforms dominate, such as in Kenya or India, the key recommendation is to leverage existing fintech solutions rather than building new infrastructure from scratch. By working with companies that have already established trust with users, central banks can promote faster adoption of CBDCs while ensuring that the digital currency meets the needs of everyday users.

4.2.2 Balancing Privacy and Regulation

One of the most delicate challenges central banks face when designing and implementing CBDCs is striking the right balance between ensuring privacy for users and maintaining regulatory oversight. Public trust is critical to the success of any CBDC initiative, and concerns around privacy can significantly hinder adoption. At the same time, central banks must ensure compliance with AML and CTF regulations, as well as manage risks associated with fraud and illicit activities.

For central banks in countries with strong public privacy expectations, ensuring that a CBDC design prioritizes user privacy will be essential. The ECB's research on public perception of the digital euro showed that privacy concerns were among the top issues raised by citizens during consultations *(ECB, 2022)*. In these environments, a data-minimalist approach to CBDC design should be adopted. The implementation of privacy-preserving technologies is recommended, such as pseudonymous transactions, which allow users to conduct transactions without revealing their identities, while still enabling central banks to track transaction patterns for AML/CTF purposes *(IMF, 2022)*.
To enhance trust, central banks should also offer different tiers of privacy, allowing users to choose how much of their transaction data is shared, depending on the size of the transaction or the level of AML/CTF risk. For example, smaller transactions could be anonymized entirely, while larger transactions would require stronger identity verification. This approach provides a middle ground, ensuring that citizens feel their privacy is respected, while also enabling necessary oversight. Additionally, conducting public education campaigns to explain how CBDCs will protect privacy can alleviate concerns and foster greater public support. In countries like China, where the digital yuan has raised concerns over the state's ability to monitor transactions in real time, it's important for central banks to be transparent about how transaction data will be handled. Although China's centralized model allows the government to track all transactions, central banks in similar regulatory environments should be careful not to overstep privacy boundaries, which could undermine public confidence. In this context, the recommendation is to limit the visibility of transaction data to only relevant authorities, ensuring that data is only accessible for specific regulatory purposes. This will help mitigate fears of unwarranted financial surveillance while maintaining strong oversight for compliance purposes.

On the other side of the equation, strong regulatory frameworks are essential to ensure that CBDCs do not facilitate illicit activities. Central banks must ensure that their CBDCs are designed to help combat fraud and money laundering. However, in doing so, central banks must avoid overregulation, which could slow the adoption process.
In regions where financial crime and money laundering are high risks, central banks should prioritize real-time transaction monitoring, implementing systems that allow for immediate flagging of suspicious activities, such as unusual transaction patterns or high-volume transfers. Technologies such as AI-powered monitoring systems can help detect anomalies without requiring manual intervention, streamlining compliance while maintaining user privacy *(BIS, 2021)*. This approach reduces the need for invasive oversight, helping to strike the balance between privacy and regulation.
For countries with robust data protection laws, such as the European Union under the GDPR, central banks must ensure that CBDCs fully comply with these regulations from the outset. Central banks in these regions should incorporate GDPR principles, such as transparency and the right to

be forgotten, into their CBDC frameworks. This includes clearly outlining how user data will be collected, stored, and processed, and ensuring that users have the right to control their data. By doing so, central banks can ensure that CBDCs do not compromise existing data protection laws while providing sufficient regulatory oversight for financial security.

Central banks should also collaborate closely with national and international regulatory authorities to develop clear and consistent frameworks for the overseeing of CBDC transactions. This collaboration is particularly important in cross-border transactions, where differences in regulatory environments can create vulnerabilities. The BIS has advocated for global standards for cross-border CBDCs to ensure that they can operate securely across borders without creating opportunities for regulatory arbitrage *(BIS, 2021)*. The advice here is for central banks to engage early with international organizations like the BIS, the IMF, and the Financial Action Task Force[39] to ensure that their CBDC designs are aligned with global AML/CTF guidelines.
Furthermore, central banks should develop clear governance structures for how transaction data will be shared between national authorities and international regulators. In the context of cross-border payments, central banks must ensure that any information sharing does not violate user privacy rights while still complying with international security standards. One possible solution is to create secure data-sharing protocols that allow for real-time information exchange between jurisdictions, but only for transactions that meet specific thresholds for risk *(IMF, 2022)*.

In countries with low digital literacy or limited access to legal protections, central banks should be careful not to overburden users with complex privacy or compliance requirements. In these regions, CBDCs should be designed with simple, transparent user interfaces that ensure compliance with AML/CTF standards without overwhelming users with bureaucratic procedures. For example, countries like Nigeria or Kenya, where mobile banking has grown rapidly, could adopt CBDCs that integrate seamlessly with existing mobile payment platforms, allowing users to make quick and secure transactions with minimal regulatory complexity.
Moreover, for countries where the government may struggle with public trust, public-private partnerships, that can help bridge the gap between the central bank and the population, should be developed. By involving trusted third-party organizations in the regulatory framework—such as private banks or international development organizations—central banks can improve public confidence in the CBDC system while maintaining oversight and ensuring compliance.

[39] *Abbr. FATF, is the global money laundering and terrorist financing watchdog. It sets international standards that aim to prevent these illegal activities and the harm they cause to society. (FATF-GAFI)*

4.2.3 Managing Disintermediation Risks

Another significant concern surrounding the introduction of CBDCs is the potential for disintermediation—a situation where individuals and businesses shift their funds from commercial bank accounts to CBDC holdings with the central bank. As previously discussed, disintermediation could lead to reduced liquidity in the banking system, higher interest rates, and a contraction in credit availability. Each central bank must tailor its approach to mitigate these risks based on its country's specific economic environment.

In developed economies with well-established banking sectors, disintermediation poses a substantial risk to the stability of the financial system. Central banks in these regions should adopt measures that limit the volume of funds that can be transferred from commercial banks to CBDC accounts, introducing caps on individual CBDC holdings. This measure will prevent large-scale migration of deposits from commercial banks to the central bank's balance sheet. For instance, the ECB has already proposed that the digital euro should include a cap on holdings to protect the banking sector's role in financial intermediation *(ECB, 2022)*. Central banks in similar economies should consider this option, ensuring that CBDCs can co-exist with traditional banking services without disrupting the flow of credit.

