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Central Bank Digital Currencies: A Systematic Literature Review



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Abstract

Central bank digital currencies (CBDCs) have moved from concept to large-scale experimentation, raising intertwined monetary, financial, technical, and legal questions. This paper presents a systematic literature review (SLR) of academic and official studies published between 2022 and mid-2025, screening major databases and institutional repositories and synthesizing 38 relevant contributions across six themes: bank intermediation, financial stability, technical design, monetary policy, regulation and international coordination, and financial inclusion and public trust. Methodologically, we apply transparent search, inclusion, and extraction protocols and classify evidence by approach (theoretical, empirical, case study/survey). The recent literature is dominated by formal models, complemented by nascent empirical work from pilots and market reactions. Three findings recur. First, disintermediation and run risks are not inherent to CBDC but hinge on design: tiered or low remuneration, quantitative holding limits, and – most commonly – two-tier retail architectures mitigate outflows while preserving competition in deposits. Second, an interest-bearing CBDC can strengthen policy-rate pass-through and broaden the toolkit (e.g., contingent remuneration), at the cost of careful calibration to safeguard stability. Third, privacy is pivotal for adoption; “privacy-by-design” for small transactions alongside robust AML/CFT is a consistent requirement. We contribute a comparative policy matrix that maps design choices (interest, limits, architecture, privacy) to their trade-offs across outcomes, offering practical guidance for phased implementation. Remaining gaps include limited real-world evidence, cross-border spillovers, distributional effects, and questions of scalability and cyber-resilience. Overall, the SLR supports cautious, incremental rollouts that complement, rather than displace, private intermediation.

Keywords

Central Bank Digital Currencies (CBDCs) · Bank Disintermediation · Financial Stability · Monetary Policy Transmission · CBDC Technical Design and Architecture

JEL Classification

E42 · E58 · G21



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Central Bank Digital Currencies: A Systematic Literature Review

Central Bank Digital Currencies (CBDCs) have emerged as a focal point of monetary innovation in the past few years. A CBDC is generally defined as a digital form of a country's sovereign currency, issued and backed by the central bank, intended to serve as legal tender for the public alongside cash and other forms of central bank money. Interest in CBDCs has been driven by multiple factors: the decline in the use of physical cash in some economies, the rise of privately issued cryptocurrencies and stablecoins, and the need to modernize payment systems. By 2022, the vast majority of central banks were exploring or actively developing CBDC prototypes, seeking potential benefits such as enhanced payments efficiency, greater financial inclusion, and sustained monetary sovereignty (i.e., preventing private or foreign digital monies from eroding control over the monetary system). At the same time, CBDCs raise significant economic and policy questions, including the risk of bank disintermediation, implications for financial stability, privacy concerns, and the need for robust technological infrastructure. These questions have spurred a rapidly growing body of literature, especially since 2020, as academics and policymakers analyze how a CBDC might transform the financial landscape.

A foundational distinction in CBDC designs is between retail and wholesale CBDCs. Retail CBDCs are intended for broad public use (by households and firms) as a digital cash equivalent, whereas wholesale CBDCs are restricted to financial institutions for interbank payments and settlements. Most active CBDC projects target the retail segment (for general-purpose use), while wholesale efforts often focus on improving cross-border or large-value settlement efficiency. Within retail CBDCs, a further classification arises in terms of architecture: A CBDC can be implemented in a direct (single-tier) model, where the central bank issues the CBDC and manages end-user accounts or wallets directly, or an indirect/intermediated (two-tier) model, where private intermediaries (such as commercial banks or payment service providers) distribute the CBDC to users while the central bank maintains the core ledger and liability. A hybrid approach is also possible, combining elements of both (for example, the central bank keeps a backup record of retail balances but day-to-day customer interface is handled by private entities).

By design, a retail CBDC is a digital liability of the central bank, just as physical cash is, and is typically envisioned to be accessible through digital wallets or accounts. Importantly, many proposed retail CBDCs would be token-based or value-based (authenticated by possession of a digital token, akin to cash) rather than purely account-based (authenticated by identity verification), although in practice hybrid approaches (with accounts but transferable by token-like mechanisms) are being considered. The technical platform for a CBDC can range from conventional centralized databases to distributed ledger technology (DLT) systems, or a combination thereof. Notably, early experiments (such as Project Aurum by the Hong Kong Monetary Authority and BIS Innovation Hub) demonstrated that a two-tier CBDC system can be built using

a hybrid of centralized and blockchain-based components. While DLT is not strictly required for CBDC implementation, it is often explored for its potential benefits in resilience and interoperability, especially in cross-border contexts.

As central banks move closer to potential deployment, researchers have been examining critical policy questions about CBDCs. How would a widely available CBDC affect traditional banks' deposit funding and credit provision? Could it trigger bank disintermediation or even destabilize the financial system during stress periods? How might CBDCs alter the transmission of monetary policy, for example by introducing an interest-bearing retail instrument directly controlled by the central bank? What design features (e.g. paying interest on CBDC, imposing holding limits, or ensuring privacy) are necessary to balance policy objectives

and mitigate risks? Since 2022, these questions have been increasingly addressed not only through theoretical models but also via empirical studies and case analyses, reflecting the gradual accumulation of data from CBDC pilots and related natural experiments (such as market reactions to CBDC announcements).

Scope and objectives: This paper presents a comprehensive systematic literature review (SLR) of the academic and policy literature on CBDCs from 2022 to 2025. We synthesize findings across multiple domains: (i) the impact of CBDCs on bank intermediation and the risk of disintermediation, (ii) financial stability considerations and risk mitigation measures, (iii) technical design approaches and infrastructure, (iv) implications for monetary policy transmission and effectiveness, (v) regulatory and international coordination issues, and (vi) financial inclusion and public trust aspects. In doing so, we evaluate how various CBDC design choices (such as interest-bearing features, quantitative holding limits, two-tier vs. direct architecture, and privacy levels) influence outcomes in these domains. A key contribution of this review is a comparative analysis of CBDC design features mapped to their economic and policy trade-offs (Section 9), including a policy decision matrix (Table 1) summarizing these trade-offs. The aim is to provide researchers and policy-makers with a structured understanding of the state of knowledge, areas of consensus or disagreement, and gaps that remain to be addressed.

Table 1

Policy Decision Matrix: Trade-offs of CBDC Design Choices on Key Outcomes

Design Feature	Bank Disintermediation	Financial Stability	Monetary Policy	Inclusion & Trust
Interest-Bearing CBDC	Increases deposit competition: banks likely lose more deposits as CBDC offers attractive risk-free return, raising disintermediation risk. However, can be tuned (lower rate to mitigate).	Policy tool for stability: central bank can adjust rate (e.g., lower to deter runs), but a high normal rate could amplify run incentives. Tiered/contingent rates can counteract runs.	Enhances transmission: aligns with policy rate, directly influences deposit rates, helps overcome the zero lower bound. New policy lever (CBDC rate) increases central bank control.	Pros and cons: offers everyone interest on holdings (promoting savings inclusion), but the public may be wary of negative rates or perceived “taxation” on money. If communicated well, can build trust; otherwise could reduce willingness to hold CBDC.
Design Feature	Bank Disintermediation	Financial Stability	Monetary Policy	Inclusion & Trust
Non-Interest (Zero-Interest) CBDC	Minimizes outflows: functions like cash—less incentive to shift large savings, so banks retain more deposits.	Limits run appeal: in crises people flee mainly for safety, not yield; overall run risk lower, but no rate tool beyond the zero floor.	Conventional transmission: similar to cash—doesn’t directly propagate rate cuts below 0; effective lower bound remains unless cash use drops.	High public comfort: conceptually simple; likely higher initial acceptance, though some may ask “why use it if it pays nothing?”.

Design Feature	Bank Disintermediation	Financial Stability	Monetary Policy	Inclusion & Trust
Holding Limits (Quantity Caps)	Protects banks: per-user caps directly curb deposit drain and wholesale shifts.	Safety valve against runs: slows/prevents rapid wholesale runs by construction.	Constrains policy impact: limits the share of money stock directly rate-controlled by the central bank.	Public perception mixed: high caps (e.g., \$5k–\$10k) rarely hinder normal use; reassures gradualism, but some may see “limited” usefulness.
Design Feature	Bank Disintermediation	Financial Stability	Monetary Policy	Inclusion & Trust
No Limits (Unlimited Holdings)	Greater disintermediation risk: no formal check on outflows—large players can move substantial funds.	Faster runs possible: mass exodus to CBDC is unconstrained; puts onus on LOLR and other tools.	Maximizes policy reach: the central bank can place any amount of liquidity directly into public hands.	Usefulness vs. trust: appeals to those wanting large balances, but may alarm banks/policymakers and indirectly affect public confidence.
Two-Tier Intermediated Model	Banks remain involved: mitigates disintermediation; banks can integrate CBDC into existing apps/services.	Leverages existing stability nets: intermediaries help smooth flows; oversight structure remains familiar.	Policy filtered through intermediaries: strong transmission with slightly less granular direct control; easier integration into the existing framework.	Familiar and convenient: leverages existing interfaces and outreach; can aid inclusion via branches/agents.
Design Feature	Bank Disintermediation	Financial Stability	Monetary Policy	Inclusion & Trust
Direct (Central Bank-Only) Model	Full disintermediation: central bank competes for deposits; banks rely more on wholesale funding.	Central bank shoulders stability management: runs become “runs to the central bank”; all on its balance sheet.	Direct policy & new capabilities: instantaneous rate changes, helicopter drops, targeting—but raises policy-politics concerns.	Trust and uptake challenges: UX and privacy concerns may dampen adoption.
Strong Privacy / Anonymity	May attract privacy-seeking depositors: marginal outflows possible.	Limited oversight data: harder to detect/mitigate emerging runs and illicit activity.	Tool constraints: per-user limits and differential rates are easier to evade (see	Boosts trust & adoption: privacy like cash aids inclusion and legitimacy.

