

An Exploratory study on the introduction of CBDCs (Central Banking Digital Currencies) by most central banks in the world. Are these a safer alternative and if so how and if so how and why? How are these new developments shaping monetary systems and cross Border payments?

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ABSTRACT

Central Bank Digital Currencies are being explored by central banks to be introduced in the economy. These would help in assisting the monetary policy of a central bank. The transmission of policy measures and the final target would be easier to achieve in an economy which is working on the CBDC framework. But the whole idea of functions of money would be mitigated if individuals are not given the option of holding cash. There have been real life instances where the economy that has been functioning without cash and with CBDCs have come to a standstill due to the government's policy. A hybrid situation where both CBDCs and cash are in existence would be an ideal one. The extent of cash in such economies could be monitored and restricted from evading taxes and being hoarded but at the same time giving flexibility to the holder in terms of choice.

Keywords: CBDC (Central Bank Digital Currency) , Monetary Policy, Cross-Border Payments, Monetary Sovereignty, Disintermediation, Programmable Money, Financial Inclusion , Physical Cash, Cashless Economy

1. Introduction

As the digitization of the world rapidly increases, banking systems across the world are exploring the usage of central bank digital currencies (CBDCs). CBDCs were primarily introduced in 1993, when the Bank of Finland launched the Avant smart card. However, the first significant experiments with CBDCs began in 2014, with the central Bank of Uruguay and China experimenting with e-Peso and e-CNY. A CBDC, or central banking digital currency, is a digital form of a country's fiat money issued and circulated by its central bank. CBDCs are modeled 1:1 to the country's traditional currency unlike cryptocurrencies which are decentralized and not

issued by a legal tender. CBDCs aim to provide a reliable form of digital payment system while reducing risks associated with commercial banks, such as credit and liquidity risks, because the central bank guarantees the funds. CBDCs have the revolutionary power to dictate developments at the intersection of finance and technology, as well as transforming financial systems given their properties as digital state money.

As of mid-2026, around 146 countries and currency unions are actively exploring CBDCs. This is a significant increase from just 87 countries in 2022, reflecting its amplified growth and global shift towards digital finance. The leading countries in research and development of CBDCs as of 2026 are emerging small market trailblazers: Bahamas, Nigeria, and Jamaica. There are countries with large scale pilot programs, with China, India, Russia, and Brazil in the lead, demonstrating retail CBDCs can reach mass-market scale. Amongst the countries advancing rapidly in CBDC development, India stands out due to the massive scale at which it is operating at and due to the complexity of navigating its financial ecosystems. The Reserve Bank of India (RBI) launched the digital rupee (₹) pilot in 2022, positioning the subcontinent as one of the largest economies experimenting with both wholesale and retail CBDCs. India's digital infrastructure, consisting of UPI, Aadhar, and widespread mobile penetration, creates a habitat perfect for CBDC adoption, while raising questions about how a state issued digital currency can co-exist with existing private payment systems. RBI's goals are focused on improving transparency and security of digital currencies, enhancing payment efficiency, reducing dependence on cash, and countering risk posed by private cryptocurrencies. India serves as one of the world's largest recipients of remittances, the digital rupee has significant implications for shaping the future of cross border transactions.

This paper will examine the economic, technological, and regulatory motivations behind the adoption of CBDCs, with a focus on RBI's initiatives. It evaluates the extent to which CBDCs offer safer alternatives to cryptocurrencies, the potential to reshape traditional functions of monetary systems, analyzing their implications for cross border payments and global financial integration.

2. Literature Review/Background

In the last 5 years, digital currencies have gained prominence globally at an exponential rate. The interest in the creation of digital wallets is driven by technological advancements in card payments, mobile apps, online banking, and digital tokens. The evolution of monetary systems has traditionally been viewed as a private sector development, however, in the past decade one of the most significant and consequential shifts introduces economies responses on shaping digital currencies. Throughout history, states have encouraged the development of the monetary system in order to support their geopolitical and economic interests, and the development of financial

institutions, central banking, to accelerate and sustain capitalistic markets. One form of digital payment method that has been introduced by the economies of countries is CBDCs (Central Banking Digital Currencies). CBDCs have been growing in popularity since, as countries worldwide explore its impact and implementation. CBDC growth projections feature a staggering Compound Annual Growth Rate (CAGR) of 19.2% and 30.15%. Since the sector has started to move out of pilot stages, total payment value is projected to skyrocket, with CBDC transactions expected to bypass nearly \$213 billion dollars.

