# Central Bank Digital Currency (CBDC) – A Global Outlook

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**Abstract-The advent of central bank digital currencies (CBDCs) is revolutionizing the global financial landscape, with countries such as India, China, and Cambodia at the forefront of this digital transformation. This article provides an in-depth examination of the current state and future prospects of CBDCs, with a focus on their classification, technological frameworks, and economic implications. A key aspect of the discussion surrounding CBDCs is the debate over their classification, particularly with regards to currencies like China's Digital Currency Electronic Payment (DCEP) and Cambodia's Bakong, which have been criticized for not meeting the traditional definition of a CBDC due to their hybrid models and lack of direct central bank liability. In contrast, India's Digital Rupee is seen as aligning more closely with the narrow definition of a CBDC. The article highlights the diverse technological approaches being employed by different countries, including India's centralized ledger with blockchain elements, China's hybrid model, and Cambodia's permissioned blockchain. These designs are driven by the need for scalability, financial inclusion, and regulatory control. Looking ahead, the adoption of CBDCs is projected to grow significantly, with 20-30 countries expected to fully deploy retail CBDCs by 2030. This growth will be driven by the development of interoperability, privacy-enhancing technologies, and quantum-resistant cryptography. However, challenges such as privacy concerns, cybersecurity risks, and potential disruptions to the banking sector will need to be addressed.**

**Keywords: Digital Money, Smart Money, Central Bank Digital Currency (CBDC), Digital Currency, Electronic Payment (DCEP), Cryptocurrency, Distributed Ledger Technology, Token, Inclusive Finance, Banking, Payment System.**

## 1. INTRODUCTION

### Overview of Banking

Banking is the backbone of modern financial systems, facilitating economic activities by providing services such as deposit management, lending, and payment processing. Banks act as intermediaries between depositors, who save money, and borrowers, who seek funds for personal or business needs. They offer a range of products, including savings accounts, loans, mortgages, and investment services, while ensuring liquidity, security, and trust in financial transactions. Traditional banking operates under strict regulatory frameworks to maintain stability and protect consumers, with central banks overseeing monetary policy and financial oversight.

### What is a Central Bank Digital Currency (CBDC)?

CBDCs represent a significant evolution in the banking and financial landscape, blending traditional banking's stability with digital innovation. A Central Bank Digital Currency (CBDC) is a digital form of a country's fiat currency, issued and backed by its central bank. Unlike cryptocurrencies like Bitcoin, which are decentralized, CBDCs are centralized and operate under the control of the issuing authority. They aim to combine the benefits of digital currencies—such as fast, secure, and low-cost transactions—with the stability and trust of traditional fiat money. CBDCs can be designed for retail use (for the general public) or wholesale use (for financial institutions), depending on the central bank's objectives.

In India, the Digital Rupee is a step toward a more inclusive and efficient financial ecosystem, while globally, CBDCs are reshaping how money is used and managed. As central banks continue to experiment and refine their approaches, CBDCs could redefine the future of banking, offering both opportunities and challenges for economies worldwide.

Defining CBDCs: Broad vs. Narrow Perspectives

The classification of CBDCs remains contentious due to differing definitions. A broad definition includes any digital currency issued or authorized by a central bank, regardless of whether it appears as a liability on the central bank's balance sheet. This encompasses currencies like China's DCEP and Cambodia's Bakong, which are authorized by their respective central banks but may not be direct liabilities. Conversely, a narrow definition restricts CBDCs to digital currencies that are explicitly accounted for as liabilities on the central bank's balance sheet, fully backed by reserves or equivalent assets.

Benefits and Challenges of CBDCs

Benefits

- Efficiency: Faster and cheaper transactions, especially for cross-border payments.
- Financial Inclusion: Improved access to digital financial services for unbanked populations.
- Transparency: Reduced fraud and enhanced traceability of transactions.
- Monetary Policy: Central banks gain better tools to manage money supply and combat illicit activities.

Implications, Challenges and Considerations

The debates over CBDC classification and design have significant implications:

- Monetary Policy: CBDCs that are direct central bank liabilities (e.g., India's e₹) allow for precise control over money supply and interest rates. Hybrid models like DCEP may dilute this control, as commercial banks play a larger role.
- Financial Stability: Deposit-replacing CBDCs could disrupt commercial banks by reducing their deposit base, potentially leading to credit contraction. Full-reserve models mitigate this but require significant central bank resources.
- Privacy and Security: Centralized e-currencies like DCEP and the e₹ raise privacy concerns due to central bank oversight. Decentralized elements in systems like Bakong may offer more anonymity but require robust cybersecurity.
- Global Standardization: The lack of agreed-upon terminology and classification standards hinders international coordination, especially for cross-border CBDC interoperability.