Design Feature	Bank Disintermediation	Financial Stability	Monetary Policy	Inclusion & Trust
Low Privacy / Full Transparency	Neutral or deposit-retentive: surveillance fears may keep funds in bank accounts/cash instead of CBDC.	Maximum visibility & control: real-time monitoring and targeted interventions enhance stability/AML.	Policy flexibility: precise enforcement of limits/remuneration; operationally unconstrained.	Public wariness: may deter use beyond small necessities; risks undermining inclusion and uptake.

The rest of the paper is organized as follows. Section 2 describes the methodology used for selecting and reviewing the literature. Sections 3–8 present thematic findings across the six outcome domains listed above. Section 9 provides a comparative evaluation of CBDC design features and their policy implications, including a summary matrix and discussion of trade-offs. Section 10 concludes with an overview of insights and directions for future research.

Methodology

Search and Inclusion Criteria

To identify relevant contributions, we conducted a structured, database-driven search for academic and policy literature on central bank digital currencies (CBDCs) published between January 2022 and mid-2025. Searches were run in major economics repositories and indexing services (EconLit, IDEAS/RePEc, and Google Scholar) and complemented with working paper and institutional repositories (SSRN; central bank working paper series; and publications from international institutions such as the BIS and IMF). We additionally used backward and forward snowballing from key surveys and policy reports (e.g., Auer et al. (2022b)) to ensure coverage of influential and widely cited contributions that may not be indexed uniformly across databases.

Keywords combined a CBDC core term with theme-specific terms aligned with our outcome domains. The core query was built around (“central bank digital currency” OR CBDC) and, where relevant, prominent project names (e.g., “digital euro,” “digital pound,” e-CNY/digital yuan). These were paired with one or more domain terms such as (bank* OR deposit* OR intermediation OR disintermediation), (“financial stability” OR bank run*), (remuneration OR “interest-bearing” OR “holding limits”), (DLT OR “distributed ledger” OR privacy OR interoperability OR offline), (regulation OR AML/CFT OR legal tender OR cross-border), and (inclusion OR adoption OR trust OR survey). Search strings were iterated for each domain (e.g., “CBDC AND banks,” “CBDC AND privacy,” “CBDC AND monetary policy”).

We applied a PRISMA-inspired, two-stage screening process. First, titles and abstracts were screened to verify that the study explicitly analyzed a CBDC (retail or wholesale) and provided insight into at least one of our six outcome domains: (i) banking/intermediation and disintermediation risk, (ii) financial stability and risk mitigation, (iii) technical design and infrastructure, (iv) monetary policy transmission and implementation, (v) regulatory frameworks and international coordination, and (vi) financial inclusion and public trust. Second, full texts were assessed for eligibility and extractable analytical content. We excluded pure commentaries without analysis, purely technological papers lacking an economic/policy dimension, and sources without verifiable details or public availability. Specifically, the workflow followed: identification → title/abstract screening → full-text eligibility assessment → inclusion in the final synthesis.

After de-duplication and screening, 40 candidate studies met the inclusion criteria and were reviewed in full. During eligibility assessment, two items were excluded due to lack of verifiable details or public availability (Chiu and Rivadeneyra, 2021; Shafranovna et al., 2024). This yielded a final evidence base of 38 studies for the systematic literature review.

Characteristics of Included Studies

The literature on CBDC from 2022 onward is characterized by a blend of theoretical modeling and emerging empirical analysis. Out of the 38 core studies reviewed, the majority (over two-thirds) employ formal analytical models or simulations to examine CBDC impacts under various assumptions. For example, general equilibrium models (including Dynamic Stochastic General Equilibrium, overlapping generations, or New Monetarist frameworks) are used in many studies to capture macro-financial interactions. Approximately 28 of the studies can be classified as theoretical or conceptual framework development, often exploring hypothetical scenarios of CBDC adoption and its effects on bank balance sheets, monetary policy, or welfare. About 11 studies use qualitative or survey-based approaches, including systematic literature reviews and comparative case analyses of CBDC projects. Only a handful (roughly 4) provide direct empirical evidence, reflecting the nascent stage of real-world CBDCs. These empirical works include an event study of U.S. bank stock reactions to CBDC news and survey-based estimations of consumer demand for CBDC. A couple of studies document early experiences from live CBDCs or advanced pilots (e.g., the Bahamas' Sand Dollar, Nigeria's eNaira, or Project Jasper/Ubin) within broader analyses.

Geographically, the research often takes a global perspective or focuses on major economies. About 14 studies consider a broad international context or multiple regions (e.g., cross-country surveys or theoretical models not tied to a single country). Among country-specific studies, the United States and euro area feature prominently (each in roughly a dozen studies), reflecting the policy interest in a digital dollar or euro. There are also several contributions focusing on China (especially regarding the digital yuan), Canada, the U.K., and emerging markets. Notably, Auer et al. (2022b) survey global CBDC motives and developments, whereas others like Lei and Wang (2024) provide regional insights (for China's Greater Bay Area).

Data Extraction and Thematic Analysis

For each included study, we extracted key information including the research question, methodology (e.g., model type or empirical strategy), and main findings or conclusions. We then categorized findings according to the thematic domains of interest. This thematic synthesis allowed us to compare and contrast results across studies addressing similar issues (for example, multiple models assessing bank disintermediation risk, or various surveys on public adoption factors). We paid particular attention to design feature considerations noted in each study (e.g., whether the analysis assumed an interest-bearing CBDC, or whether it discussed limits or privacy), as these factors often explained differences in conclusions. The evidence was then organized into narrative sections (Sections 3–8) corresponding to each theme. Within each theme, we highlight points of consensus as well as divergent findings (including any contradicting evidence between studies) and identify the role of key design features in shaping outcomes. In Section 9, we synthesize these insights to evaluate specific design choices in a comparative manner. To aid readability, [Table 2](#) provides a concise overview of the key thematic insights and associated design levers synthesized across Sections 3–8.

Before turning to the detailed thematic synthesis, we provide a compact map of the main recurring findings in [Table 2](#).

Table 2

Summary of Key Thematic Insights (2022–mid-2025 CBDC Literature)

Theme (Sections 3–8)	Key thematic insights (what the literature broadly finds)	Design levers / policy implications highlighted in the literature
Bank disintermediation and banking	Deposit outflows are plausible, but magnitudes vary widely across models; outcomes depend on CBDC remuneration, holding limits, bank market power, and banks' ability to substitute funding. Some	Tiered/contingent remuneration; holding limits and/or frictions on large

Theme (Sections 3–8)	Key thematic insights (what the literature broadly finds)	Design levers / policy implications highlighted in the literature
Financial stability and run risk	<p>models highlight a competition effect (higher deposit rates) that can partially offset outflows.</p> <p>A retail CBDC can accelerate flight-to-safety in stress scenarios if conversions are frictionless. Yet multiple studies find run risk is manageable with safeguards and can even improve monitoring/early warning under certain designs.</p>	<p>conversions; two-tier intermediation; liquidity backstops to smooth funding transitions.</p> <p>Holding limits/caps, tiered remuneration (especially punitive rates on large balances), and contingent tools (e.g., adjusting remuneration or conversion constraints in stress episodes).</p>
Technical design and infrastructure	<p>Most proposals favor two-tier/hybrid architectures. DLT is explored for resilience and interoperability, but scalability and privacy remain key constraints. Offline functionality, cybersecurity, and interoperability standards are recurrent design priorities.</p>	<p>Two-tier architecture; permissioned/hybrid ledgers where appropriate; privacy-by-design (tiered privacy); open interfaces/APIs; offline/contingency mechanisms; robust cyber and operational resilience.</p>
Monetary policy transmission	<p>Interest-bearing CBDC can strengthen pass-through by providing a policy-linked retail rate and may relax the effective lower bound in cash-light economies. The presence of multiple administered rates (CBDC vs reserves) requires careful communication and operational design.</p>	<p>Clear remuneration framework (often tiered); alignment with the policy corridor; communication of the CBDC rate as part of the toolkit; safeguards to balance transmission gains with banking stability.</p>
Regulation and international coordination	<p>Implementation requires legal tender clarity, AML/CFT compliance, data governance, and consumer protection. Cross-border access raises spillover risks (digital dollarization/capital flight) and increases the value of standards for interoperability and information-sharing.</p>	<p>Legislative updates; tiered KYC/AML design; clear data-access governance; consumer redress rules; cross-border coordination and limits for non-resident usage; shared standards.</p>
Inclusion and public trust	<p>Inclusion benefits are design- and rollout-dependent; adoption is not automatic. Trust hinges on privacy assurances, security, reliability, and a clear complementarity with cash and existing payment options.</p>	<p>Multiple access modes (apps, cards, offline); low-cost basic services; tiered KYC for entry-level wallets; education and transparent governance; privacy protections for low-value payments with due-process access for larger transactions.</p>