Monetary policy can be defined as the strategies and tools a country's central bank uses to manage the money supply. This they do by controlling interest rates and regulating the availability of credit. The primary goal of a country is to promote stability, mitigate inflation, and regulate the availability of credit. The potential introduction of CBDCs represents the next major leap in finances, necessitated by rapid changes in how modern societies transact.

The origins of CBDCs can be traced as far back as the aftermath of the 2008 Global Financial Crisis, which created the path for public distrust in traditional banking systems and paved the way for the creation of Bitcoin in 2009. Cryptocurrencies, such as Bitcoin, do not come from a central bank or government: Instead, it is a digital asset generated through advanced computer software, cryptographic algorithms, and distributed networks. The concept of cryptocurrencies was conceptualized as far back as the 1980s, but the first fully functional implication of the digital money, Bitcoin, was officially launched in 2009 by an anonymous programmer under the pseudonym Satoshi Nakamoto. Bitcoin introduced the world to decentralized ledger technology (DLT) and the possibility of trustless, peer-to-peer transactions outside the purview of a middle man, aka banks. However, due to the extreme volatility of the first generations of cryptocurrencies, their utility as a standard of medium of exchange or unit of account became limited. To combat this, private sectors introduced stablecoins, digital currencies pegged to the value of a fiat currency, most commonly the US Dollar. Stablecoins successfully minimized price volatility, while introducing severe counterparty, liquidity, and operational risks, as they lacked legal backings from a sovereign state and often lacked transparent reserve audits.

The turning point that shifted central bank attitudes from a passive observation to an active approach occurred in 2019, when Meta announced the creation of Libra (rebranded as Diem). Libra threatened central banks by potentially usurping sovereignty and monetary control. Since it was backed by multi-currency reserves and tied to a global user base, central banks feared it would compromise their ability to control financial transactions, domestic interest rates, combat inflation, and enforce financial regulations. Consequently, the defense of national monetary sovereignty became the primary motivation for economy backed digital currencies.

Domestic market changes in 2019 accelerated the push for CBDCs. Economies in China, India, and Brazil, developed a rapid decline in physical cash usage; this was accompanied by the rise of private mobile payment applications, such as WeChat Pay, Alipay, and UPI. Private platforms monopolizing infrastructure poses threats to a state's financial ecosystem. If a private platform experiences a technical outage, or gets hacked: a nation's entire commercial activity could come to a halt. Central banks recognize that a state-issued digital alternative is necessary to ensure resilience, redundancy, and widespread accessibility of the payment infrastructures. As central banks finalized their research frameworks between 2020 and 2022, the introduction of CBDC into two distinct operational categories was introduced based on their target audience. *Wholesale CBDC* emerged as a digital form of bank money restricted to financial institutions, such as commercial banks and clearing houses. *Retail CBDCs*, on the other hand, are designed for the general public. *Retail CBDCs* vary between regions and are a digital equivalent to physical cash, allowing consumers and businesses to make direct, secure, and government-backed transactions. Emerging markets, such as India, use retail CBDCs to enhance financial inclusion, optimize government welfare delivery, and reduce heavy administrative costs associated with management of physical cash.

Through these compounding historical circumstances, ranging from decentralized critique of traditional banking, post-2008, to the threat of corporate stablecoins, CBDCs have evolved at the forefront of many nations as an evolution in monetary transactions and finance. The research and continued innovation into CBDC by central banks worldwide led CBDCs to metamorph from a theoretical macroeconomic concept into a geopolitical and economic initiative for central banks globally.

3. Research Gap and Methodology

The aim of this paper is to analyze the introduction of CBDCs as an authentic alternative to the use of cash. In developing economies with a huge informal sector, how relevant and practical would it be to shift to the CBDC system. Scandinavian countries have attempted to move towards CBDC but have encountered problems of complete control of monetary transactions in the economy. Cash transactions give a certain freedom to the spender as well as the purchaser in terms of control of wealth. CBDCs being completely a part of the central banks of an economy leads to a loss of this ownership. How far is this the correct path to follow given different types of governance of various countries? There are two aspects with respect to complete conversion to CBDCs. For developed economies, how far is it correct and practical to completely give up all cash ownership and for developing countries how far is it possible to convert all cash transactions in the informal economies.