Challenges -

- Cybersecurity: CBDC ecosystems are vulnerable to cyberattacks, requiring robust cryptographic protocols and stakeholder collaboration.
- Privacy Trade-Offs: Balancing user privacy with regulatory oversight remains a challenge, with countries like the EU and UK prioritizing privacy-enhancing technologies.
- Adoption Barriers: Limited adoption in countries like Nigeria highlights the need for user education and infrastructure development
- Scalability: Large economies like the US and EU require scalable technologies, favoring centralized or permissioned systems over public blockchains due to transaction volume demands.

## 2. REVIEW LITERATURE

A key concern surrounding central bank digital currencies (CBDCs) is their potential disintermediating effect on the banking sector, particularly the risk of bank runs during crises. This paper investigates the implications of an interest-bearing CBDC on banking crises using a dynamic bank run model with a financial accelerator. The analysis differentiates between bank failures due to illiquidity and insolvency. A numerical exercise reveals that CBDC reduces banks' net worth in normal times but mitigates bank run risk during crises. The financial stability implications depend on the central bank's balance sheet treatment of CBDC. If CBDC issuance is paired with asset purchases, it delays the onset of both types of bank failures. In contrast, if CBDC issuance is paired with loans to banks, it significantly reduces illiquidity-driven failures but has a limited impact on insolvency-driven failures. (Bitter. L, 2025)

The development and launch of central bank digital currencies (CBDCs) is a revolutionary innovation that presents an emerging research field. This paper provides a framework for understanding CBDCs, highlighting their differences from other digital currencies and cash in terms of advantages and disadvantages. The current and future outlook of CBDCs is discussed, and a cross-sectional analysis of

tweets with the CBDC hashtag is presented to explore prevalent themes and inform policymakers and decision-makers about the opportunities and challenges involved. The analysis aims to provide insights into the emerging landscape of CBDCs and support informed decision-making. (Ozturkcan. S, Senel. K, & Ozdinc. M, 2022).

This paper provides an overview of recent advances in central bank digital currency (CBDC) research, aiming to inform researchers, policymakers, and practitioners. The review reveals a consensus that CBDCs are central bank liabilities with cash-like attributes. Key motivations for issuing CBDCs include enhancing financial inclusion, improving monetary policy implementation, and promoting efficient digital payments. Many central banks are exploring CBDCs due to their potential benefits. However, some studies caution against over-optimism, citing design limitations and the challenge of meeting multiple competing objectives. Future research areas include finding the optimal CBDC design, empirical evidence on CBDC's impact on credit costs and financial stability, balancing user CBDC holdings, and conducting country-specific and regional case studies on CBDC design. These insights can guide further research and inform decision-making on CBDC development. (Peterson K. Ozili, 2023)

This paper explores key considerations for designing central bank digital currencies (CBDCs) that balance benefits and risks, highlighting best practices from a global perspective. China's CBDC serves as a case study to illustrate a two-tier or multi-tier ledger design, which enables central banks to manage process flows, focus on monitoring and control, and mitigate over-centralized risks. The paper proposes ten enablers for mass adoption and successful implementation. It concludes that CBDCs will be a primary tool in the future digital economy, and countries that master the technology will gain a competitive advantage. To ensure successful implementation, it is essential to learn from experience, continuously review existing regulations, and adapt to changing international dynamics. (Lee, D. K. C., Yan, L., & Wang, Y. 2021)

## 3. RESEARCH METHODOLOGY

Source of Data

Secondary research was conducted to study the CBDC Systems and its current positions around the world and in India, based on online or web-based reports, blogs, articles and research papers. This paper first offers conceptual discussion on the Government and its ideology over the CBDC in future.

Research Objectives

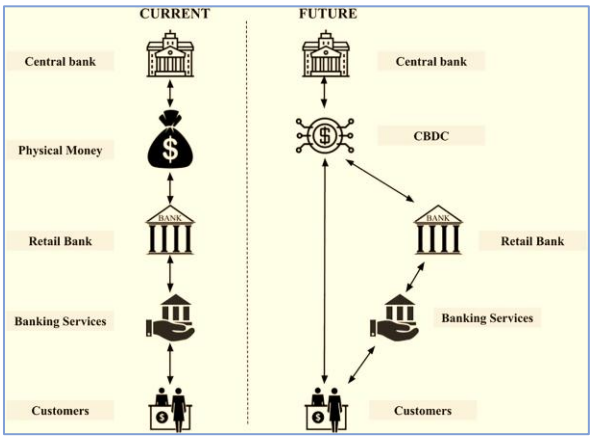
- To examine the CBDC implementation among various countries around the world, covering Indian perspectives.
- To understand technology, methodology to implement and its pivotal role in the economy.

Scope of the Study & Limitations

- The present study covers planning aspects on CBDC by countries, its adaptability and benefits with challenges and
- This study covers the steps taken and areas this can be implemented to be more efficient along with technology used to develop the currency.
- The aim is to unlock the potential for digital currency to replace traditional fiat money.
- This conceptual writing covers only based on various countries government plan and expert opinion based on the market news.
- The implementation of CBDC is only in its infant stage, various proposals are under scrutiny, based on these facts article tries to explore the future of the CBDC.