Bank Disintermediation and the Future of Banking

One of the central questions in the CBDC debate is whether introducing a risk-free digital alternative to bank deposits will cause significant bank disintermediation, i.e. a reduction in traditional bank deposit funding and a corresponding shrinkage of bank lending. Early theoretical work raised the concern that if

consumers have the option to hold money in the form of a CBDC, especially an interest-bearing one, they might shift a substantial portion of funds out of bank deposits into CBDC, thereby “crowding out” banks’ primary source of cheap funding (deposits).

This could force banks to curtail lending or seek more expensive and volatile funding sources, potentially increasing loan rates and contracting credit in the economy. The literature from 2022 onward has largely corroborated that disintermediation is a real risk, though its magnitude depends crucially on CBDC design and banks’ responses.

Several studies model scenarios in which CBDC competes with bank deposits in household portfolios. Chang et al. (2023) develop a portfolio choice model with heterogeneous agents and find that introducing a CBDC tends to reduce equilibrium bank deposit volumes, as some depositors reallocate to CBDC for its safety and convenience. Similarly, Whited et al. (2023) estimate a dynamic banking model (calibrated to U.S. data) and predict that a widely adopted CBDC would lead to a non-trivial outflow of deposits from the banking sector. They quantify that impact on lending could be negative but modest if banks can replace lost deposits with other funding (such as wholesale borrowing), although bank profits might shrink due to higher funding costs. Empirical evidence supporting these model predictions is provided by Beckmann et al. (2024), who examine U.S. bank stock reactions around Federal Reserve communications on CBDC. They find that announcements perceived as increasing the likelihood of a retail CBDC caused statistically significant declines in the stock prices of banks that are more deposit-dependent. This suggests that markets anticipate CBDC could threaten banks’ low-cost deposit base. Importantly, Beckmann et al. (2024) also show that when officials emphasized measures to mitigate disintermediation risk (for instance, indicating a CBDC would be non-interest-bearing or subject to holding limits), the stock price declines for the most exposed banks were reversed into relative gains. This indicates that certain CBDC design choices can reassure investors by limiting deposit outflows.

The extent of disintermediation is highly sensitive to CBDC design parameters and the competitive response of banks. A consistent finding is that if the CBDC pays interest (especially interest close to or above rates on bank deposits), it will be a stronger substitute for deposits and thus draw more funds away from banks (Whited et al., 2023, 5). Andolfatto (2021a) demonstrated in a theoretical monopoly bank model that an interest-bearing CBDC would indeed compete with bank deposits; however, banks could respond by raising the deposit interest rates they offer, thereby retaining some deposits. In his model, if the central bank sets the CBDC interest rate moderately (for example, below typical bank deposit rates or similar to the interest on central bank reserves), banks’ optimal response can neutralize much of the outflow, resulting in only limited reduction in bank lending. This somewhat counter-intuitive result—CBDC need not drastically shrink banking activity—hinges on banks adjusting their pricing. It highlights that the competitive dynamics are crucial: banks with market power might initially lose rents but not volumes, as they match CBDC’s attractiveness up to a point (Andolfatto, 2021a). Kumhof and Noone (2021) likewise argue that remuneration tiering (setting a zero or low interest rate on CBDC up to a certain quantity per user, to make it unattractive as a large-scale investment) can significantly blunt deposit substitution while still allowing CBDC to function as a payments medium.

In line with these theoretical arguments, macroeconomic models with more complexity find a range of outcomes from near-complete disintermediation to net increases in intermediation, depending on conditions. Chiu et al. (2023) incorporate a CBDC into a general equilibrium banking model with imperfect competition (banks have market power in deposit markets). They show that if banks were previously earning oligopoly rents on deposits, the introduction of a CBDC (especially a CBDC with “cash-like” features such as

no interest) can spur banks to increase deposit rates to avoid losing customers, thereby transferring some rents to consumers. This competition effect can lead to an increase in total bank intermediation (“crowd-in”) in certain parameter ranges: more households deposit funds (or keep money in the banking system) when deposit rates improve, potentially offsetting the direct substitution into CBDC. In their quantitative assessment calibrated to Canada and the U.S., Chiu et al. (2023) indeed find cases where the volume of bank lending rises relative to a no-CBDC baseline, because banks respond by becoming more competitive. Another study by Chiu and Davoodalhosseini (2023) (with a focus on a “cash-like” CBDC design) similarly suggests macroeconomic benefits from inducing banks to operate more efficiently. These findings contradict a simplistic view that CBDC introduction always harms banks—instead, the impact is conditional on market structure and design. In economies or segments where banks have high margins due to market power, a CBDC can erode that power and improve allocative efficiency, potentially expanding credit availability if banks optimize to maintain market share.

That said, even studies finding potential “crowd-in” effects usually acknowledge that the composition of bank funding and profitability will change. Banks might need to rely more on non-deposit funding (e.g. issuing bonds or drawing on central bank credit lines) if significant deposits migrate to CBDC. Infante et al. (2023) point out that the overall effect on lending depends on banks’ access to such alternative funding and its cost. If capital markets are deep or the central bank provides ample liquidity, banks can replace lost deposits and maintain lending (though at lower profit margins). If not, a contraction in loan supply is more likely. Nyffenegger (2024) introduce a distinction between CBDC as a medium of exchange vs. a savings vehicle: if CBDC is primarily used for transactions and kept in limited amounts (medium of exchange), banks might lose some payments-related deposits but retain most savings balances, so disintermediation remains mild. Conversely, if CBDC is also attractive as a store of value for large balances (savings vehicle), the impact on bank funding would be much larger. Their model suggests that design choices like holding limits or unattractive interest on large CBDC holdings can ensure CBDC is used mainly for payments, thereby protecting banks’ role in maturity transformation and long-term savings intermediation (Nyffenegger, 2024).

In summary, the literature indicates that a retail CBDC could crowd out a portion of bank deposits, but the severity ranges widely. Key determinants include: (i) the interest rate on CBDC relative to bank deposit rates, (ii) quantitative limits or frictions on moving funds into CBDC, (iii) the competitive structure of the banking sector, and (iv) banks’ strategic responses (such as adjusting interest rates or fees). Empirical and model-based studies generally find non-negligible deposit outflows if CBDC is sufficiently attractive; for instance, Whited et al. (2023) estimate that even a modest adoption of CBDC could reduce aggregate bank lending by a small percentage, although they note the effect on lending in their calibrated scenario was less than 0.2% (given banks’ ability to adapt). Meanwhile, Beckmann et al. (2024) highlight that policy announcements can mitigate market-perceived risks—signals that the central bank would implement CBDC with safeguards (non-interest-bearing design, caps on holdings) led to positive reactions for deposit-heavy banks, implying confidence that such features can preserve the essence of the traditional intermediation role.

To conclude this section, there is consensus that CBDC design matters enormously for banking outcomes. A well-designed CBDC can minimize disintermediation risks: for example, a tiered remuneration structure (paying zero or below-market interest on large CBDC balances) and holding limits are frequently cited as tools to prevent an abrupt flight of deposits to CBDC in normal times. Conversely, a very attractive CBDC (high interest, no limits, perceived as perfectly safe) in a competitive banking market could siphon off deposits, though even then banks might innovate or adjust to sustain lending. The interplay of these factors is complex, and different studies reach somewhat different quantitative estimates, but no study outright dismisses the risk of disintermediation. The prudent takeaway for policymakers is that if maintaining credit provision is a priority, CBDC must be introduced with measures to calibrate its competitiveness vis-à-vis

bank deposits. Many authors (e.g., Kumhof and Noone (2021); Bindseil and Senner (2025)) stress that it is possible to design a CBDC that provides the public benefits (safer digital money, improved payments) without “breaking” the banking system, by carefully choosing parameters and providing banks time and facilities to adjust. This theme also closely links with financial stability, which we examine next, as sudden or excessive disintermediation could translate into systemic stress.