The methodology adopted would be of the mixed type, where both quantitative and qualitative analysis would be adopted. All data collected and analyzed would be from authentic secondary resources. The quantitative data would be explained with the help of qualitative analysis.

4. Analysis of the Increasing Adoption of CBDCs across the world

One of the primary catalysts behind the rapid development of CBDCs is the perceived threat to national monetary sovereignty by corporations. Historically, the management and operations of currency have been designated by sovereign states; however, the rise of borderless, decentralized cryptocurrencies and corporate backed global stablecoins (such as Meta's Libra) presented a direct challenge to this monopoly. The global momentum towards CBDC represents more than just technological advancement from physical cash to digital tokens. It is a reengineering of the modern monetary system. By analyzing recent macroeconomic frameworks from the IMF, the European Central Bank (ECB), and empirical studies on the emerging markets, we see the complex realities of monetary sovereignty, control of central banks, and the solution required to mitigate systemic failure amongst financial institutions.

To successfully balance macroeconomic scales, global financial institutions and economic bodies, such as the ECB, have engineered a matrix of structural and regulatory solutions to counter the systemic threats inherent in a fully digitalized, state controlled currency. One of the major structural hazards is the risk of instantaneous digital bank runs and credit freezes during periods of intense market anxiety. Since citizens can effortlessly transfer their funds from vulnerable commercial banks to the safety of a CBDC with a single screen swipe, central banks have proposed instituting strict quantitative holding caps paired with two-tiered remuneration frameworks. This would help prevent structural disintermediation of the commercial banking system; the dual approach ensures that new public monetary instruments, specifically CBDCs, are utilized primarily as a medium of exchange rather than a massive, risk-free store of value. Under this system, balances held within designated caps earn a baseline or zero yield, while surplus funds are penalized with deeply negative interest rates. This preserves the deposit foundation necessary for private credit creation.

To alleviate the Orwellian privacy concerns and the administrative burden of performing KYC (Know-Your-Customer) and AML (Anti-Money Laundering) compliance auditing for millions of people, global authorities universally reject a direct banking model in favor of an indirect, two-tier operational architecture. Within this framework, the central bank acts strictly as a wholesale infrastructure provider, while regulated commercial banks and fintech corporations serve as strictly intermediaries managing the consumer facing front ends, digital wallets, and customer service. This decentralized approach allows for the integration of complex

cryptographic safeguards to achieve anonymity, ensuring that low-value, day-to-day retail microtransactions retain the complete, untraceable privacy of physical cash. While large scale assets trigger higher tier identity verification and regulatory visibility to actively suppress cyber-theft and illicit financing.

To truly prevent the digital exclusion of heavily cash reliant informal economies within developing nations, such as India and Brazil, central banks are researching hardware based, tokenized offline functionalities. This typically targets nations where smartphone connectivity and continuous cloud connectivity are structurally inconsistent across the country. By embedding secure hardware enclaves into low cost smart cards, basic feature phones, or specialized SIM cards, an individual can execute peer to device transactions using localized NFCs (Near Field Communication) or Bluetooth protocols. These tokens clear and settle permanently at electrical grid failures, and only sync with the central sovereign ledger once a device reestablishes network connection. The integration of this solution transforms the introduction of sovereign CBDC from an economic hazard into a resilient public utility, establishing a safe, government backed digital ecosystem that complements the existing payment structure while preserving the foundational stability of commercial market capitalism.

To mitigate severe systemic losses associated with a fully digitized, state operated currency, global monetary authorities such as the Reserve Bank of India (RBI) came up with a framework and strategic deployment of digital tokens, such as the deployment of the Digital Rupee. The RBI is implementing its CBDC through a phased, calibrated rollout while simultaneously integrating a multi layered defense system to counter severe threats like financial disintermediation, cyber fraud, and privacy risks. By expanding its retail, Digital Rupee, and wholesale to millions of users and dozens of commercial banks, the RBI is systematically testing security protocols before executing a nationwide launch.