## 4. RESULTS AND DISCUSSION

Banking and Financial services: Current vs Future.




The development of central bank digital currencies (CBDCs) is gaining momentum, with the question no longer being if, but when and which digital currencies will be offered by various central banks. In response to this emerging trend, a collaboration between major central banks and the Bank for International

Settlements (BIS) has established common foundational principles and core features for CBDCs. The core principles include ensuring that CBDCs do not compromise monetary or financial stability, complementing existing forms of money, and promoting innovation and efficiency.

The introduction of CBDCs is expected to bring about both opportunities and challenges. One potential impact is the disruption of the traditional linear structure of financial services, which currently has the central bank at one end and customers at the other. With CBDCs, individuals may be able to hold accounts directly with the central bank, potentially reducing or eliminating the need for retail banks' deposit accounts. This could allow banks to focus on innovative financial services, but it also raises concerns about the potential loss of deposits and the impact on the banking system.

Another key consideration is the trade-off between the benefits of CBDCs and the potential loss of personal freedom and privacy. While physical money allows individuals to make choices about how they store and use their cash without sharing information, CBDCs would be fully traceable and potentially subject to disclosure requirements. This could enable better measures to identify illicit economies, such as money laundering, and improve taxation, but it also raises concerns about privacy and the potential for surveillance.

Current Context of Central Bank Digital Currency (CBDC) Classification and Design –

Central Bank Digital Currencies (CBDCs) are rapidly evolving as central banks worldwide explore digital alternatives to traditional fiat currencies. However, debates persist regarding their classification, design, and accounting treatment, particularly concerning whether certain digital currencies, such as China's Digital Currency Electronic Payment (DCEP) and Cambodia's Bakong, qualify as true CBDCs. This discussion hinges on varying definitions, the role of central bank liabilities, and the technological frameworks underpinning these currencies. This document examines the current situation, focusing on the classification debates, design considerations, and the implications for global financial systems, with a particular emphasis on India and other relevant jurisdictions as of July 22, 2025.

China's DCEP

China's Digital Currency Electronic Payment (DCEP), also known as the Digital Yuan (e-CNY), is a prominent example. Launched in pilot phases since 2020 by the People's Bank of China (PBoC), DCEP operates as a centralized digital currency integrated into China's payment ecosystem. It is designed to complement cash and reduce reliance on private payment platforms like Alipay and WeChat Pay. However, critics argue that DCEP does not fully qualify as a CBDC under the narrow definition because it functions as a "wrapped" currency. The PBoC authorizes commercial banks to distribute DCEP, which is backed by fiat reserves but not always recorded as a direct liability on the PBoC's balance sheet. Instead, it operates as a hybrid model where commercial banks hold reserves to back DCEP, blurring the line between central bank and commercial bank liabilities.

Cambodia's Bakong

Cambodia's Bakong, launched by the National Bank of Cambodia (NBC) in 2020, is another case study. Bakong is a blockchain-based digital currency aimed at enhancing financial inclusion and reducing cash dependency in a largely unbanked population. It operates as a centralized ledger system managed by the NBC, with participating financial institutions facilitating transactions. Like DCEP, Bakong is authorized by the central bank but is not always treated as a direct liability on the NBC's balance sheet. Instead, it functions as an electronic representation of the Cambodian riel, backed by fiat reserves held by participating institutions. This has led to debates about whether Bakong qualifies as a true CBDC or a synthetic CBDC (sCBDC), where the currency is issued by intermediaries under central bank oversight rather than directly by the central bank.

India's Digital Rupee

In India, the Reserve Bank of India (RBI) has taken a more traditional approach with its Digital Rupee (e₹), launched in pilot phases in December 2022. The e₹ is designed as a direct liability of the RBI, fitting the narrow definition of a CBDC. It operates on a centralized ledger (with blockchain elements under

exploration) and is fully backed by fiat reserves. The RBI has piloted both retail (for public use) and wholesale (for interbank transactions) versions, aiming to enhance financial inclusion, reduce transaction costs, and strengthen monetary policy control. Unlike DCEP or Bakong, the e₹'s accounting as a central bank liability is clear, aligning with the narrow CBDC definition.

Design Considerations: Full Reserve vs. Deposit Replacement

CBDCs can be designed to operate under different models, which further complicates their classification:

Central Bank Digital Currencies (CBDCs): Models and Implications

Full Reserve Model - In the full reserve model, CBDCs are entirely backed by reserves held by the central bank. This means that each digital unit of the currency corresponds to an equivalent amount of fiat currency or assets. This model aligns with the narrow definition of CBDCs, where the digital currency is a direct liability of the central bank. A notable example of this model is India's Digital Rupee (e₹), which is backed by reserves held by the Reserve Bank of India (RBI). This backing ensures stability and trust in the digital currency, as it is directly linked to the central bank's reserves.