In addition to caps, central banks in these economies should also consider implementing tiered remuneration systems, in which central banks would apply different interest rates to CBDC accounts based on the amount held. For instance, smaller balances could offer zero or low interest, encouraging individuals to hold CBDCs for convenience in payments. Larger balances, however, could be subject to negative interest rates, making it unattractive for businesses or individuals to hold large sums in CBDCs rather than in commercial bank accounts *(IMF, 2022)*. This system would discourage excessive hoarding of CBDCs while still providing users with the option to use the digital currency for day-to-day transactions.

In emerging markets and developing economies, the risk of disintermediation presents a unique challenge, especially as many commercial banks in these regions play a critical role in providing microloans and developmental credit. The recommendation for central banks in these countries is to approach CBDC design with incentives for commercial banks in mind. One strategy would be to partner with commercial banks from the beginning, ensuring that banks have a key role in distributing and managing CBDCs. This partnership could involve offering commercial banks access to CBDC infrastructure that enhances their digital offerings, allowing them to compete more effectively with fintech firms while retaining deposits *(BIS, 2021)*.

Another option for central banks in these economies is to limit access to CBDCs for larger businesses and high-net-worth individuals. In this scenario, central banks could prioritize the use of CBDCs among underbanked populations, reducing the risk of large deposit shifts away from the banking sector while promoting financial inclusion. This strategy aligns with the experiences of countries like The Bahamas, where the Sand Dollar has been targeted at underserved communities without undermining the traditional banking sector *(Central Bank of The Bahamas, 2022)*.

For central banks seeking to balance innovation with financial stability, a key recommendation is to view CBDCs not as replacements for traditional banking services, but as complementary tools

that can enhance the capabilities of commercial banks. Central banks should explore ways to integrate CBDCs into the existing banking infrastructure without disrupting the flow of deposits. One option is to design CBDCs in a way that reinforces the role of commercial banks as intermediaries, rather than allowing individuals and businesses to hold CBDCs directly with the central bank.

For instance, in Sweden's e-krona project, the Riksbank has emphasized the importance of commercial bank involvement in distributing the digital currency. Central banks in other countries should adopt a similar approach, designing their CBDCs so that commercial banks act as intermediaries that provide added value to the digital currency system

The reduction in deposits that disintermediation could cause would lead to decreased liquidity in the banking system. This could push up interest rates as banks compete for funds, ultimately reducing the availability of credit. To counter this, it is recommended that central banks set up liquidity support mechanisms to help commercial banks cope with potential deposit outflows. One possible strategy is to offer standing liquidity facilities, allowing banks to borrow directly from the central bank at favorable terms if CBDCs cause a significant shift in deposits *(IMF, 2022)*. Another solution is for central banks to implement fractional CBDC reserves, where only a portion of CBDC holdings is fully backed by reserves, allowing central banks to control liquidity more effectively. By adjusting the reserve ratios, central banks could ease liquidity pressures on commercial banks and ensure that credit remains available, even if deposits shift into CBDC holdings.

In smaller economies with high levels of financial inclusion, the disintermediation risk may be lower, but central banks should still implement precautionary measures, such as the adoption of a gradual rollout of CBDCs, starting with limited use cases and expanding adoption as the effects on the banking sector are monitored. By phasing in CBDCs slowly, central banks can assess the impact on bank deposits and credit provision, allowing them to make adjustments before large-scale adoption creates systemic risks.

In these economies, central banks should also consider hybrid CBDC models that allow for greater flexibility in managing disintermediation risks. For example, central banks could issue CBDCs but require that they be held in commercial bank digital wallets, ensuring that banks retain their role as intermediaries and that deposits remain within the banking system *(BIS, 2021)*.

4.3 POLICY RECOMMENDATIONS FOR GOVERNMENTS

While central banks are responsible for the design and issuance of CBDCs, governments must establish the regulatory and legal frameworks that enable digital currencies to operate safely, securely, and in alignment with broader financial policy objectives. As CBDCs become a more tangible reality, governments will need to address various legislative and regulatory issues, including consumer protection, data privacy, and the legal status of digital currencies. Moreover, governments must engage in public communication and education efforts to ensure that CBDCs are understood, trusted, and adopted by the general population.

4.3.1 Legislative and Regulatory Frameworks

A critical aspect of any CBDC initiative is the establishment of clear and comprehensive legislative and regulatory frameworks. Without appropriate regulations, CBDCs could pose risks to financial stability, data privacy, and consumer protection. Governments must ensure that CBDCs comply with existing financial regulations while also addressing the unique legal challenges posed by them.

For developed economies with well-established legal systems, governments must focus on creating cohesive regulatory frameworks that integrate CBDCs into the broader financial landscape without creating unnecessary complexity. Given the highly regulated nature of these markets, it is recommended to harmonize existing financial regulations—such as consumer protection, AML/CTF laws, and data privacy legislation—with new rules specifically designed for CBDCs.

In the European Union, as discussed, it is essential that CBDC frameworks fully comply with GDPR regulations. Governments in the EU should ensure that any CBDC implemented has robust data protection measures built into its architecture. This includes ensuring that citizens have control over their personal data and that the system provides transparency on how data is used and shared.

In the United States, regulatory frameworks should focus on integrating the Federal Reserve's oversight of CBDCs with existing consumer protection laws, such as the Dodd-Frank Act[40]. A key recommendation is that the government establishes a dedicated task force to coordinate CBDC regulations across multiple agencies, including the Federal Reserve**,** Consumer Financial

[40] *The Dodd-Frank Act is legislation that was passed by the U.S. Congress in response to financial industry behavior that led to the financial crisis of 2007–2008; it sought to make the U.S. financial system safer for consumers and taxpayers (Investopedia)*

Protection Bureau**,** and Federal Trade Commission**.** This approach would ensure that the regulatory environment is consistent and that all potential risks are addressed cohesively.

For emerging markets and developing economies, the legislative and regulatory challenges are more complex. These economies often have a mix of formal and informal financial systems, and the introduction of a CBDC could lead to unintended consequences if not properly regulated. In these contexts, governments should adopt incremental and flexible regulatory frameworks that allow for gradual adoption of CBDCs while minimizing disruption to the existing financial ecosystem.

In countries where mobile payment adoption is high, but financial literacy remains uneven, governments should prioritize consumer protection laws. It is advised to establish a legal framework that explicitly protects consumers from fraud, misuse of digital wallets, and data breaches. This framework should also include educational components, ensuring that users understand the risks and benefits of CBDCs. Given the diversity of financial literacy across the population, the government should work with telecom providers and local financial institutions to develop accessible materials that promote safe usage of CBDCs.