Financial Stability and Risk Mitigation

Beyond gradual disintermediation, policymakers are concerned that a CBDC could pose acute financial stability risks, particularly the potential to facilitate digital bank runs in times of stress. The intuition is that if depositors can at the click of a button transfer their bank deposits into a risk-free CBDC (especially if immediately available via a central bank app), then at the first sign of trouble with a bank or the banking system, depositors might rapidly shift en masse into CBDC, exacerbating a run on banks (Infante et al., 2023). This concern has been echoed by many central bankers and is a recurrent topic in the literature. Research in 2022–2025 delves into whether CBDC indeed increases run risk and what design or policy measures can mitigate such risks. The consensus is that without safeguards, CBDC could marginally increase run propensity, but well-crafted measures (tiered remuneration, quantity limits, and contingent policies) can significantly reduce this threat.

Several theoretical models explicitly incorporate bank run scenarios. Hoffmann et al. (2023) develop a global games model of bank runs where depositors choose between keeping funds in a bank vs. moving to CBDC. They find a U-shaped relationship between the CBDC interest rate and bank fragility: if CBDC remuneration is very low (close to zero) or if it is very high, bank run risk is elevated, whereas at intermediate levels banks adjust contract terms and stability can improve. The reasoning is that a very attractive CBDC (high interest) makes it a dominant option during any hint of trouble (so even healthy banks face panics), whereas a very unattractive CBDC (zero interest) might not attract normal times flows but in a crisis scenario depositors still run to it purely for safety, and banks have less competitive pressure to discipline themselves ex ante. However, when the CBDC has a moderate interest and banks compete by offering better deposit terms, depositors are less skittish, yielding a more stable outcome. This nuanced result underscores that whether CBDC increases fragility is not a binary yes/no but depends on calibration. Importantly, Hoffmann et al. (2023) evaluate various policy tools to mitigate runs: they show that imposing a cap on individual CBDC holdings can substantially raise the threshold for a run equilibrium (because large depositors cannot instantly withdraw all funds into CBDC), and a contingent remuneration policy—for instance, the central bank could lower the CBDC interest rate to zero or negative during a systemic crisis—can deter runs by making the CBDC less rewarding exactly when a rush would occur. These tools, in their model, can almost eliminate the difference in run propensity between a world with CBDC and one without, if implemented stringently (Hoffmann et al., 2023).

Another influential study by Keister and Monnet (2022) looks at CBDC and bank fragility through a model where banks invest in loans but face possible runs, and a CBDC provides an alternative transaction medium with perfect safety. They find that a properly designed CBDC can, somewhat counter-intuitively, reduce financial fragility. The mechanism is twofold: (1) if CBDC holdings are observable by the central bank in real time, unusual movements into CBDC can serve as an early warning indicator of bank distress (essentially providing more information to regulators about depositors’ confidence levels); (2) the central bank can act as a stabilizer by using CBDC to provide liquidity directly to the public if needed (for example, accommodating surges in CBDC demand by supplying more CBDC, thereby preventing fire sales of bank assets). In their framework, when a bank run threat looms, the ability of depositors to flee to CBDC does increase immediate pressure on banks, but because the central bank sees this happening it can swiftly intervene (for instance

by lending to banks or freezing conversions in extreme cases). Moreover, Keister and Monnet (2022) argue that if a CBDC exists, authorities will preemptively implement policies (like those tiered remunerations or caps) that make the system more robust, whereas without CBDC, runs remain but perhaps less monitored. In summary, they suggest that with the right policy stance, a CBDC need not undermine stability and might even enhance it by broadening the toolkit for managing liquidity crises.

Still, the prevailing view is cautious: many researchers stress that absent preventative measures, a CBDC does make fleeing from banks easier and thus could exacerbate a systemic bank run. Kumhof and Noone (2021) emphasize that to maintain financial stability, CBDC must be

introduced alongside measures such as: (i) quantity constraints (either hard limits on individual CBDC balances or temporary limits on conversion rates in stressed conditions), (ii) tiered remuneration (e.g., a lower or zero interest on large CBDC holdings, to disincentivize wholesale investors from hoarding CBDC in a panic), and (iii) possibly conversion fees or delays that could be imposed in emergencies (though these are politically sensitive). Their analysis, supported by calibrated scenarios, shows that these design features can make holding large sums of CBDC unattractive in normal times and slow the pace of runs, giving banks and regulators time to react. In fact, Kumhof and Noone (2021) argue that with a well-calibrated combination of an interest tier (for example, CBDC pays interest up to a modest amount per person but anything above that either pays no interest or incurs a penalty rate) and caps, one can simulate a situation where retail users enjoy CBDC for payments and small savings, but institutional or panic-driven shifts are discouraged. This aligns with proposals many central banks have discussed: e.g., the European Central Bank has contemplated tiered remuneration for a digital euro precisely to protect financial stability by preventing large-scale disintermediation in crisis scenarios (Bindseil, 2020).

Empirical insights on CBDC and stability remain limited due to the lack of actual crises with CBDC in place. However, one case often mentioned is the experience of China's e-CNY and its design: it is released in a two-tier fashion and with daily transaction and balance limits for individuals (at least in pilot phases), reflecting an intent to prevent large sudden flows. While no bank run has occurred to test it, these limits mirror the theoretical prescriptions found in the literature (Auer et al., 2022b). Another indirect piece of evidence is from (Beckmann et al., 2024): the positive stock reaction of deposit-heavy banks when officials mentioned non-interest-bearing CBDC or limits implies investors believed those features would reduce the risk of deposit flight or an abrupt shock to those banks' funding.

In sum, regarding financial stability, the literature finds that CBDC-related run risk is a manageable but important concern. Without safeguards, a CBDC can act as a "safe haven" that depositors run to at the first sign of bank trouble, potentially accelerating bank runs (as classically argued by Fernández-Villaverde and Sanches (2019)). With appropriate design and policy measures, however, this risk can be substantially mitigated. The measures discussed—tiered remuneration, holding limits, and possibly the ability to impose emergency conversion constraints—reduce the attractiveness of shifting large volumes into CBDC quickly, thereby keeping banks less vulnerable to sudden runs. Additionally, the presence of a CBDC might allow the central bank to play a more direct role in stabilizing the system during panic (for instance, by directly crediting individuals' CBDC wallets in lieu of deposit insurance payouts, or by observing flows and intervening preemptively). Policymakers generally appear to heed these findings: many have stated that if a retail CBDC is issued, it will likely have safeguards (e.g., the Bank of England noted it might implement a £20,000 holding limit in a digital pound initially, specifically citing financial stability reasons).

Finally, it is worth noting that a few studies consider scenarios of cross-border or foreign currency CBDCs and their stability implications. Popescu (2022) point out that if a "strong" currency CBDC (say, a digital dollar) is accessible in jurisdictions with weaker currencies or banking systems, it could facilitate digital

bank runs across borders—during stress, not only might domestic depositors flee to their own central bank's CBDC, but they might even convert into foreign CBDC if available, accelerating capital flight. This raises the need for international coordination (discussed later in Section 7) to ensure one country's CBDC doesn't inadvertently undermine another's financial stability. Such considerations reinforce the literature's overarching message: careful design and cooperative policy frameworks are essential to harness CBDC benefits without endangering stability.

Technical Design and Infrastructure

The successful implementation of a CBDC hinges on complex technical design and infrastructure decisions. The literature in this area addresses how to build a CBDC system that is secure, efficient, and scalable, while meeting policy goals such as privacy and interoperability. From 2022 to 2025, numerous publications—both technical surveys and case studies of pilots—have shed light on prevailing design approaches. A recurring theme is that most central banks favor a two-tier architecture where the central bank provides the core infrastructure and issues the CBDC, but intermediaries (banks or licensed payment service providers) handle customer-facing services. This approach leverages existing financial institutions for KYC/AML compliance and customer support, reducing the operational burden on the central bank and preserving a role for the private sector in payments innovation. For example, Auer et al. (2022b) note that virtually all advanced retail CBDC projects (e.g., the ECB's digital euro proposals, Sweden's e-krona pilot, China's e-CNY) involve private-sector intermediaries in distribution, rather than a pure direct model where citizens would bank solely with the central bank.