Deposit Replacement Model - The deposit replacement model proposes a different approach, where CBDCs could potentially replace commercial bank deposits. In this scenario, individuals would hold digital currency directly with the central bank, reducing the role of commercial banks as intermediaries. However, this model raises questions about the nature of the CBDC's liability. It is unclear whether the CBDC would remain a central bank liability or if it would become a hybrid instrument backed by other assets. For instance, synthetic CBDCs (sCBDCs) involve private institutions issuing digital currencies under central bank authorization, with the underlying fiat held by these institutions rather than the central bank.

Hybrid Models and Ambiguity – Few of the CBDCs operate in a hybrid space, creating ambiguity about their liability classification. For example, China's Digital Currency Electronic Payment (DCEP) allows commercial banks to hold reserves to back the digital currency, while the People's Bank of China (PBoC) maintains oversight. This structure enables scalability but blurs the lines regarding the digital currency's status as a direct claim on the central bank. Similarly, Cambodia's Bakong relies on financial institutions to hold reserves, creating uncertainty about its classification as a true CBDC. In both cases, the involvement of commercial banks and financial institutions in holding reserves or backing the digital currency complicates the determination of whether the CBDC is a direct liability of the central bank.

Token vs. E-Currency: Terminology Challenges

Understanding CBDC Terminology and Models - The terminology surrounding Central Bank Digital Currencies (CBDCs) can be complex and nuanced. A key distinction lies between tokens and digital currencies:

Tokens vs. Digital Currencies

- Decentralized Tokens: These operate on blockchain or distributed ledger technology (DLT) without a single controlling entity. Examples include cryptocurrencies like Bitcoin or Ethereum.
- Centralized E-Currency: Managed by a central authority, such as a central bank, on a centralized ledger. This ensures control over issuance and transactions. Examples include India's Digital Rupee and China's Digital Currency Electronic Payment (DCEP).

Characteristics of Centralized E-Currencies

⇒ Centralized Ledger: Operated and managed by a central authority.

⇒ Control and Oversight: The central authority maintains control over the issuance, distribution, and transactions of the digital currency.

⇒ Examples:

⇒ India's Digital Rupee: Operates on a centralized system managed by the Reserve Bank of India (RBI).

⇒ China's DCEP: Uses a centralized ledger, incorporating blockchain elements for traceability.

⇒ Cambodia's Bakong: While blockchain-based, it is centralized in its governance, making it closer to an e-currency than a decentralized token.

Synthetic CBDCs (sCBDCs) and Liability
sCBDCs are digital currencies issued by private institutions (e.g., commercial banks) under central bank authorization. They are backed by fiat reserves but not necessarily recorded as a central bank liability. But arguments over this sCBDCs are not true CBDCs because they lack direct central bank issuance and liability status. Instead, they are "wrapped" currencies digital representations of fiat held by intermediaries.

Examples:
China's DCEP: Commercial banks issue DCEP to users, backed by reserves deposited with the People's Bank of China (PBoC). This structure allows the PBoC to maintain control without directly issuing the currency to the public.
Cambodia's Bakong: Relies on financial institutions to manage the currency's circulation, with the National Bank of Cambodia (NBC) providing oversight.

Implications and Debates

⇒ Scalability and Integration: sCBDCs prioritize scalability and integration with existing financial systems. However, this diverges from the narrow CBDC definition, sparking debates about their classification.
⇒ Liability Status: The lack of direct central bank liability in sCBDCs raises questions about their status as true CBDCs.
⇒ Standardized Terminology: The absence of standardized terminology globally complicates discussions, leading to misunderstandings and debates about the nature and classification of CBDCs.

CBDC Technology Adoption Across the Globe -
The technologies propositioned or adopted by various countries for introduction over Central Bank Digital Currencies (CBDCs), focusing on the technological frameworks outlined by their respective central banks or governments. The technological approaches, including whether they use blockchain, distributed ledger technology (DLT), centralized ledgers, or other systems, and highlights specific design choices where available.