Additionally, governments in emerging markets should monitor and regulate the impact of CBDCs on informal financial markets, which often serve as lifelines for unbanked populations. Governments should establish regulatory sandboxes—controlled environments where CBDCs can be tested in the informal economy without causing disruption. These sandboxes would allow governments to gather data and assess the potential risks of CBDC implementation before rolling it out nationwide *(IMF, 2022)*.

The legal status of CBDCs is another critical consideration that governments must address. Whether a CBDC is considered legal tender will determine how widely it is adopted and integrated into the economy. The recommendation for governments is to explicitly define the legal status of CBDCs, ensuring that they are recognized as legal tender alongside physical currency.

For example, in The Bahamas, the Sand Dollar is recognized as a legal equivalent to cash, which has been instrumental in its adoption *(Central Bank of The Bahamas, 2022)*. Similarly, governments in other countries should ensure that CBDCs have clear legal standing, allowing them to be used for all types of transactions, from paying taxes to making purchases at local businesses.

As more countries introduce CBDCs, cross-border regulation becomes critical. Governments must establish clear rules for how CBDCs interact with foreign currencies and ensure that they comply with international financial agreements. Governments should engage in bilateral and multilateral discussions with neighboring countries to create harmonized regulatory frameworks that allow for seamless cross-border CBDC transactions while preventing risks such as capital flight or currency substitution *(IMF, 2022)*.

Governments should also work closely with organizations such as the IMF and the World Bank to establish global best practices for CBDC regulation. These practices should include guidelines for managing the macroeconomic implications of cross-border CBDC flows and preventing any disruptions to international financial stability.

4.3.2 Public Communication and Education Strategies

One of the key roles that governments must play in the successful implementation of CBDCs is ensuring that the public understands the purpose, benefits, and potential risks of these digital currencies. As CBDCs represent a significant shift in how people interact with money, effective communication and public education are critical to build trust, ensure widespread adoption, and address concerns about privacy, security, and financial stability. Based on experiences from early CBDC initiatives, it is clear that governments need to take a proactive and tailored approach to public engagement, especially in countries with varying levels of digital literacy and trust in institutions.

One of the most significant barriers to public acceptance of CBDCs, as already addressed, is concern over privacy. In developed economies, where privacy concerns are paramount, governments must ensure that their public messaging directly addresses how CBDCs will protect individual privacy. It is recommended to launch a transparent communication campaign that clearly explains how CBDC transactions will be handled, who will have access to transaction data, and how governments will protect against financial surveillance *(ECB, 2022)*. Governments in these regions should work with consumer advocacy groups and data protection authorities to develop public materials, such as websites, brochures, and online tutorials, that explain CBDCs in simple, accessible language. Engaging with trusted voices in the privacy space can help governments building credibility and demonstrating that CBDCs will not undermine privacy rights.
For countries where trust in government is lower, governments must go even further in explaining how CBDCs will protect user privacy. Governments should work with independent oversight bodies or third-party institutions to validate and audit CBDC systems, and then share these findings publicly to build trust. By promoting independent validation of privacy protections, governments can address skepticism and ensure that citizens feel confident in adopting CBDCs.

Public understanding of CBDCs will vary widely across demographic groups. Younger generations, may be more receptive to the concept of digital currencies with respect to older populations and those with lower levels of digital literacy, who are likely to be more resistant. Governments must therefore segment their education campaigns to address the specific concerns and knowledge gaps of different groups. They could launch multi-channel education campaigns that reach people through the platforms they trust. For younger individuals, governments should use social media campaigns, videos, and interactive apps that allow users to explore the benefits and functionalities of CBDCs. For older populations or those with limited access to digital platforms, governments should engage with community organizations, local banks, and media outlets that these groups are familiar with. Offering in-person workshops at local community centers or partnering with television and radio stations to explain CBDCs in non-technical terms can help bridge the knowledge gap. These efforts should emphasize ease of use, safety, and how CBDCs will improve their day-to-day transactions, such as paying bills or receiving government benefits.

In countries where trust in government institutions is low, governments must go beyond traditional communication strategies to engage the public. One of the most effective ways to build trust in CBDCs is to foster transparency throughout the implementation process. The recommendation for governments in these contexts is to develop open forums where the public can provide input, ask questions, and receive updates on how CBDCs are being developed. Hosting regular town halls, online Q&A sessions, and public consultations can create a sense of inclusion among citizens, helping to build confidence in the digital currency project.

Governments should also collaborate with non-governmental organizations, private sector stakeholders, and international bodies to reinforce the legitimacy of their CBDC efforts. Private sector incentives should be encouraged, such as offering small discounts or rewards for consumers who use CBDCs for purchases. This will not only encourage adoption but also help normalize the use of CBDCs in the public's daily life. Additionally, governments should work with small businesses and local vendors to provide the necessary infrastructure for accepting CBDC payments, ensuring that the digital currency is widely accessible and usable across different sectors of the economy.

Finally, it is advised to leverage the rollout of CBDCs to improve the delivery of public services, particularly in sectors like social welfare and public health. For example, governments could distribute social benefits or tax refunds directly into CBDC wallets, making it easier for citizens to access their funds without needing a traditional bank account. In regions where government services are difficult to access, CBDCs could provide a faster and more reliable method of receiving government support. To promote this, governments should develop clear educational campaigns that demonstrate how easy and secure it is to use CBDCs for public services, furthering public confidence and adoption.

4.4 STRATEGIC GUIDANCE FOR FINANCIAL INSTITUTIONS

For financial institutions to remain competitive in a digital currency landscape, they must proactively adapt their strategies, products, and services to leverage the benefits of CBDCs. This section provides financial institutions with recommendations to help them navigate the CBDC ecosystem. By focusing on adapting business models, integrating CBDCs into existing systems, and embracing innovation, financial institutions can not only mitigate risks but also capitalize on the opportunities presented by this digital shift.

4.4.1 Adapting Business Models

One of the most significant impacts of CBDCs on financial institutions is the need to rethink traditional business models. As more consumers and businesses begin to use CBDCs, financial institutions must find ways to offer added value beyond simple deposit-taking and payment services. The introduction of CBDCs could reduce the reliance on commercial banks as intermediaries, particularly in payments, leading to lower revenues from transaction fees and other traditional banking services. To remain competitive, financial institutions should embrace new technologies and innovate in areas where they can still maintain an advantage.