The RBI's execution strategy lies upon a calibrated, multi stage rollout that leverages existing commercial bank infrastructure. By adopting this two-tiered distribution model, the RBI issues the Digital Rupee directly to commercial banks, which then handle client wallet distribution, customer service, and regulatory compliance. This strategy expands user scale through phased retail and wholesale pilots, introducing programmable features to automate targeted government subsidies and testing offline transaction capabilities for areas with limited internet access. Rather than completely transforming the monetary systems and financial institutions, this controlled form of approach allows the RBI to continuously gather quantitative, telemetry data, refine cyber defenses, and ensure stability before committing to nation wide adoption of CBDC.

Beyond just system resilience and financial inclusion, targeting CBDC also allows sovereign economies an unprecedented monetary authority for macroeconomic interventions. Unlike

physical fiat or traditional commercial bank deposits, CBDCs can be embedded with self-executing smart contracts. This transforms the transmission mechanism used in the status quo. Programmable currency allows central banks to precisely target economic stimulation by directing funds toward specific sectors and implementing time sensitive restrictions, such as expiration dates that combat liquidity traps and ensure consumer spending. Furthermore, this technology facilitates atomic settlements in wholesale markets, eliminating counterparty risks by allowing asset delivery and payment.

Finally we need to understand the cross border implications of CBDCs, this requires looking beyond domestic monetary policies and into the structure of global trade. International deployment of wholesale CBDCs is arguably the most disruptive shift in global finance since the establishment of the Bretton Woods System: this was a system of global monetary agreement established in 1944 that pegged currencies of 44 nations to the US Dollar, while backing the dollar with gold at \$35 per ounce. It established exchange rate stability and created the IMF and the World Bank before collapsing in the 1970s.

For decades, cross border payments have relied on the corresponding banking network, primarily facilitated through the SWIFT messaging system. This architecture is fundamentally asymmetric and structurally inefficient. For example, when a corporate entity in Thailand wants to pay a supplier in the UAE, the transaction rarely occurs directly between their local banks. Instead, the payment must hop through a chain of intermediary correspondent banks, often requiring conversion into a dominant global reserve currency (like the US dollar) before being converted into the final local currency. This multi-intersecting process creates trapped liquidity, which introduces a significant counterparty threat, and results in settlement times that can take up to five business days.

To resolve these conflicts, global monetary authorities are leaning towards shared ledger architecture known as mCBDCs. Which means, rather than sending messaging instructions across fragmented private banks, participating central banks can agree to operate on a single, shared, distributed ledger. By tokenizing their domestic fiat and hosting it on a mutually governed blockchain, nations can achieve atomic settlement. The theoretical capabilities of cross border payments using CBDCs have already shown signs of usage in the real world. The most prominent example is Project mBridge, a massive collaborative initiative between the central banks of China, Hong Kong, Thailand, and the UAE, with Saudi Arabia joining the framework later on. As of early 2026, the mBridge platform has evolved into an independent, high-volume financial system, processing over \$55 billion in cross border transactions while bypassing the traditional US Dollar banking network.

The expansion of these platforms represents a global shift in profound geopolitical power. By establishing a frictionless, peer-to-peer network for global trade using CBDCs, emerging economies can directly bypass the traditional dollar dominated clearinghouses. This strategy allows nations to capture their trade flows from external sanctions and geopolitical pressures. It transforms the US dollar's status from a structural necessity for global transactions to merely one of several available options. As these wholesale markets emerge and mature, while integrating more participating nations, we will witness the physical, technological infrastructure of a multipolar monetary system being laid down by financial institutions globally.

Ultimately, the global rise in research and development of CBDC signifies a fundamental reconstruction of modern monetary systems and financial institutions. By balancing both domestic and international interests through two-tiered distribution architectures, quantitative holding caps, and tokenized offline capabilities, central banks are successfully revamping commercial banking ecosystems while advancing financial institutions. Simultaneously, on the international stage, the introduction of multi-CBDC shared ledgers like Project mBridge is actively reshaping legacy correspondent bank frictions and bypassing the traditional dollar dominated clearinghouses. As sovereign based digital tokens bridge the gap between domestic policy transmissions and cross border settlement, they are also laying the framework for institutional and technological restructuring of highly resilient, friction free, and multiple global economies.

5. Role of Monetary Policy in Universal Usage of CBDCs

Bringing Central Bank Digital Currencies, or CBDCs, into the global economy is a massive shift—a total rethinking of how monetary policy works. It doesn't just tweak the edges of how governments manage money; it rewrites the script about who's in charge and how they interact with everything from everyday savings accounts to corporate finance.