India: Digital Rupee (e₹)
The Reserve Bank of India (RBI) has launched a pilot phase for the Digital Rupee, a central bank digital currency (CBDC), in December 2022. The Digital Rupee is being implemented using a centralized ledger system with blockchain-based elements under exploration for enhanced transparency and security. While the RBI has not fully committed to a public blockchain, it is utilizing a permissioned distributed ledger technology (DLT) to ensure controlled access and scalability.
The Digital Rupee is distributed through an intermediated model, where commercial banks and payment service providers manage user-facing digital wallets. The RBI maintains the core infrastructure, ensuring that the currency remains a direct liability of the central bank. This approach enables the RBI to leverage existing banking infrastructure to scale distribution while maintaining control over monetary policy and compliance.
In terms of security, the RBI employs cryptographic protocols to ensure transaction security and is exploring privacy-enhancing technologies to balance user anonymity with anti-money laundering (AML) requirements. The Digital Rupee is designed to integrate with existing payment systems like the Unified Payments Interface (UPI), leveraging India's robust digital payment infrastructure for seamless adoption.
The centralized approach adopted by the RBI ensures control over monetary policy and compliance, while the incorporation of blockchain elements enhances traceability and reduces fraud. The intermediated model allows for efficient distribution and scalability, making the Digital Rupee a promising initiative in India's digital payment landscape.

China: Digital Yuan (e-CNY/DCEP)
The People's Bank of China (PBoC) has been conducting large-scale pilots for the e-CNY since 2020, expanding it nationwide by 2022. As of 2025, the e-CNY has garnered over 300 million users.

Technology
The e-CNY utilizes a hybrid centralized ledger with blockchain components. The PBoC maintains a centralized ledger for core issuance and control, while permissioned blockchain elements are used for transaction processing and traceability. This system is

designed to ensure the PBoC retains authority over the ledger, rather than being fully decentralized.

Distribution and Usage
The e-CNY is distributed through an intermediated model, where commercial banks and private-sector payment platforms, such as Alipay and WeChat Pay, manage digital wallets. These institutions hold reserves to back the currency, ensuring its stability and legitimacy.

Features
The e-CNY incorporates several key features, including:
Controllable Anonymity: Cryptographic techniques allow for "controllable anonymity," enabling users to transact anonymously for legal purposes while allowing the PBoC to monitor transactions for AML and CTF compliance.
Smart Contract Integration: The e-CNY supports programmable payments, enabling use cases like automated government disbursements or conditional transactions.

Rationale
The hybrid model adopted by the PBoC balances scalability with central bank oversight, reducing reliance on private payment platforms while leveraging their infrastructure. The incorporation of blockchain technology enhances transaction efficiency and security, while controllable anonymity addresses privacy concerns. Overall, the e-CNY represents a significant step forward in China's digital payment landscape, offering a secure, efficient, and widely adopted digital currency.

Cambodia: Bakong
Bakong, Cambodia's digital currency, was launched in 2020 and has gained significant traction, with over 10 million users by 2025.

Technology
Bakong operates on a permissioned blockchain built using Hyperledger Fabric, a technology that allows for controlled access and transaction validation. The National Bank of Cambodia (NBC) manages the system, with financial institutions acting as nodes. This approach ensures the integrity and security of the blockchain.

Distribution and Access
The Bakong system uses an intermediated model, where participating banks and microfinance institutions facilitate user access through mobile apps and digital wallets. Fiat reserves back the currency, ensuring its stability and legitimacy.

Features
Bakong's design includes several key features:
Mobile Integration: Bakong is integrated with mobile applications, enabling low-cost, real-time transactions and promoting financial inclusion in rural areas.
Security Features: The system uses cryptographic protocols for secure transactions and is designed to be resilient against cyberattacks, while remaining centralized for regulatory oversight.

Rationale
The permissioned blockchain model adopted by Bakong allows for scalability and financial inclusion in a country with limited banking infrastructure. The centralization of the system ensures NBC control, while Hyperledger Fabric provides transparency and immutability without the energy-intensive consensus mechanisms of public blockchains. Overall, Bakong represents a significant step forward in Cambodia's digital payment landscape, offering a secure, efficient, and widely adopted digital currency.

Bahamas: Sand Dollar
The Sand Dollar, the central bank digital currency (CBDC) of the Bahamas, was launched in 2020 as one of the first retail CBDCs. This pioneering initiative has transformed the country's financial landscape.

Technology
The Sand Dollar operates on a centralized ledger with distributed ledger technology (DLT) elements. While not fully blockchain-based, the system incorporates DLT for secure transaction recording, ensuring the integrity and transparency of financial transactions.

Distribution and Access
The Sand Dollar is distributed through an intermediated model, where licensed financial institutions and payment providers manage digital wallets. The central bank maintains control over the core ledger, overseeing the entire system.

Key Features

The Sand Dollar's design includes several notable features:

Mobile-First Approach: The Sand Dollar is accessible via mobile apps, targeting financial inclusion for remote island communities with limited banking access. This approach enables residents to participate in the digital economy, regardless of their geographical location.

Privacy and AML Compliance: The system uses encryption for secure transactions and requires identity verification to comply with anti-money laundering (AML) regulations. While users can enjoy some level of convenience, full anonymity is limited to ensure regulatory compliance.

Rationale

The centralized DLT approach adopted by the Sand Dollar ensures low-cost, scalable transactions in the Bahamas' small economy. The mobile-first design addresses the geographical challenges of the archipelago, providing a secure, efficient, and widely accessible digital currency. By leveraging technology, the Sand Dollar promotes financial inclusion, economic growth, and innovation in the Bahamas.