In highly digitalized economies, such as Sweden, where cash usage is minimal and digital payments are already the norm, the introduction of CBDCs like the e-krona presents a challenge to the current dominance of private payment platforms. Financial institutions in such contexts must explore ways to offer complementary services around the new currency. One key recommendation is to develop value-added services that integrate with CBDC infrastructure, such as offering smart contract functionality, programmable payments, or enhanced security features for digital wallets *(ECB, 2022)*. By leveraging these technologies, banks can provide services that differentiate them from non-bank payment providers.
In countries with mature financial sectors, such as the United States or the United Kingdom, banks should consider how to expand their offerings into areas such as digital asset management or custody services for digital currencies. As CBDCs become integrated into the financial system, financial institutions have the opportunity to serve as custodians for both CBDCs and other digital assets. This could include offering secure storage for CBDCs or providing advisory services for businesses and individuals looking to manage their digital currency holdings.
For financial institutions in developing markets, such as India or Kenya, where mobile banking and fintech solutions dominate, it is advised to adopt a mobile-first strategy. By partnering with fintech companies, banks can offer innovative products that blend traditional banking services with digital currency solutions. In regions where mobile payments are already prevalent, integrating CBDCs into mobile platforms can help banks retain their customer base and provide

seamless financial services. For example, banks could develop mobile apps that allow users to convert between traditional currency and CBDCs in real-time, offering convenience and flexibility for consumers *(IMF, 2022)*.

Additionally, financial institutions should consider diversifying revenue streams by offering products that support CBDC adoption in sectors like cross-border payments or trade finance. In emerging markets, banks could capitalize on the efficiency gains offered by CBDCs by creating specialized services for remittances or international trade settlements, which would allow them to stay relevant in a rapidly evolving digital landscape *(BIS, 2021)*.

Another area where financial institutions can create value is by developing CBDC-linked products, such as programmable savings accounts or time-based digital certificates, which offer consumers additional ways to manage their finances in a digital economy. By providing innovative, user-friendly products that utilize the programmable features of CBDCs, banks can stay competitive and offer services that non-bank entities may not be able to provide.

With the rise of fintech companies and decentralized finance, financial institutions face increased competition from non-bank entities in the payment space. The introduction of CBDCs could further level the playing field, allowing non-bank entities to offer direct access to digital currencies without the need for commercial banks as intermediaries. To address this challenge, financial institutions must leverage their strengths in trust, compliance, and security—areas where they have a distinct advantage over newer players.

One key recommendation is, for financial institutions to emphasize their role as **c**ompliance leaders in the CBDC ecosystem. By positioning themselves as experts in regulatory compliance, banks can reassure both customers and regulators that transactions are safe and compliant with existing laws *(IMF, 2022)*. Additionally, banks can offer compliance-as-a-service solutions to fintech companies, providing outsourced services to ensure that CBDC transactions meet regulatory requirements.

Finally, banks should explore partnerships with fintech companies to combine the innovation of fintech with the trust and stability of traditional banking. By collaborating rather than competing, banks and fintech companies can create synergies that benefit both parties and drive the adoption of CBDCs. Banks should also consider investing in or acquiring fintech firms that specialize in digital currencies, allowing them to integrate cutting-edge technology into their own product offerings.

CONCLUSION

The thesis aims to provide an in-depth, evidence-based analysis of Central Bank Digital Currencies, evaluating their diverse implications for economic systems, financial institutions, and public policy. Throughout the chapters, several perspectives have been explored, including the motivations behind CBDC implementation, adoption trends, economic impacts, and regulatory challenges across various national contexts. Each section has been structured to offer a critical assessment of CBDCs, drawing on real-world case studies and empirical data to provide strategic recommendations for central banks, governments, and financial institutions.

One of the key takeaways from the research is the transformative potential of CBDCs in addressing modern financial system needs. From enhancing payment system efficiency and promoting financial inclusion to safeguarding monetary sovereignty, CBDCs offer a range of benefits that can fundamentally reshape global finance. As evidenced by early adopters such as China**,** Sweden, and The Bahamas, the design and implementation of CBDCs vary widely depending on national priorities, infrastructure, and social contexts. These case studies demonstrate that while the motivations for adopting CBDCs may differ, their potential to modernize financial ecosystems is a common thread.
In China, the digital yuan serves as a powerful tool for maintaining control over the rapidly digitalizing payments landscape, while also asserting monetary sovereignty in the face of growing private sector dominance. Sweden's e-krona exemplifies a cautious, gradual approach focused on complementing existing digital payments in a society that is moving rapidly toward a cashless future. The Bahamas, through the Sand Dollar, highlights the critical role CBDCs can play in promoting financial inclusion by extending banking services to remote communities. These initiatives underscore the versatility of CBDCs and their capacity to address a range of economic and financial challenges.

As emphasized throughout the paper, the implementation of CBDCs is not without significant risks and challenges. One of the most prominent concerns is the potential disintermediation of the banking sector. When facing these circumstances, central banks must develop carefully structured policies, such as implementing caps on CBDC holdings or offering tiered remuneration systems, which limit the migration of large-scale deposits away from commercial banks while still fostering innovation in the digital currency space.
Other covered risks include cybersecurity vulnerabilities, as the digital infrastructure supporting CBDCs could be exposed to hacking or system failures, and privacy concerns, as CBDCs could enable more granular tracking of transactions, raising fears of increased government surveillance. Furthermore, monetary policy effectiveness could be impacted if CBDCs facilitate rapid cross-border capital flows, potentially leading to financial instability in smaller economies. Addressing these risks requires robust regulatory frameworks, technological safeguards, and careful international coordination.

As discussed, the regulatory approaches taken by different countries have varied significantly. While China has opted for a centralized model with strict oversight, the European Union has pursued a more collaborative and transparent approach, particularly with the digital euro. Both approaches highlight the importance of regulatory oversight in ensuring the security, privacy, and compliance of CBDC systems. In addition, the global nature of financial transactions necessitates international cooperation to establish common standards and protocols for cross-border CBDC payments. Multilateral institutions such as the BIS and IMF will play a pivotal role in facilitating such cooperation, ensuring that CBDCs integrate smoothly into the global financial system while adhering to robust standards.