In terms of underlying technology, the debate often centers on using distributed ledger technology (DLT) versus conventional centralized databases. Studies like Tang and Si (2025) provide a global survey of CBDC technical designs across 44 countries, finding that a significant subset of experiments have utilized DLT (or blockchain) in some form, especially for proofs-of-concept, but many central banks remain open to or are actively considering centralized systems for efficiency reasons. The key advantages cited for DLT include enhanced resiliency (decentralized nodes reduce single points of failure) and potential for easier interoperability across borders or with other digital asset systems, as well as enabling programmability of money (smart contracts) (Tang and Si, 2025). However, concerns about DLT's scalability and privacy are prominent. Several studies question whether current DLT platforms can handle a nation's retail payment volumes with low latency and high throughput—processing tens or hundreds of thousands of transactions per second reliably. Mancini-Griffoli et al. (2019), for instance, remain cautious on DLT, pointing out that traditional centralized payment architectures (like those used in large RTGS systems or credit card networks) can typically process transactions at far greater

volumes than public blockchain platforms, and that fully decentralized consensus might be unnecessary for a trust-backed sovereign currency. Privacy trade-offs also arise: if a CBDC is on a distributed ledger, transaction data might be more broadly replicated (even if among permissioned nodes), raising the risk of data compromise, whereas a tightly controlled centralized database might allow easier implementation of data access controls. As a result, some central bank experiments (like the BIS Project Aurum (Hong Kong Monetary Authority (HKMA), 2022) and Project Dunbar (Gorton and Zhang, 2022)) use hybrid models—permissioned DLT with only central bank and select financial institutions as nodes, combining cryptographic techniques to protect privacy.

The literature identifies privacy, cybersecurity, interoperability, and programmability as key technical challenges and design focal points. Privacy is especially delicate: CBDC systems must comply with anti-money laundering (AML) and combating the financing of terrorism (CFT) regulations, which suggests some level of identity-linking or traceability for transactions above certain thresholds. Yet, to gain public trust,

a CBDC should ideally offer cash-like privacy for everyday small transactions. Technically, achieving this balance has led to proposals for tiered privacy: users might transact anonymously (or pseudonymously) up to a low-value limit, beyond which identification is required. Choi et al. (2025) highlight that consumer demand for CBDC is higher when privacy protections are assured; their structural analysis with survey data indicates a significant fraction of the public would only adopt a CBDC if it offers at least some privacy guarantees (e.g., not all transaction details visible to authorities by default). Some technical solutions, such as zero-knowledge proofs or blind signatures, have been discussed in the context of CBDC to enable verification of transactions without revealing identities, but these add complexity and are still being tested in pilot form (for instance, the ECB's investigation into a "privacy-enhancing technique" for digital euro small payments, or MIT's work with the Boston Fed on a privacy-preserving CBDC prototype).

Interoperability refers to the ability of the CBDC to interface with existing banking systems, other countries' CBDCs, and possibly other payment platforms. Tang and Si (2025) note that an interoperable CBDC—one that can be seamlessly exchanged or used in cross-border payments—could unlock enormous efficiency gains in international transactions. Several multicountry experiments (such as Project mBridge involving the BIS and central banks of Hong Kong, Thailand, UAE, and China) have demonstrated the technical feasibility of connecting multiple wholesale CBDC ledgers for cross-border trade settlement. However, at the retail level, interoperability also means making sure the CBDC can be used in the same point-of-sale and online contexts as other forms of money (integration with payment terminals, mobile apps, etc.). Many studies emphasize a modular, flexible infrastructure that can adapt over time. For example, Auer et al. (2021) advocates for building CBDC systems with open APIs and possibly open-source components, allowing private sector innovation on top of the core infrastructure. Indeed, Tang and Si (2025) find that some central banks plan to publish technical

standards or even open-source certain parts of their CBDC code to encourage compatibility and innovation. The rationale is that a CBDC ecosystem will need a variety of wallet providers, fintech services (like programmable payment logic for businesses), and so forth, which is best achieved if the core is not a closed proprietary system.

Related to this, public-private collaboration is a recurring recommendation. Several studies argue that the central bank should not attempt to "go it alone" in building and running everything, but rather harness the expertise of commercial banks, fintech firms, and academia. Boar and Wehrli (2021) describe how their approach was to engage external stakeholders in prototyping (e.g., hackathons, partnerships with tech firms) to ensure the CBDC design is robust and user-friendly. Such collaborations can also help address cybersecurity: involving experienced industry players can strengthen defenses and continuous monitoring. Cybersecurity is of paramount importance since a CBDC will presumably be part of national critical infrastructure. While detailed cybersecurity discussions are often beyond the scope of public literature (for security reasons), it's acknowledged that introducing a CBDC expands the attack surface that central banks must defend (now including possibly millions of retail endpoints if devices store value, etc.). Therefore, technical designs like hardware security modules, secure element chips in phones, or dedicated physical tokens (smart cards) for offline CBDC use are considered to ensure the system's resilience even if parts of the network (users' devices or certain intermediaries) are compromised.

Lastly, programmability and smart contracts integration are sometimes touted advantages of a CBDC infrastructure. A few studies explore use cases such as programmable payments (e.g., automatic tax or conditional transfers) that a CBDC might natively support. Chiu and Rivadeneyra (2021) discuss how a CBDC could be embedded with logic to allow things like timebound money (vouchers that expire) or micro-automated transactions in IoT contexts. However, others caution that programmability can be achieved through

platforms layered on top of money (as is done currently with bank money and fintech apps) and that building it into the base layer of CBDC might introduce risks (bugs or vulnerabilities in smart contract code affecting the money supply or transactions). The consensus is not settled, but a modular approach is often suggested: make the CBDC capable of supporting smart contracts, but perhaps keep the core ledger simple and allow private sector to develop programmable features via secure interfaces.

In summary, technical design debates revolve around ensuring the CBDC system is robust, secure, and user-acceptable. Key points from the literature include:

- Two-tier (hybrid) architectures are preferred to balance innovation and legacy integration, and to avoid the central bank becoming a retail service provider at scale.
- DLT vs centralized: many pilots use DLT, but performance and privacy concerns mean some central banks lean toward non-DLT or permissioned DLT solutions. Some studies question DLT's necessity and highlight scalability issues.
- Privacy and data protection are pivotal: designs likely include anonymity for low-value payments and robust encryption. Public trust in the technology will depend on perceived privacy (as well as reliability).
- Interoperability and flexibility: building with standard interfaces, possibly open source components, and involving private intermediaries to foster an ecosystem of services around CBDC is recommended.
- Resilience: the system should operate even if power/internet is down in parts (hence proposals for offline functionality using secure hardware), and withstand cyber-attacks, requiring state-of-the-art IT security measures at the core and endpoint levels.

Ultimately, technical design is an area where theory meets practice; as actual pilot results come in (e.g., report on Project Aurum (Hong Kong Monetary Authority (HKMA), 2022)), they feed into the literature, refining what is considered feasible or optimal. The period 2022–2025 has seen significant progress, but also recognition that no one-size-fits-all: each jurisdiction might tailor its CBDC infrastructure depending on existing payment systems and policy priorities.

Monetary Policy Transmission and Efficacy

The introduction of a CBDC could have profound implications for monetary policy transmission. By providing a new form of central bank liability directly accessible to the public, the CBDC changes the monetary policy toolkit and how policy decisions propagate through the economy. The literature generally finds that a CBDC enhances the central bank's ability to transmit policy rates to households and firms, especially if the CBDC is interest-bearing, but also notes potential complications in managing policy if not well coordinated with other instruments.

A primary argument in favour of CBDC from a monetary policy perspective is that it can serve as an instrument to strengthen the pass-through of interest rates. Meaning et al. (2018), in their early analysis, highlighted that if a central bank could pay interest (including possibly negative interest) on a universally accessible CBDC, it could overcome the effective lower bound imposed by zero-interest cash. In scenarios where cash usage is dwindling, a CBDC could allow the policy rate to directly influence the return on virtually all liquid assets held by the public, thereby broadening the impact of monetary policy changes. For instance, in an environment of very low or negative interest rates, holding cash yields zero, so people might hoard cash rather than accept negative deposit rates—a CBDC with properly designed interest could

mitigate this by either discouraging hoarding or by enabling negative remuneration on digital holdings if needed, thus preserving the potency of monetary policy (Meaning et al., 2018). More generally, Jiang and Zhu (2021) show that in a model calibrated on Canadian and U.S. data, introducing an interest-bearing CBDC improves the pass-through from the central bank's policy rate to deposit and lending rates in the banking system, particularly in situations where banks have market power. In their model, banks normally do not pass the full extent of policy rate changes to depositors (especially cuts, due to deposit rate floors), but with a CBDC, depositors have an alternative, forcing banks to adjust their deposit and lending rates more in line with the policy rate changes to avoid disintermediation. Thus, monetary policy becomes more "effective" in influencing credit conditions and aggregate demand (Jiang and Zhu, 2021).