Nigeria: eNaira

The eNaira, Nigeria's central bank digital currency (CBDC), was launched in 2021. While it has faced challenges in adoption, with limited uptake by 2025, the initiative remains a significant step in the country's digital payment landscape.

Technology

The eNaira operates on a permissioned blockchain built using Hyperledger Fabric, managed by the Central Bank of Nigeria (CBN). This technology ensures secure, transparent transaction records while maintaining central bank control over the financial system.

Distribution and Access

The eNaira is distributed through an intermediated model, where commercial banks and fintechs manage digital wallets. The CBN oversees the core infrastructure, ensuring the stability and legitimacy of the digital currency.

Key Features

The eNaira's design includes several notable features:

Mobile Integration: The eNaira is accessible via mobile apps, targeting Nigeria's large unbanked population. QR code-based payments enable offline transactions, increasing the currency's usability in areas with limited internet connectivity.

Security and Privacy: Cryptographic protocols secure transactions, but the system requires identity verification for anti-money laundering (AML) and counter-terrorism financing (CTF) compliance, reducing anonymity.

Rationale

The permissioned blockchain supports financial inclusion in Nigeria's cash-heavy economy, while centralization ensures regulatory oversight, supporting financial inclusion while mitigating risks. Mobile integration targets the unbanked, though adoption challenges persist due to low digital literacy and other factors. Despite these challenges, the eNaira represents a significant initiative in Nigeria's digital payment landscape.

European Union: Digital Euro

The European Central Bank (ECB) is currently in the research and pilot phase of its central bank digital currency (CBDC) project, known as the Digital Euro. A potential launch is anticipated post-2026.

Technology

The ECB is exploring two potential technological approaches for the Digital Euro:

Permissioned DLT: A permissioned distributed ledger technology (DLT) model, where licensed financial institutions operate nodes to distribute the Digital Euro. This approach would enable secure, transparent, and efficient transactions.

Centralized Ledger: A centralized ledger is also being considered for simpler implementation and control. This approach would allow the ECB to maintain direct oversight of the Digital Euro's core infrastructure.

Distribution and Access

The Digital Euro is expected to be distributed through an intermediated model, where financial institutions will manage user-facing services, such as digital wallets. The ECB will oversee the core infrastructure and issuance, ensuring the stability and legitimacy of the digital currency.

Key Features

The Digital Euro's design includes several notable features:

Privacy-Enhancing Technologies: The ECB is prioritizing privacy, exploring cryptographic techniques like zero-knowledge proofs to enable anonymous transactions for small payments while ensuring anti-money laundering (AML) and counter-terrorism financing (CTF) compliance for larger transactions.

Interoperability: The Digital Euro aims to integrate with existing payment systems like TARGET2 and TIPS for seamless cross-border and domestic transactions.

Rationale

The ECB's approach to the Digital Euro balances efficiency with control, while prioritizing privacy and interoperability. A permissioned DLT or centralized ledger would enable the ECB to maintain oversight while ensuring the Digital Euro's compatibility with Europe's advanced financial infrastructure. The use of privacy-enhancing technologies addresses citizen concerns about surveillance, making the Digital Euro a potentially attractive option for European residents.

United Kingdom: Digital Pound

The Bank of England (BoE) is currently in the research phase of its central bank digital currency (CBDC) project, known as the Digital Pound. A potential launch is anticipated after 2025.

Technology

The BoE is exploring a centralized ledger for the Digital Pound, while also conducting research into permissioned distributed ledger technology (DLT) for enhanced transparency and efficiency. This approach would allow the BoE to maintain control over the financial system while leveraging the benefits of DLT.

Distribution and Access

The Digital Pound is expected to be distributed through an intermediated model, where private-sector providers, such as banks and fintechs, will offer digital wallets. The BoE will manage the core ledger, ensuring the currency remains a central bank liability.

Key Features

The Digital Pound's design includes several notable features:

Privacy Protections: The BoE emphasizes privacy, with plans to use cryptographic protocols to prevent government or central bank access to personal data, except for anti-money laundering (AML) and counter-terrorism financing (CTF) purposes.

Programmability: The Digital Pound may support programmable payments, leveraging smart contract-like features to enable automated transactions, such as rent payments.

Rationale

The BoE's approach to the Digital Pound prioritizes control, trust, and innovation. A centralized approach ensures the BoE's control over the financial system, while DLT exploration aims to future-proof the system. Privacy protections address public concerns about surveillance, and programmability supports innovative use cases, making the Digital Pound a potentially attractive option for users.