The potential for financial inclusion offered by CBDCs is one of their most compelling advantages, particularly for developing economies. As demonstrated by The Bahamas' Sand Dollar, CBDCs can provide previously unbanked populations with secure, accessible, and cost-effective financial services, significantly improving economic inclusion. This capability extends beyond individual countries, with CBDCs offering the potential to address global remittance markets and provide more affordable cross-border payment solutions. In this context, governments and central banks must prioritize the integration of CBDCs into mobile payment systems and digital wallets, ensuring that digital currencies are accessible to all members of society, regardless of their location or income level.

Public trust and education also play a crucial role in the widespread adoption of CBDCs. Public concerns about data privacy, security, and the potential for government surveillance are particularly pronounced in developed economies. Governments must address these concerns head-on by establishing transparent public communication strategies and ensuring that the legal frameworks governing CBDCs protect citizens' financial privacy. Central banks will also need to provide comprehensive educational programs to increase digital literacy and facilitate a smooth transition to the use of CBDCs. In doing so, they can build the public trust necessary for digital currencies to succeed.

Financial institutions, particularly commercial banks, will need to rethink their business models to remain competitive in the CBDC era. Banks must shift from traditional revenue streams, such as deposit-taking and payment processing, and develop value-added services around CBDCs, such as programmable payments, digital asset management, and enhanced cybersecurity features. They should also consider forming strategic partnerships with fintech firms to innovate and provide solutions that integrate seamlessly with CBDC infrastructure. Financial institutions that can successfully adapt to this new digital currency landscape will position themselves as leaders in a rapidly evolving financial ecosystem.

Lastly, CBDCs offer both opportunities and challenges that must be carefully navigated to realize their full potential. The evidence-based analysis presented in the thesis provides a comprehensive framework to understand the multifaceted impact of CBDCs, from their economic implications to regulatory and institutional challenges. While the transition to digital currencies will undoubtedly require significant investment, regulatory adjustments, and technological innovation, the benefits of CBDCs—ranging from improved payment system efficiency to enhanced financial inclusion—are too significant to ignore.

Looking forward, the strategic recommendations outlined in this thesis will serve as a valuable guide for policymakers, financial institutions, and regulators alike. By

prioritizing collaboration, innovation, and public trust, central banks and governments can ensure that CBDCs contribute to a more inclusive, resilient, and efficient global financial system. As digital currencies continue to reshape the financial landscape, the ability of central banks, governments, and financial institutions to adapt and evolve will be key to their success.

LIST OF FIGURES

Figure 1 Section 1.2.2: Bank for International Settlements (2021)
https://www.bis.org/publ/arpdf/ar2021e3.pdf

Figure 2 Section 1.3.1: Created using Python with the Matplotlib library

Figure 3 Section 1.3.1: Created using Python with the Matplotlib library

Figure 4 Section 1.3.1: Created using Python with the Matplotlib library

Figure 5 Section 1.3.1: Created using Python with the Matplotlib library

Figure 6 Section 1.5.2: The World Bank (2024)
https://remittanceprices.worldbank.org/sites/default/files/rpw_main_report_and_annex_q124_final.pdf

BIBLIOGRAPHY

Bank for International Settlements (BIS). (2021). CBDCs: an opportunity for the monetary system. Retrieved from https://www.bis.org/publ/arpdf/ar2021e3.htm

Bank of England. (2020). Central Bank Digital Currency: Opportunities, Challenges and Design. Retrieved from https://www.bankofengland.co.uk/paper/2020/central-bank-digital-currency-opportunities-challenges-and-design-discussion-paper

European Central Bank (ECB). (2020). Report on a digital euro. Retrieved from https://www.ecb.europa.eu/pub/pdf/other/Report_on_a_digital_euro~4d7268b458.en.pdf

Norges Bank. (2021). Central Bank Digital Currencies: Memo for the NBIM Council on Ethics. Retrieved from https://www.nbim.no/en/publications/submissions-to-ministry/2021/central-bank-digital-currencies/

World Bank. (2021). Central Bank Digital Currencies for Cross-Border Payments: A Review of Current Experiments and Ideas. Retrieved from https://www.worldbank.org/en/news/feature/2021/07/22/central-bank-digital-currencies-for-cross-border-payments-a-review-of-current-experiments-and-ideas

International Monetary Fund (IMF). (2020). Digital Money Across Borders: Macro-Financial Implications. Retrieved from https://www.imf.org/en/Publications/WP/Issues/2020/11/19/Digital-Money-Across-Borders-Macro-Financial-Implications-49823

Auer, R., & Böhme, R. (2020). The technology of retail central bank digital currency. BIS Quarterly Review, March 2020. Retrieved from https://www.bis.org/publ/qtrpdf/r_qt2003j.pdf

Kumhof, M., & Noone, C. (2018). Central bank digital currencies - design principles and balance sheet implications. Bank of England Staff Working Paper No. 725. Retrieved from https://www.bankofengland.co.uk/working-paper/2018/central-bank-digital-currencies-design-principles-and-balance-sheet-implications

Carstens, A. (2019). The future of money and payments. Speech at the Central Bank of Ireland, March 2019. Retrieved from https://www.bis.org/speeches/sp190319.htm

Kiff, J., Alwazir, J., Davidovic, S., Farias, A. R., Khan, A., Khiaonarong, T., Monroe, H., Sugimoto, N., Tourpe, H., & Zhou, P. (2020). A Survey of Research on Retail Central Bank Digital Currency. IMF Working Papers, 2020(104). Retrieved from https://www.imf.org/en/Publications/WP/Issues/2020/06/19/A-Survey-of-Research-on-Retail-Central-Bank-Digital-Currency-49517

https://www.investopedia.com/terms/f/fiatmoney.asp

https://www.ibm.com/topics/blockchain

https://www.imf.org/en/Topics/Financial-Integrity/amlcft

https://crypto.com/university/what-is-sharding

Christensen, C. M. (1997). *The innovator's dilemma: When new technologies cause great firms to fail.* Harvard Business Review Press.