However, the literature also acknowledges complexities. For one, monetary policy implementation must account for the interplay between CBDC and banks' demand for reserves. Kumhof and Noone (2021) analyze how having a CBDC alongside reserve balances might change a central bank's balance sheet and interest rate control. If a significant share of money is held as CBDC, the central bank could adjust the interest on CBDC as a novel policy rate (distinct from the interest on excess reserves, IOER). This raises questions: should the CBDC interest rate equal the policy rate or IOER? If not, what is the optimal spread? Some studies (like Bindseil and Senner (2025)) argue that setting the CBDC interest slightly lower than market rates can help prevent massive outflows from bank deposits, yet still provide a floor to deposit rates. But having multiple rates (one on CBDC, one on reserves) could complicate policy signals and arbitrage relationships. Niepelt (2020) and Schilling et al. (2021) have explored conditions under which the presence of a CBDC is neutral for monetary policy (i.e., certain designs allow an equivalent outcome as before), versus when it changes equilibrium outcomes. One key insight is that if CBDC simply replaces physical cash (which is non-interest-bearing) with an instrument that can bear interest, then the central bank effectively gains an additional lever (the CBDC rate) that can complement conventional policy. If cash remains, but CBDC coexists, then if interest rates go deeply negative, people might shift to cash unless measures are taken (like curbing cash or using holding fees on cash as some theoretical proposals go). So, CBDC could make negative rates more feasible by reducing reliance on cash, as noted by Bordo and Levin (2019).

Another angle is how CBDC might alter the transmission through bank lending and credit channels. If, as discussed in Section 3, a CBDC exerts competitive pressure on banks, one result might be narrower interest spreads (banks pay more to depositors, accept slightly lower margins) (Chiu et al., 2023). This could mean that for a given central bank policy cut, banks are quicker to lower loan rates to remain competitive and retain borrowers (since deposit funding might become more elastic). Conversely, if a CBDC causes some bank disintermediation, banks might become more reliant on wholesale funding which typically links more directly to central bank rates or market rates, potentially also tightening the link between policy changes and banks' cost of funds. Garratt et al. (2022) investigate the influence of CBDC design on market structure and policy pass-through. Their multi-sector model suggests that if CBDC draws deposits mostly from smaller banks or non-banks and consolidates funds in the central bank or large banks, there could be changes in competition that affect how evenly policy gets transmitted across regions or bank types. For example, large banks might weather a deposit outflow better than small community banks, possibly affecting the distribution of credit (a structural effect beyond aggregate transmission). They caution that policymakers might need to monitor such structural shifts—monetary transmission might strengthen on average but could become uneven if some segments lose access to funding.

The possibility of using CBDC for direct monetary policy operations is also discussed. For instance, Auer et al. (2022b) entertain the idea that a central bank could conduct "helicopter drops" more directly via CBDC: crediting each citizen's CBDC wallet in a crisis to stimulate spending. While this veers into fiscal territory, it underscores that CBDC infrastructure could allow novel forms of policy implementation that were not

feasible with only cash (where physical distribution is slow) or bank accounts (which not everyone has, and payments via banks take time and targeting). Even short of such extreme measures, fine-tuning interest on CBDC could give a more granular control—e.g., the central bank could maintain the policy rate but adjust CBDC remuneration to influence liquidity preference if needed, though most likely it would keep them aligned for simplicity.

The literature also addresses potential risks or complications for monetary policy. One concern is that if a CBDC leads to significant changes in the volume of bank credit, the central bank might need to account for that in setting policy. For example, if CBDC adoption means the banking sector shrinks and more financial intermediation happens through capital markets (or potentially through central bank's balance sheet if it lends against CBDC flows to banks), the interest-rate channel versus asset-price channels of policy might shift in relative importance. Additionally, Fernández-Villaverde et al. (2021) points out the risk of political pressure: once the public holds CBDC accounts, there may be pressure to use them for targeted policies (like subsidized rates for certain groups) which could complicate the central bank's mandate and the uniformity of monetary policy. Clear communication and legal frameworks would thus be needed to keep CBDC as a neutral monetary instrument.

Another subtlety is the interaction with reserve requirements and central bank balance sheet size. Bindseil and Senner (2025) simulate scenarios for a digital euro and note that if many deposits convert to CBDC, banks could become more reliant on central bank refinancing (borrowing reserves to replace lost deposits). This could enlarge the central bank's balance sheet (more CBDC liabilities, more lending assets to banks). Monetary policy implementation in such a regime might resemble wartime or crisis measures with abundant central bank intermediation. While not necessarily bad (the central bank can control rates via the terms of lending facilities), it does mean the central bank is more entwined with credit allocation. The literature generally suggests that careful calibration (like limiting CBDC quantity or adjusting reserve requirements) can avoid a scenario where central bank balance sheet balloons unexpectedly. Niepelt (2020) argued that a modest CBDC could be introduced without disrupting the equivalence between central bank money and commercial bank money in normal times, thus preserving traditional policy frameworks, as long as interest rates are managed properly.

Overall, the consensus from recent studies is that monetary policy can be made more effective with CBDC, but requires coordination and clarity in design. In particular:

- An interest-bearing CBDC improves monetary control and transmission, acting as a floor or conduit for policy rates (Meaning et al., 2018).
- Policy communication should treat the CBDC interest as a key policy rate (likely aligning it with the main policy target rate to avoid confusion, as advocated by several central banks).
- The presence of CBDC might allow more direct and faster implementation of unconventional policies (e.g., direct transfers or tiered interest incentives to spur spending) in extreme situations, although these blur fiscal-monetary lines.
- Optimal policy with CBDC might involve new trade-offs: for example, how low to set CBDC rates in a downturn to stimulate spending without unduly hurting banks—some models suggest there's an optimal CBDC interest that balances financial stability and stimulus (Hoffmann et al., 2023).
- A few voices warn that if not well-designed, CBDC could complicate policy—imagine a scenario where, say, the central bank wants to raise rates but fears that doing so will attract too much into CBDC from banks at once; having multiple targets (bank stability vs price stability) could create tension. However, most studies maintain that those tensions are manageable via the tools discussed earlier (remuneration tiers, etc.).

In conclusion, the literature paints a mostly optimistic picture in which CBDC enhances monetary policy capacity, provided the central bank aligns CBDC design with its policy framework. Many authors call for further research using macroeconomic models to fully map out long-term policy impacts, since empirical evidence is scant. As actual CBDC pilots mature (e.g., if one of the major central banks like the ECB or PBoC proceeds), observing real monetary operations with CBDC will greatly inform this discussion. For now, the theoretical and preliminary empirical work indicates that central banks can maintain, or even strengthen, their influence over interest rates and liquidity conditions through a well-implemented CBDC regime.

Regulatory Frameworks and International Coordination

The introduction of a CBDC not only poses economic design questions but also necessitates a robust regulatory and legal framework, potentially at both domestic and international levels. The literature in 2022–2025 consistently emphasizes that clear and updated regulations are required for CBDC implementation, touching on issues of legal tender status, privacy rights, anti-money laundering (AML) compliance, consumer protection, and cross-border usage. Additionally, many scholars argue that because CBDCs could have spillover effects across borders (especially if a major currency's CBDC is used internationally), international coordination and standards will be crucial to avoid unintended consequences and promote interoperability.

On the domestic front, legal clarity is the first step. Auer et al. (2022a) note that many central banks have undertaken reviews of whether existing laws allow them to issue a digital form of currency to the public. In some jurisdictions, the central bank charter or currency laws may need amendment to explicitly include digital currency as legal tender. For example, Kumhof and Noone (2021) mentions that the EU would need to pass legislation to support a digital euro, defining its legal tender status and the obligations of intermediaries. Having CBDC as legal tender would ensure it is universally accepted for payments (with some arguing this is essential to guarantee inclusion), but it also raises questions: would merchants be required by law to accept it (as they are with cash in many countries)? If so, what infrastructure obligations fall on them or the government to enable that?

Another key area is data governance and privacy regulations. As noted in Section 5, privacy is a technical issue but also a regulatory one. Tang and Si (2025) highlight that jurisdictions differ in their privacy frameworks (e.g., the EU's GDPR, which would apply to CBDC data about individuals). A central bank may need legislative backing to collect and process personal data for CBDC (for instance, to comply with AML/CFT while still respecting data protection laws). Several authors recommend that CBDC systems incorporate "privacy-by-design" principles and that regulators clearly delineate who can access what data. For example, Chiu and Davoodalhosseini (2023) argue that public trust in CBDC requires regulatory assurance that transactional data will not be misused—for example, that law enforcement access will require proper warrants, similar to how bank account information is treated today. Some proposals envisage independent oversight of CBDC data management, possibly involving data trusts or splitting roles (the central bank runs the system but doesn't directly see user identities, which are managed by intermediaries, a model that requires legal underpinning).

Consumer protection regulation is another area of focus. If individuals hold significant value in CBDC wallets, what protections do they have if something goes wrong (e.g., fraudulent transactions, technical glitches)? Unlike bank deposits, which typically are covered by deposit insurance (up to a limit) and banking conduct regulations, CBDC might need analogous protections. Some propose that CBDC holdings could be guaranteed by the government (since it's central bank money, arguably it is already "safe" up to sovereign risk). However, operational issues like false transfers or mistaken payments might require new rules for error resolution or reimbursement. Yusifov (2024) provides a comprehensive overview of the evolution of digital currencies and stresses that a successful CBDC regime must maintain or enhance trust by offering

at least the same level of consumer rights as existing payment methods (e.g., dispute resolution channels, transparency of fees or charges). Many central banks have published draft principles stating that using CBDC will be free or very low-cost for basic services; ensuring that legally might be considered (for example, prohibiting intermediaries from imposing exorbitant fees on basic CBDC wallet services).