Central banks—like the Fed, the ECB, the Bank of England—do not deal with the public directly. Instead, they pull their monetary levers by changing the rates they charge commercial banks. There's always a middleman: big banks, little banks, and regional banks. So, if a central bank increases rates to fight inflation, or cuts them to get the economy moving, they are hoping that commercial banks will pass these changes to the public—by increasing the savings rate earned on your savings or making business loans cheaper. Banks are businesses, they have to earn profit and meet their targets. At times they hesitate in passing the benefits of lower interest rates to the consumers. During downturns, they might not lower rates as quickly as the central bank wants, just to protect their income. Or, when panic hits, banks stash cash instead of lending it out, which means even the boldest moves by the central bank barely reach the real economy

immediately. There is always a lag between policies being adopted by the central banks and being passed onto the commercial banks to the public.

Adoption of CBDCs would disallow what has been mentioned above. If the central bank allows everyone to have a digital wallet, and cash sits in the same way as a checking account. Then instead of waiting for the bank to adjust the savings rate, the central bank can change the interest on digital dollars overnight. They want people to spend money. Just dial down the rate, and suddenly it doesn't make sense to sit on cash. CBDCs represent a profound paradigm shift in modern macroeconomics, rewriting the operational relationship between central banks, commercial financial institutions, and private citizens. While traditional fiat currency relies on a multi-tiered banking system to circulate money and implement monetary policies, a sovereign digital currency introduces a direct pipeline from the monetary authority to the consumer. This system streamlines economic interventions, but simultaneously introduces unprecedented mechanisms for financial control and systemic risk. By analyzing the structural mechanics of CBDCs, we can isolate four core dimensions of this transformation: the acceleration of direct monetary policy transmission, elimination of the zero lower bound, deployment of programmable fiscal stimulus, and the potential disintermediation of the commercial banking sector.

The current financial architecture consists of central banks influencing the economy indirectly by adjusting benchmark interest rates, relying on commercial banks to pass these changes down to consumers through retail loans and deposit accounts. This form of transmission mechanism is often plagued by delays, friction, and asymmetric adjustments. Direct monetary policy transmission via CBDCs eliminates these intermediaries entirely, allowing central banks to implement interest rate adjustments instantly across the entire economic landscape simultaneously. This direct relationship also effectively dismantles the macroeconomic constraint known as the *zero lower bound*: The zero lower bound or zero nominal lower bound is a macroeconomic problem that occurs when the short-term nominal interest rate is at or near zero leading to a *liquidity trap* and limiting the central banks's capacity of inflation targeting. In a traditional economy, central banks easily push nominal interest rates deep into negative territory because citizens cannot withdraw their funds as physical cash and hoard it to avoid losing equity. However, in a digital ecosystem where physical cash is non-existent, this evasion tactic becomes impossible. Central banks could directly apply negative interest rates to CBDC wallets, causing idle balance to steadily shrink. Even though this mechanism serves as a powerful tool to compel immediate consumer spending and jolt a frozen economy back to life, it sparks intense ethical debates regarding state overreach; as it can effectively penalize individual savings to enforce macroeconomic objectives.

Beyond basic interest rate adjustments, the true disruptive capability of CBDCs lies in programmable money, which would allow policy rules to be hardcoded directly into the currency. Unlike traditionally “helicopter money” (an unconventional macroeconomic policy proposal where a central bank creates a large sum of new money and distributes it directly to the public to revive a struggling economy) programmable stimulus can be bound to strict parameters, such as a 30-day expiration date or restrictions to vital sectors like groceries and local businesses. This targeting allows central planners to revive distressed industries without triggering broader inflationary pressures, while fundamentally stripping money of its neutrality. Consequently, currency is transformed from a simple medium of an exchange into an active behavioral tool for statecraft and social nudging, leading to a severe reduction of personal financial autonomy.