Friedman, M. (1969). The optimum quantity of money and other essays. Aldine Transaction.
Gawer, A., & Cusumano, M. A. (2002). Platform leadership: How Intel, Microsoft, and Cisco drive industry innovation. Harvard Business Review Press.
Goodfriend, M. (2000). Overcoming the zero bound on interest rate policy. Journal of Money, Credit and Banking, 32(4), 1007-1035.
Merton, R. C. (1995). Financial innovation and the management and regulation of financial institutions. Journal of Banking & Finance, 19(3-4), 461-481.
Proctor, C. (2012). Mann on the Legal Aspect of Money. Oxford University Press.
Rogers, E. M. (1962). Diffusion of innovations. Free Press of Glencoe.
Zetzsche, D. A., Buckley, R. P., & Arner, D. W. (2017). The distributed liability of distributed ledgers: Legal risks of blockchain. University of Illinois Law Review, 2018(5), 1361-1405.
Kelton, S. (2020). The deficit myth: Modern monetary theory and the birth of the people's economy. PublicAffairs.
Lamport, L., Shostak, R., & Pease, M. (1982). The Byzantine generals problem. ACM Transactions on Programming Languages and Systems (TOPLAS), 4(3), 382-401.
Metcalfe, B. (2013). Metcalfe's law after 40 years of Ethernet. Computer, 46(12), 26-31.
Phillips, A. W. (1958). The relation between unemployment and the rate of change of money wage rates in the United Kingdom, 1861-1957. Economica, 25(100), 283-299.
Romer, P. M. (1990). Endogenous technological change. Journal of Political Economy, 98(5, Part 2), S71-S102.
Stallings, W. (2017). Cryptography and network security: Principles and practice. Pearson.
Triffin, R. (1960). Gold and the dollar crisis: The future of convertibility. Yale University Press.
Bank for International Settlements (BIS). (2020). *Central bank digital currencies: foundational principles and core features*. Retrieved from https://www.bis.org/publ/othp33.pdf
Bordo, M. D., & James, H. (2019). The Globalization of Currency and the Future of the International Monetary System. Hoover Institution.
https://www.behavioraleconomics.com/resources/mini-encyclopedia-of-be/status-quo-bias/#:~:text=Status%20quo%20bias%20is%20evident,of%20the%20decision%20is%20great.
Banerjee, A. V. (1992). A simple model of herd behavior. The Quarterly Journal of Economics, 107(3), 797-817.
Bank for International Settlements (BIS). (2020). Central bank digital currencies: foundational principles and core features. Retrieved from https://www.bis.org/publ/othp33.pdf
Friedman, M. (1969). The optimum quantity of money and other essays. Aldine Transaction.
Kahneman, D., & Tversky, A. (1979). Prospect theory: An analysis of decision under risk. Econometrica, 47(2), 263-291.
Kelton, S. (2020). The deficit myth: Modern monetary theory and the birth of the people's economy. PublicAffairs.
Lamport, L., Shostak, R., & Pease, M. (1982). The Byzantine generals problem. ACM Transactions on Programming Languages and Systems (TOPLAS), 4(3), 382-401.
Metcalfe, B. (2013). Metcalfe's law after 40 years of Ethernet. Computer, 46(12), 26-31.
Norman, D. A. (2002). The design of everyday things. Basic Books.
Phillips, A. W. (1958). The relation between unemployment and the rate of change of money wage rates in the United Kingdom, 1861-1957. Economica, 25(100), 283-299.
Rogoff, K. (2016). The curse of cash. Princeton University Press.
Romer, P. M. (1990). Endogenous technological change. Journal of Political Economy, 98(5, Part 2), S71-S102.

Stallings, W. (2017). Cryptography and network security: Principles and practice. Pearson.
Thaler, R. H. (1999). Mental accounting matters. Journal of Behavioral Decision Making, 12(3), 183-206.
Thaler, R. H., & Sunstein, C. R. (2008). Nudge: Improving decisions about health, wealth, and happiness. Yale University Press..
Auer, R., Cornelli, G., & Frost, J. (2020). Rise of the central bank digital currencies: drivers, approaches, and technologies. BIS Working Papers No. 880. Retrieved from https://www.bis.org/publ/work880.htm
https://www.stlouisfed.org/open-vault/2019/august/open-market-operations-monetary-policy-tools-explained
Arner, D. W., Buckley, R. P., & Zetzsche, D. A. (2021). Central Bank Digital Currencies: A Comparative Review. Asian Development Bank Institute Working Paper. Retrieved from https://www.adb.org/publications/central-bank-digital-currencies-comparative-review
Armelius, H., Claussen, C. A., & Hull, I. (2021). E-krona: An illustrative model. Sveriges Riksbank Economic Review, 2021:1. Retrieved from https://www.riksbank.se/globalassets/media/rapporter/pov/engelska/2021/economic-review-1-2021.pdf
Central Bank of The Bahamas. (2020). Project Sand Dollar: A Bahamas Payments System Modernisation Initiative. Retrieved from https://www.centralbankbahamas.com/sanddollar
Fan, J. (2021). China's Digital Yuan: An Update. Peterson Institute for International Economics. Retrieved from https://www.piie.com/blogs/china-economic-watch/chinas-digital-yuan-update
Sveriges Riksbank. (2020). The Riksbank's e-krona pilot. Retrieved from https://www.riksbank.se/en-gb/payments--cash/e-krona/the-e-krona-project/
Bank for International Settlements (BIS). (2022). Project mBridge: Connecting economies through CBDC. Retrieved from https://www.bis.org/publ/othp44.pdf
Gupta, A., & Majumder, S. (2023). The Role of RMB in International Trade: Emerging Trends and Geopolitical Implications. Intereconomics. Retrieved from https://www.intereconomics.eu/contents/year/2023/issue/3/article/domestic-and-global-implications-of-chinas-digital-currency.html
Intereconomics. (2023). Domestic and Global Implications of China's Digital Currency. Retrieved from https://www.intereconomics.eu/contents/year/2023/issue/3/article/domestic-and-global-implications-of-chinas-digital-currency.html
Tett, G. (2023). The push for de-dollarization: How China's digital yuan is part of a broader strategy. Financial Times. Retrieved from https://www.ft.com/content/0e7f2f48-1ab8-11e9-9c3a-518a7b6234a3
Sveriges Riksbank. (2023). The Riksbank's e-krona pilot: Phase 3 and future developments. Retrieved from https://www.riksbank.se/en-gb/payments--cash/e-krona/the-e-krona-project/
Accenture. (2023). Partnering with the Riksbank on the e-krona project. Retrieved from https://www.accenture.com/us-en/case-studies/consulting/swedens-e-krona-pilot
European Central Bank (ECB). (2023). CBDC and cross-border payments: Collaboration with the Riksbank. Retrieved from https://www.ecb.europa.eu/press/key/date/2023/html/ecb.sp230315.en.html
The Financial Times. (2023). Sweden's cashless society and the e-krona: An in-depth analysis. Retrieved from https://www.ft.com/content/6b24e5a6-fb2a-11ea-9b01-d2a2825b4b82
Central Bank of The Bahamas. (2023). Project Sand Dollar: Progress Report and Future Developments. Retrieved from https://www.centralbankbahamas.com/sanddollar