In terms of AML/CFT, Auer et al. (2022a) and others underscore that regulatory adaptation is needed so that the CBDC system can fulfill AML/CFT requirements in a digitally native way. This may involve adjusting know-your-customer (KYC) rules to allow a tiered approach (lighter KYC for small accounts) as some central banks have suggested. Regulators will have to coordinate with law enforcement and international bodies (like FATF, the Financial Action Task Force) to ensure CBDC doesn't inadvertently create new avenues for illicit finance. Notably, Gorton and Zhang (2022) show that cross-border CBDC flows could complicate capital controls and AML monitoring, requiring pre-arranged sharing of information between central banks when designing cross-border linkages.

The importance of international coordination is repeatedly highlighted, especially for major reserve currencies. A common scenario discussed is "digital dollarization": if, say, the

U.S. issues a FedCoin and some emerging market experiences a crisis, people in that country might try to shift into FedCoin if accessible, much more easily than acquiring physical cash dollars or opening foreign bank accounts. Popescu (2022) simulate such scenarios and find that a widely accessible foreign CBDC can indeed amplify capital flight and exchange rate pressures for countries with weaker currencies. To mitigate this, global coordination and perhaps reciprocal agreements might be necessary. Some authors propose that central banks might agree on certain standards or limits for foreign usage of each other's CBDCs (e.g., non-residents can only hold up to a certain amount, or foreign CBDC holdings don't earn interest). Additionally, institutions like the IMF have begun to examine how to update their frameworks for digital currencies crossing borders. While no formal agreements yet exist, literature suggests proactive dialogue. For example, Auer et al. (2022b) points out that international standard-setting bodies (BIS, CPMI, etc.) are working on guidelines for CBDC interoperability and exchange.

Another aspect is exchange rate and monetary sovereignty concerns. If multiple countries issue CBDCs, how will they interact? Ferrari Minesso et al. (2022) (cited indirectly via references on open economy effects) suggests that introducing a CBDC in one currency could increase the sensitivity of exchange rates to monetary policy differences between countries, as global investors might reallocate between CBDCs quickly. This calls for possibly coordinating not only technical standards but also sharing information on cross-border flows. Some proposals involve using multi-CBDC platforms for foreign exchange that could be supervised collectively. Project mBridge (mentioned earlier) is one such example, where central banks jointly ran a platform for international settlements using their CBDCs, ensuring compliance and oversight.

There is also the idea of avoiding regulatory arbitrage. If one country's CBDC has certain features (say full anonymity) and another's doesn't, bad actors might route funds through the more permissive one. This suggests aligning certain regulatory expectations internationally. Many studies thus call for a cooperative approach: regular exchanges between central banks on CBDC design choices and their cross-border implications, and possibly developing global principles (for example, the G7 and G20 have issued high-level principles for CBDCs focusing on transparency, rule of law, economic and financial stability).

Finally, a subtle but important regulatory point is the role of intermediaries in a CBDC ecosystem. If private banks or payment firms are intermediating CBDC, what regulations apply to them? Are they acting as bank-like entities (thus subject to bank supervision, consumer protection, etc. in that role) or mere technical service providers? Barr et al. (2020) note that regulators may need to extend certain oversight to these new entities (for example, if telecom companies offer CBDC wallets, central banks might need new oversight

frameworks with telecom regulators). The consensus is that existing regulatory frameworks (banking, payments, data) will need tweaks but can largely be adapted to cover CBDC operations. Many central banks have established cross-disciplinary working groups (including monetary policy, banking supervision, payment systems, and legal departments) to ensure a comprehensive policy stance.

In conclusion, the literature stresses that introducing a CBDC is not just a technical or economic project but also a regulatory one. Key recommendations include:

- Enacting or updating laws to authorize CBDC issuance and clarify its legal tender status and relationship to cash.
- Establishing clear rules on data privacy and access, to balance law enforcement needs with individual rights and thereby foster trust.
- Protecting consumers by ensuring the CBDC system has reliability and redress mechanisms, possibly formalized through regulation or central bank commitments.
- Cooperating internationally to manage cross-border flows and avoid harmful spillovers (e.g., collectively addressing how CBDCs might be used in cross-border payments, and ensuring compatibility of AML regimes).
- Considering global standards or principles to guide CBDC design in a way that preserves financial stability worldwide (for instance, an IMF guideline on CBDC foreign holdings could be envisaged if major issues arise).

The broad message is that regulation and governance need to evolve in tandem with the technology. As Surpiah et al. (2025) aptly puts it, the evolution from private digital monies to CBDCs will only achieve its intended outcomes (efficiency, stability, inclusion) if underpinned by a robust policy framework that addresses risks and engenders public confidence. The upcoming years will likely see considerable legislative and regulatory activity accompanying any major CBDC launch, reflecting many of the issues identified in the current literature.

Financial Inclusion and Public Trust

One of the oft-cited motivations for CBDC projects—especially in emerging and developing economies—is the potential to promote financial inclusion. By providing a digital payment instrument that is safe, simple, and widely accessible (even to those without bank accounts), CBDCs could bring more people into the formal financial system. However, whether this promise is realized depends heavily on design and rollout. Moreover, underlying everything is public trust: the degree to which people trust the CBDC (and the institutions behind it) will fundamentally determine adoption rates. The literature from 2022 onward explores these themes, combining survey evidence, conceptual arguments, and early case studies.

Starting with inclusion, design for accessibility is crucial. Bijlsma et al. (2021) conducted a survey in the Netherlands to understand what would drive consumers to adopt a CBDC. They found that ease of use, low (or no) transaction costs, and offline functionality were significant positive factors. Notably, those who are currently underserved by banks (e.g., some unbanked or underbanked groups) could benefit if the CBDC is delivered through channels they can access—this might include mobile phone apps that work on basic phones, or smart cards for those without phones. Surpiah et al. (2025), examining implications for monetary policy and inclusion, argue that in emerging economies, a CBDC must be part of a broader strategy including expanding digital infrastructure and financial literacy. For example, Nigeria's eNaira aimed partly at inclusion,

but uptake has reportedly been slow because of factors like limited awareness, technological barriers, and perhaps distrust or insufficient clear advantage over cash and mobile money.

Public trust is indeed the linchpin. Surveys repeatedly show that people's willingness to use a CBDC hinges on trusting the central bank and the CBDC's reliability and privacy. Li (2023) in a Canadian context structurally estimated demand for CBDC using survey data and found that concerns over privacy and cybersecurity were among the top reasons respondents might not use a CBDC. Conversely, those who trusted the central bank and were confident in the technology were more likely to express interest in using it. The implication is that central banks need to actively cultivate trust—through transparency about how data is handled, through guarantees or demonstrations of security, and by building on their reputational capital as stable institutions.

It's notable that financial inclusion is not automatic with a CBDC. People who are unbanked often face barriers like lack of digital devices, no reliable internet, or simply mistrust of formal financial instruments. A CBDC, if it requires a smartphone and internet connectivity, could inadvertently exclude some of the same groups we hope to include. Researchers emphasize offering multiple access modes: smartphone apps for those who have them, and physical card-based or even SMS-based solutions for those who don't (Auer et al., 2022b). Some countries explore "tiered KYC" where minimal identification is needed for low-tier wallets (to remove documentation barriers). For example, Auer et al. (2022a) mention that the Eastern Caribbean Central Bank's DCash and the Bahamas Sand Dollar tried offline cards and simplified onboarding to reach rural and older populations. Still, initial usage has been modest, underlining that trust and convenience take time to build.

Public trust also involves the perceived stability and usefulness of the CBDC. If people worry that a CBDC introduction is a step towards abolishing cash (a concern raised in some public debates) or that it might be used to impose negative interest on their savings, they might resist adoption. Bindseil (2020) (European perspective) argued for an approach that emphasizes CBDC as complement, not replacement, to cash to maintain trust and choice. Many central banks have echoed this in communications.

Another dimension is trust in the broader digital ecosystem. In countries where mobile money or fintech payment providers are prevalent (like Kenya's M-Pesa or Chinese tech platforms), a CBDC's take-up may depend on integration with those services and whether it offers something additional (maybe greater security or no reliance on a private intermediary). If the public already trusts existing solutions, they may see little reason to switch unless CBDC is very compelling. Andolfatto (2021b) notes that as digital currency evolves, public-private partnership might be essential to leverage the strengths of each (for instance, combining the central bank's trust with private sector innovation and user interface expertise could yield a product people find both trustworthy and useful).