CBDCs introduce the systemic risk of commercial bank disintermediation, threatening the foundational model of fractional reserve lending. If citizens are able to hold risk-free accounts directly with the central bank, a rapid flight to safety during economic instability could drain commercial banks of the consumer deposits they rely on to fund long term credit products. This loss of liquidity would make ordinary business loans and mortgages more expensive or entirely inaccessible, forcing central banks to intervene heavily with holding caps or tiered interest structures to keep the private banking system alive. In conclusion, *by shifting money from a passive store of value to an instrument of public policy, CBDCs push the financial system into uncharted territory where macroeconomic precision exists in permanent, direct tension with individual financial freedom and private sector stability.*

6. Limitations of Moving Completely Away from a Cash Dominated System of Exchange

Even though a completely digital financial system powered by CBDCs promises enhanced transaction speeds, seamless tax compliance, and surgical macroeconomic control, it introduces critical structural fragility by eliminating physical cash as an offline failsafe. Digital financial services depend entirely on an interconnected web of electricity, cellular service, and remote data servers, making them highly vulnerable to single points of failure. When these systems collapse due to natural disasters, cyberattacks, or routine corporate eros, such as the massive July 2022 Rogers telecom outage in Canada, entire communities are instantaneously paralyzed, leaving citizens unable to purchase basic necessities like food, fuel, or medicine. Physical cash operates as a vital insurance policy, maintaining the economy during times of digital collapse and resilience.

Beyond just technological vulnerabilities, a purely digital monetary system presents an extreme threat to individual privacy and civil liberties as well, by eradicating transaction anonymity. When every financial exchange is mediated by a centralized ledger, private spending becomes

permanent public data, granting the state or network operators unprecedented visibility into personal behavior. This system allows financial access to be weaponized as a tool for political compliance, enabling authorities to bypass traditional judicial due process and unilaterally freeze the accounts of dissidents, protestors, or ordinary donors. The real-world execution of this capability was demonstrated during the 2022 Canadian Freedom Convoy protests, illustrating how a cashless society can enforce ideological alignment by aligning compliance directly into the core of a financial system.

Finally, mandating a 100% digital economy enforces a harsh mechanism of socioeconomic exclusion that disproportionately harms marginalized populations. Vulnerable groups, including senior citizens who struggle to navigate digital applications, rural families with spotty or nonexistent internet connectivity, and unbanked individuals, rely on cash not merely for convenience, but because their livelihoods depend on it. Stripping away physical currency completely draws a rigid societal barrier that deprives millions of people of their financial independence and dignity. True economic stability requires maintaining diverse transactional choices, ensuring that the most vulnerable members of society are not left stranded by the pursuit of absolute administrative efficiency.

7. Conclusion

The global proliferation of CBDCs represents the most significant shift in monetary systems since the abandonment of the gold standard. Driven by the rapid ascent of decentralized cryptocurrencies and private corporate stablecoins, central banks have entered a technological arms race to preserve sovereign authority. Unlike highly volatile crypto assets prone to speculative bubbles and exchange vulnerabilities, CBDCs offer a structurally superior safety profile because they are a medium of exchange into programmable software done by equipping central banks with domestic policy tools capable of deploying targeted fiscal stimulus and executing real-time adjustments to manage inflation with precision.

On the global stage, CBDCs are fundamentally altering global financial geopolitics by streamlining cross-border architecture. Decentralized initiatives, such as *Project mBridge*, collaboratively developed by central banks in China, the UAE, Thailand, and other nations, utilize advanced cryptography to enable speedy, peer-to-peer sovereign settlements. By bypassing traditional intermediary networks, such as the SWIFT system, and reducing reliance on US Dollar dominance, these platforms offer emerging economies a mechanism to insulate themselves from geopolitical choke points, trade sanctions, and currency weaponization. The international deployment of CBDCs introduces a fragmented, multipolar financial landscape characterized by greater regional autonomy.

However, the realization of a completely cashless architecture introduces severe vulnerabilities regarding civil liberties and systemic resilience. Centralizing all transactional data onto a state-monitored ledger eliminates financial privacy and creates an architecture ripe for political weaponization, demonstrated by the extrajudicial freezing of banks accounts during the 2022 Canadian protest response. A purely digital economy lacks the offline resilience of physical cash, exposing entire populations to catastrophic commerce halts during power grid failures or telecommunication outages. To mitigate these risks, a deliberate, hybrid approach, such as the Reserve Bank of India's cautious rollout of the Digital Rupee, is essential. By maintaining physical cash as a foundational baseline and insurance for online collapse, developing offline hardware wallets for network failures, and integrating privacy-preserving protocols like zero-knowledge proofs, central banks can find the necessary balance between administrative innovation and the preservation of public trust, individual autonomy, and systemic security.

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