United States: Digital Dollar (Hypothetical)

The US Federal Reserve is currently in the research phase of developing a central bank digital currency (CBDC), known as the Digital Dollar, with no decision on issuance as of 2025. Here's an overview of the project's status and key aspects :

Technology

Centralized Ledger with DLT Experiments: The Federal Reserve is exploring a centralized ledger for the Digital Dollar, while conducting experiments with permissioned distributed ledger technology (DLT) for enhanced scalability and security, such as Project Hamilton with MIT.

Intermediated Model: Private-sector intermediaries, like banks and fintechs, would manage digital wallets, while the Federal Reserve oversees the core infrastructure.

Key Features

Privacy and Security: The Federal Reserve prioritizes robust cybersecurity and privacy, leveraging existing anti-money laundering (AML) and know-your-customer (KYC) frameworks, and exploring privacy-enhancing technologies.

Interoperability: The Digital Dollar would integrate with existing payment systems like FedNow, ensuring compatibility with instant payment networks.

Rationale
Control and Scalability: A centralized ledger ensures Federal Reserve control, while DLT experiments assess scalability for a large economy like the US.
Public Trust: Privacy and cybersecurity are critical to maintaining public trust in the Digital Dollar.
It's worth noting that Fed Chairman Jerome Powell has stated that there will be no CBDC in the US while he is head of the Fed. However, the Digital Dollar Project warns that the US dollar must modernize its technology infrastructure to preserve its global reserve currency status, amid increasing competition from digital currencies and CBDCs worldwide

Jamaica: JAM-DEX
Jamaica's central bank digital currency, JAM-DEX, was launched in 2022, aiming to promote financial inclusion and efficiency in the country's financial system. Here's how it works:
Centralized Ledger: The Bank of Jamaica uses a centralized ledger to manage JAM-DEX, focusing on simplicity and control. This approach is considered cost-effective and suitable for Jamaica's small-scale financial system.
Intermediated Model: Financial institutions, such as banks and mobile wallet providers like Lynk, distribute JAM-DEX through digital wallets. The central bank oversees issuance and settlement, ensuring the stability and legitimacy of the digital currency.
Mobile Integration: JAM-DEX is accessible via mobile apps, targeting financial inclusion among the unbanked population. This approach enables users to transact digitally without needing traditional banking services.
Security Features: Encryption and identity verification ensure secure transactions and anti-money laundering (AML) compliance, protecting users and maintaining the integrity of the financial system.
The JAM-DEX initiative has shown promise, with the Bank of Jamaica issuing $230 million in CBDC during a pilot phase. The government has also incentivized adoption by offering rewards to users who open digital wallets. As of July 2025, Jamaica's CBDC expansion had brought about 115,000 subscribers, who executed 146,000 transactions. The Bank of Jamaica plans to host Christmas work programs to encourage payments in JAM-DEX and is partnering with the government to boost adoption.

Sweden: e-Krona
Sweden's central bank, Riksbank, has been testing a central bank digital currency (CBDC) called e-Krona since 2020. Here's an overview of the e-Krona's development:
Technology: The Riksbank is exploring a permissioned blockchain for the e-Krona, prioritizing scalability and security for retail transactions. This approach allows for controlled access and efficient transaction processing.
Distribution: The e-Krona will be distributed through an intermediated model, where banks and payment providers manage user-facing services, while the Riksbank oversees the core ledger.
Offline Capabilities: The e-Krona pilots include offline transaction capabilities using mobile apps, ensuring accessibility in low-connectivity areas and promoting financial inclusion.
Privacy Features: The Riksbank is investigating cryptographic techniques to balance user privacy with regulatory compliance, addressing public concerns in a privacy-conscious society.
The e-Krona aims to:
Complement cash: As Sweden becomes increasingly cashless, the e-Krona could ensure the public still has access to a secure and reliable form of central bank money.
Improve efficiency: A digital currency could streamline transactions, reduce costs, and enhance financial inclusion.
Support innovation: The e-Krona's design may incorporate programmability features, enabling automated transactions and innovative use cases.
However, Swedish banks have raised concerns about the potential impact on their operations, citing risks to financial stability and liquidity. The Riksbank will need to address these concerns as it moves forward with the e-Krona's development.

Observations – Opportunities and Threats
Most countries, including India, China, the UK, and the US, are opting for centralized ledgers or permissioned blockchains for their CBDCs. This approach enables central banks to maintain control over the issuance, distribution, and transactions of the digital currency, ensuring compliance with Anti-

Money Laundering (AML) and Counter-Terrorism Financing (CTF) regulations, as well as supporting monetary policy objectives. Permissioned blockchains, such as Hyperledger Fabric, are popular for their balance of transparency, security, and central oversight. Countries like Cambodia, Nigeria, and Sweden are using permissioned blockchains to achieve these benefits.

In terms of implementation, nearly all CBDCs are using an intermediated model, where private-sector institutions, such as banks and fintechs, handle user-facing services. This approach reduces the central bank's operational burden and leverages existing infrastructure and expertise. To address public concerns about surveillance, countries are exploring privacy-enhancing technologies, such as zero-knowledge proofs and controllable anonymity, while ensuring AML/CTF compliance through identity verification.