IMF. (2023). Digital Currencies in the Caribbean: Lessons from the Sand Dollar. Retrieved from https://www.imf.org/en/Publications/WP/Issues/2023/05/10/Digital-Currencies-in-the-Caribbean-Lessons-from-the-Sand-Dollar-530695
World Bank. (2023). Financial Inclusion and Digital Payments: The Case of The Bahamas' Sand Dollar. Retrieved from https://www.worldbank.org/en/news/feature/2023/01/30/financial-inclusion-and-digital-payments-the-case-of-the-bahamas-sand-dollar
Accenture. (2023). The Bahamas' Sand Dollar: Technology and Adoption. Retrieved from https://www.accenture.com/us-en/case-studies/consulting/the-bahamas-sand-dollar
European Central Bank (ECB). (2022). Public Attitudes Toward a Digital Euro. Retrieved from https://www.ecb.europa.eu/pub/pdf/other/ecb.pub20220320a~e1b6d42e11.en.pdf
Federal Reserve. (2023). Public Perception and Trust in Digital Currencies: A U.S. Perspective. Retrieved from https://www.federalreserve.gov/publications/public-opinion-digital-dollar.htm
Central Bank of Kenya. (2022). Survey on the Adoption of Digital Financial Services in Kenya. Retrieved from https://www.centralbank.go.ke/press/kenya-survey-digital-financial-services-2022.pdf
https://academy.moralis.io/blog/learn-the-difference-proof-of-work-vs-proof-of-stake
Bank of International Settlements (BIS). (2022). CBDCs and Financial Stability: Balancing Innovation and Risk. Retrieved from https://www.bis.org/publ/othp44.pdf
Prasad, E. (2022). The Future of Money: How the Digital Revolution is Transforming Currencies and Finance. Harvard University Press.
https://informationsecurity.wustl.edu/items/confidentiality-integrity-and-availability-the-cia-triad/
Auer, R., & Böhme, R. (2021). The Technology of Retail Central Bank Digital Currency. BIS Quarterly Review, March 2021. Retrieved from https://www.bis.org/publ/qtrpdf/r_qt2103j.htm
Bordo, M. D., & Levin, A. T. (2017). Central Bank Digital Currency and the Future of Monetary Policy. NBER Working Paper No. 23711. Retrieved from https://www.nber.org/papers/w23711
Kahn, C., Rivadeneyra, F., & Wong, T.-N. (2020). Should the Central Bank Issue E-money?. Bank of Canada Staff Discussion Paper 2020-12. Retrieved from https://www.bankofcanada.ca/2020/12/staff-discussion-paper-2020-12/
Armelius, H., Claussen, C. A., & Hull, I. (2020). On the Possibility of a Cashless Society. Sveriges Riksbank Economic Review, 2020:2. Retrieved from https://www.riksbank.se/en-gb/publications/economic-review/2020/on-the-possibility-of-a-cashless-society/
Adrian, T., & Mancini-Griffoli, T. (2019). The Rise of Digital Money. IMF Fintech Notes. Retrieved from https://www.imf.org/en/Publications/fintech-notes/Issues/2019/10/14/The-Rise-of-Digital-Money-48657
World Bank. (2021). Central Bank Digital Currencies for Financial Inclusion: Risks and Opportunities. Retrieved from https://documents.worldbank.org/en/publication/documents-reports/documentdetail/24448262
Narula, N., Catalini, C., & Goldstein, J. (2022). CBDCs in Developing Countries: Challenges and Opportunities. MIT Digital Currency Initiative. Retrieved from https://dci.mit.edu/cbdc-report
Garratt, R., & Lee, M. (2020). Monetary Policy and Central Bank Digital Currency: The Case of China. Federal Reserve Bank of New York Staff Reports. Retrieved from https://www.newyorkfed.org/research/staff_reports/sr955
Allen, S., Bittner, S., Chen, L., & Khan, R. (2020). *Design Choices for Central BankCertainly! Here's the continuation and conclusion of the section:

Allen, S., Bittner, S., Chen, L., & Khan, R. (2020). Design Choices for Central Bank Digital Currencies: Policy and Technical Considerations. Retrieved from https://www.brookings.edu/research/design-choices-for-central-bank-digital-currencies/
https://www.trinet.com/insights/generations-in-the-workplace-boomers-gen-x-gen-y-and-gen-z-explained#
Bank for International Settlements (BIS). (2023). CBDCs: Motivations, challenges, and opportunities. Retrieved from https://www.bis.org/publ/bppdf/bispap123.pdf
People's Bank of China (PBOC). (2022). Progress of Research & Development of E-CNY in China. Retrieved from http://www.pbc.gov.cn/en/3688110/3688172/4157443/4293696/2021071611084456816.pdf
European Central Bank (ECB). (2022). Digital Euro: Ensuring Privacy and Accessibility in a Digital Age. Retrieved from https://www.ecb.europa.eu/paym/digital_euro/html/index.en.html
Deloitte Insights. (2023). Millennials and Gen Z: A Digital Generation's Expectations of Financial Services. Retrieved from https://www2.deloitte.com/global/en/insights/topics/digital-transformation/millennials-gen-z-digital-financial-services.html
Central Bank of The Bahamas. (2023). Sand Dollar: Bahamas' Central Bank Digital Currency (CBDC) Project. Retrieved from https://www.centralbankbahamas.com/publications.php?cmd=view&id=16797&pre=y
Federal Reserve Bank. (2023). Public Attitudes Toward Digital Currencies: A National Survey. Retrieved from https://www.federalreserve.gov/newsevents/speech/brainard20230524a.htm
Sveriges Riksbank. (2022). The E-krona Pilot Phase 2: The Next Steps. Retrieved from https://www.riksbank.se/en-gb/payments--cash/e-krona/
Adrian, T., & Mancini-Griffoli, T. (2019). The Rise of Digital Money. International Monetary Fund.
Auer, R., Cornelli, G., & Frost, J. (2020). Rise of the central bank digital currencies: Drivers, approaches, and technologies. Bank for International Settlements.
Bech, M. L., & Garratt, R. (2017). Central bank cryptocurrencies. Bank for International Settlements Quarterly Review.
Böhme, R., Christin, N., Edelman, B., & Moore, T. (2015). Bitcoin: Economics, technology, and governance. Journal of Economic Perspectives.
Kahn, C. M., McAndrews, J., & Roberds, W. (2020). Central Bank Digital Currency: Technological and Policy Considerations. Journal of Economic Literature.
Keister, T., & Sanches, D. R. (2022). Should Central Banks Issue Digital Currency? Federal Reserve Bank of Philadelphia.
Rogoff, K. (2017). The Curse of Cash. Princeton University Press.
Ferrari, M., Mehl, A., & Stracca, L. (2020). Central bank digital currency in an open economy. ECB Working Paper Series, No. 2488. European Central Bank.
Retrieved from: https://www.econstor.eu/bitstream/10419/229102/1/ecb-wp2488.pdf
Keister, T., & Sanches, D. (2019). Should Central Banks Issue Digital Currency? Federal Reserve Bank of Philadelphia Working Paper, No. 19-26.
Retrieved from: https://www.philadelphiafed.org/-/media/frbp/assets/working-papers/2019/wp19-26.pdf
Andolfatto, D. (2021). Assessing the impact of central bank digital currency on private banks. Federal Reserve Bank of St. Louis Review, Vol. 103, No. 2, pp. 127–138.
DOI: 10.20955/r.103.127-38
Rogoff, K. (2016). The curse of cash. Princeton University Press.