CBDCs are also being designed to integrate with existing payment systems, such as India's Unified Payments Interface (UPI), the US's FedNow Service, and the EU's TARGET2 system. This ensures seamless adoption and cross-border potential. Furthermore, CBDCs are targeting unbanked populations, particularly in developing economies, through mobile-first approaches and offline capabilities. Examples include the Bahamas, Nigeria, and Cambodia, which are using mobile-first approaches to increase accessibility, while Sweden is exploring offline capabilities to reach a wider audience.

By designing CBDCs with financial inclusion in mind, countries can promote greater access to financial services and reduce poverty. Overall, the design and implementation of CBDCs require careful consideration of various factors, including central bank control, regulatory compliance, privacy, security, interoperability, and financial inclusion.

## 5. CONCLUSION

The development of central bank digital currencies (CBDCs) is characterized by a diverse range of technological approaches, reflecting the unique economic priorities, infrastructure, and regulatory frameworks of each country. For instance, India's Digital Rupee employs a centralized ledger with blockchain elements to achieve control and scalability, whereas China's e-CNY utilizes a hybrid model to optimize efficiency. Other countries, such as Cambodia and Nigeria, have leveraged permissioned blockchains like Hyperledger Fabric to promote financial inclusion, while the European Union and the United Kingdom are exploring privacy-focused distributed ledger technology (DLT) systems. The United States, on the other hand, remains in the research phase, testing both centralized and DLT options.

Despite these differences, several common trends are emerging in CBDC development. Many countries are adopting intermediated models, incorporating privacy-enhancing technologies, and prioritizing interoperability with existing financial systems. Furthermore, there is a preference for centralized or permissioned DLT over decentralized blockchains, allowing central banks to maintain oversight and control. These technological choices aim to strike a balance between efficiency, security, and financial inclusion, while also addressing the complex challenges of privacy and cybersecurity.

The design and implementation of CBDCs can significantly impact their classification and functionality, highlighting the need for a nuanced understanding of different approaches. For example, the full reserve model, deposit replacement model, and hybrid approaches each have distinct implications for the potential benefits and challenges of CBDCs in the financial system. Similarly, understanding the differences between tokens, digital currencies, and synthetic CBDCs (sCBDCs) is crucial for navigating the complex landscape of CBDCs. The distinction between decentralized tokens and centralized e-currencies, as well as the nuances of sCBDCs, underscores the need for clarity and standardization in CBDC terminology.

As central banks continue to refine their approaches to CBDCs, the evolution of these digital currencies will likely shape the future of banking, financial inclusion, and monetary policy worldwide. The current situation surrounding CBDCs reflects a complex interplay of technological innovation, regulatory frameworks, and economic priorities. Systems like China's DCEP and Cambodia's Bakong, which challenge traditional classifications due to their hybrid designs and reliance on intermediaries, highlight the need for global consensus on terminology and standards. Ultimately,

the development of CBDCs will require ongoing collaboration and coordination among central banks, regulators, and other stakeholders to ensure that these digital currencies promote financial stability, efficiency, and inclusion.

Future Perspective –

The future of central bank digital currencies (CBDCs) is poised to have a transformative impact on the global financial landscape. With countries like India and China leading the charge, CBDCs are expected to account for 20-30% of global transactions by 2035. This growth will be driven by the adoption of centralized or permissioned distributed ledger technology (DLT) systems, privacy-enhancing technologies, and cross-border interoperability. As the development of CBDCs continues to evolve, classification debates will likely be resolved through the establishment of global standards that favor broader definitions, including hybrid models like China's Digital Currency Electronic Payment (DCEP).

However, the implementation of CBDCs also poses significant challenges, including concerns around privacy, cybersecurity, and potential disruption to the banking sector. To mitigate these risks, careful management and regulation will be essential. Despite these challenges, the potential benefits of CBDCs are immense, including enhanced financial inclusion, streamlined payments, and reshaped monetary policy. In addition, while projecting developments over the next 5–10 years based on current trends, technological frameworks, and policy directions.

India's Digital Rupee, with its robust infrastructure and focus on inclusion, is well-positioned to be a global leader in CBDC development. China's e-CNY, on the other hand, is expected to drive de-dollarization efforts and further solidify the country's influence in the global financial system. Over the next decade, CBDCs will redefine the financial landscape, striking a balance between innovation and stability.

As of mid 2025, over 100 countries are actively researching or piloting CBDCs, with some already implementing them at scale. The future outlook for CBDCs is shaped by ongoing global experimentation, technological advancements, and evolving economic priorities. As the development of CBDCs continues to unfold, it is essential to focus on the key trends and innovations that will shape the future of banking, finance, and monetary policy.

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