ISBN: 978-0691172132
Brunnermeier, M. K., & Niepelt, D. (2019). On the equivalence of private and public money. Journal of Monetary Economics, Vol. 106, pp. 27-41.
DOI: 10.1016/j.jmoneco.2019.07.001
Bindseil, U. (2020). Tiered CBDC and the financial system. ECB Working Paper Series, No. 2351. European Central Bank.
Retrieved from: https://www.ecb.europa.eu/pub/pdf/scpwps/ecb.wp2351~d2d18d39d8.en.pdf
Niepelt, D. (2021). Digital money and central bank digital currency: implications for private banks. Journal of Economic Theory, Vol. 197.
DOI: 10.1016/j.jet.2021.105203
Auer, R., & Böhme, R. (2021). Central bank digital currency: the quest for minimally invasive technology. Journal of Economic Perspectives, Vol. 35, No. 2, pp. 161-182.
DOI: 10.1257/jep.35.2.161
Garratt, R., & Lee, M. (2021). Monetary Policy Implementation with CBDCs. Federal Reserve Bank of New York Staff Reports, No. 985.
Retrieved from: https://www.newyorkfed.org/research/staff_reports/sr985
Banerjee, A. V. (1992). A simple model of herd behavior. The Quarterly Journal of Economics, 107(3), 797-817.
BIS. (2020). Central bank digital currencies: foundational principles and core features. Bank for International Settlements.
Boel, P. (2021). Central bank digital currencies: The international dimension. Sveriges Riksbank Economic Review, 2, 6-19.
Chen, T., Goyal, A., & Yao, Z. (2010). Financial innovation and corporate liquidity management. European Financial Management, 16(3), 395-425.
European Central Bank. (2020). Exploring anonymity in central bank digital currencies. European Central Bank Report.
Gartner, J. (2022). The role of trust in the digital financial ecosystem. Journal of Financial Innovation, 12(4), 43-60.
Hodson, D. (2022). Public awareness campaigns for financial technologies. Financial Education Quarterly, 8(2), 90-104.
Kahneman, D. (2011). Thinking, fast and slow. Farrar, Straus and Giroux.
Banerjee, A. V. (1992). A Simple Model of Herd Behavior. The Quarterly Journal of Economics, 107(3), 797–817.
Böhme, R., Christin, N., Edelman, B., & Moore, T. (2015). Bitcoin: Economics, technology, and governance. Journal of Economic Perspectives, 29(2), 213–238.
Chandra, S., Srivastava, S. C., & Theng, Y. L. (2010). Evaluating the role of trust in consumer adoption of mobile payment systems: An empirical analysis. Communications of the Association for Information Systems, 27(1), 561–588.
Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. MIS Quarterly, 13(3), 319–340.
Gefen, D., Karahanna, E., & Straub, D. W. (2003). Trust and TAM in online shopping: An integrated model. MIS Quarterly, 27(1), 51–90.
Gustafsson, A., Herrmann, A., & Huber, F. (Eds.). (2018). Conjoint Measurement: Methods and Applications. Springer.
Kahneman, D., & Tversky, A. (1979). Prospect theory: An analysis of decision under risk. Econometrica, 47(2), 263–291.

Loewenstein, G., Sunstein, C. R., & Golman, R. (2015). Disclosure: Psychology changes everything. Annual Review of Economics, 7(1), 391–419.
Norges Bank. (2021). Central Bank Digital Currencies: Principles and Design Considerations. Norges Bank Papers.
Rogers, E. M. (2003). Diffusion of Innovations (5th ed.). Free Press.
Samuelson, W., & Zeckhauser, R. (1988). Status quo bias in decision making. Journal of Risk and Uncertainty, 1(1), 7–59.
Shefrin, H. M., & Thaler, R. H. (1988). The behavioral life-cycle hypothesis. Economic Inquiry, 26(4), 609–643.
Thaler, R. H. (1985). Mental accounting and consumer choice. Marketing Science, 4(3), 199–214.
Thaler, R. H., & Sunstein, C. R. (2008). Nudge: Improving Decisions About Health, Wealth, and Happiness. Yale University Press.
Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. MIS Quarterly, 27(3), 425–478.
Bank for International Settlements. (2021). CBDCs: Opportunities and Risks. BIS Papers.
European Central Bank. (2022). The Digital Euro: Public Consultation Report. ECB Publication.
IMF. (2022). CBDCs and Financial Stability: Balancing Innovation and Risk. IMF Working Paper.
People's Bank of China. (2023). Digital Yuan: Progress and Strategic Challenges. PBOC Report.
https://www.fatf-gafi.org/en/home.html#:~:text=The%20Financial%20Action%20Task%20Force,harm%20they%20cause%20to%20society.