Empirical research is still emerging on actual inclusion outcomes. Auer et al. (2022a) indicates that many central banks place high priority on inclusion objectives but acknowledge that it's challenging to measure potential impact. One early anecdotal result: Nigeria's eNaira has, according to reports, not significantly boosted inclusion yet, as people continue to use cash and established mobile banking more. Reasons cited include limited merchant acceptance and technical issues early on. This aligns with Surpiah et al. (2025) which warns that simply offering a CBDC doesn't guarantee adoption—attention must be paid to digital literacy and building an ecosystem where using CBDC is beneficial (e.g., perhaps government payment transfers via CBDC could encourage usage, or merchant incentives).

In terms of public trust metrics, repeated surveys (like the ECB's public consultation on a digital euro, or Federal Reserve focus groups in 2022) highlight privacy as a paramount concern. Many respondents desire at least the same privacy as they have with cash for small payments. If a CBDC is perceived as a surveillance

tool, adoption might be minimal outside of forced usage. On the other hand, if designed and communicated as preserving privacy (for normal transactions) but traceable under due process for illicit activity, then it may gain acceptability. Kumhof and Noone (2021) point out that ironically, a CBDC can also enhance trust in the currency and system if people worry about private money stability (like stablecoins or even banks). Knowing one has access to a central bank form of money might reassure depositors, as found by Kumhof and Noone (2021) in stability context. So trust is two-edged: trust in central bank fosters CBDC use, and availability of CBDC might foster trust in overall monetary arrangements if people see it as a safe fallback.

Another inclusion aspect is cost savings and innovation that benefit end-users. If CBDC reduces transaction costs (especially for remittances or micro-payments), it could draw in users who currently rely on expensive informal channels. Some literature points out CBDC could enable very low-fee domestic transfers and possibly cross-border (if linked), which can financially include those who found fees prohibitive. Lei and Wang (2024) study the Greater Bay Area in China, implying that a cross-region CBDC might facilitate economic integration; presumably, one outcome could be more inclusive financial access across Hong Kong, Macau, and Guangdong province.

In summary, financial inclusion and public trust will determine CBDC success on the ground. Key take-aways from the literature:

- Accessibility features (offline capability, simple onboarding, multiple access platforms) are indispensable for reaching unbanked or digitally less savvy groups.
- Education and communication: central banks should engage in extensive public education to raise awareness about how to use CBDC and to reinforce trust (this has been echoed in pilot observations; lack of awareness has been a hurdle).
- Leverage existing networks: partnering with post offices, local banks, or mobile operators could extend reach into communities that central banks don't directly interface with.
- Public trust in the institution: surveys indicate that in many countries central banks enjoy relatively high trust; they must maintain that by clearly addressing concerns (especially around personal data and whether CBDC might negatively impact banks or lead to hidden costs).
- Gradual approach: some propose starting with a limited rollout (both in scope and functionality) to build experience and trust, then scaling up. This can allow resolving teething issues without affecting too many users, thereby not undermining trust from the get-go.

As Auer et al. (2022b) succinctly put it, "Public trust is the sine qua non for any successful currency, digital or otherwise." The literature concurs and provides guidance that trust can be built by ensuring CBDC meets genuine user needs (inclusion, convenience, privacy) better than or at least as well as current options. Ultimately, a well-used CBDC could further strengthen trust in the central bank and currency by providing a modern yet safe form of money, but getting to that virtuous circle requires careful design choices and policy support which we have detailed across the previous sections.

Comparative Evaluation of CBDC Design Features and Policy Trade-offs

Central banks contemplating a retail CBDC confront a set of interdependent design choices whose consequences cut across bank intermediation, financial stability, monetary policy transmission, and inclusion and trust. The most salient levers—interest remuneration, quantitative holding limits, architectural choices (direct versus two-tier intermediation), and privacy—rarely move these objectives in the same direction. This section synthesizes the literature to map each design element to likely outcomes and to articulate

the policy trade-offs, summarized in [Table 1](#). While we examine each feature *ceteris paribus* for clarity, the policy problem is inherently multidimensional: in practice, central banks will assemble a package of mutually reinforcing features, a point emphasized by proposals advocating judicious combinations of remuneration, limits, architecture, and privacy to achieve robustness across objectives (Chiu et al., 2023; Assenmacher et al., 2021).

Whether the CBDC bears interest is arguably the pivotal choice. An interest-bearing instrument competes directly with retail deposits as a store of value. If the CBDC rate shadows the policy rate and thereby exceeds typical checking-account rates, substantial deposit migration is plausible, heightening disintermediation pressures and forcing banks to reprice liabilities or shrink balance sheets (Paul et al., 2025; Whited et al., 2023). By contrast, a non-interest (“cash-like”) CBDC primarily attracts transactional balances, dampening deposit flight and resembling digital cash substitution (Keister and Sanches, 2023). Even so, when deposit rates are near zero, a zero-yield CBDC can still crowd out some deposits; banks can, however, counter with small positive rates, consistent with findings that cash-like CBDC entails limited disintermediation (Nyffenegger, 2024).

The stability implications of remuneration are two-sided. A high CBDC rate increases the attractiveness of a risk-free haven and may amplify run incentives. Yet an adjustable CBDC rate provides a stabilizing instrument: authorities can lower—or even set negative—remuneration in stress episodes to blunt flight into CBDC (Bitter, 2024). The literature suggests non-monotonicity: very high rates heighten fragility, very low (including zero) rates may leave banks insufficiently disciplined to preempt runs, and intermediate settings can improve resilience (Hoffmann et al., 2023). On balance, absent active use of remuneration as a macroprudential tool, lower or zero interest reduces baseline run incentives; with active use, interest-bearing CBDC adds a valuable policy lever unavailable with cash.

For monetary policy, interest-bearing CBDC strengthens transmission. By offering a policy-aligned risk-free retail asset, it imposes a floor under deposit rates and tightens pass-through from policy to household returns (Meaning et al., 2018; Jiang and Zhu, 2021). It also facilitates implementation of negative rates by removing the zero-yield digital refuge that cash otherwise provides. A non-interest CBDC, while potentially improving payments data and usage, does little to relax the effective lower bound. Thus, [Table 1](#) marks a clear transmission advantage for interest-bearing designs, acknowledging the operational nuance of setting and communicating a CBDC rate alongside conventional instruments.

Inclusion and trust cut the other way in important respects. Paying interest can broaden access to safe returns, especially for households that currently earn little or nothing on liquid balances (Bordo and Levin, 2019), and survey evidence indicates even modest remuneration materially raises stated willingness to adopt (Li, 2023). Yet the possibility of negative rates is politically sensitive and may erode trust. By contrast, a straightforward non-interest CBDC is familiar—akin to digital cash—and avoids perceptions of policy “taxation,” a consideration reflected in proposals to begin with zero remuneration to facilitate acceptance (Paul et al., 2025).

Quantity constraints—per-person holding limits or transfer caps—are a direct instrument to mitigate disintermediation. By capping how much can migrate from deposits into CBDC, limits reduce banks’ funding exposure both in normal times and under stress (Kumhof and Noone, 2021). Market reactions to the prospect of a limited CBDC have been consistent with this stabilizing interpretation (Beckmann et al., 2024). The trade-off is usability: overly tight caps can constrain legitimate transactional needs (e.g., SMEs), while tiered structures can preserve convenience for typical users while curbing large reallocations. In crises, limits slow the effective speed and size of digital runs and can be complemented by the central bank’s option to adjust caps temporarily (Hoffmann et al., 2023). From a monetary policy perspective, however, limits attenuate the

reach of policy through the CBDC channel: when balances are constrained, the proportion of the money stock directly remunerated by the central bank is smaller, tempering improvements in pass-through (Bindseil, 2020). Policymakers may accept that constraint as the price of stability, with the understanding that limits can be recalibrated as experience accumulates.

Architectural choices also bear on these margins. A two-tier system—issuance by the central bank with distribution and customer interface via private intermediaries—preserves banks' role and mitigates disintermediation by keeping relationship, onboarding, and liquidity management functions in the private sector (Auer et al., 2021). A direct architecture, in which the central bank operates retail accounts or wallets, increases head-to-head competition for deposits and may accelerate balance-sheet reallocation, raising the stakes of transition (Fernández-Villaverde et al., 2021). For stability, two-tier models harness existing liquidity management capacities and allow policy measures (including throttling and risk controls) to be implemented via intermediaries. Direct models centralize operational and cyber risk and may require more frequent central bank intermediation to support credit during deposit migrations. With respect to monetary policy, both architectures can deliver effective transmission if remuneration and access are specified; a direct model arguably offers greater immediacy for direct transfers or emergency measures, whereas two-tier arrangements rely on intermediaries for execution. Inclusion and trust considerations typically favor two-tier approaches that leverage familiar interfaces and customer service networks, reducing perceptions of disintermediation by the state and concerns about a government-run retail platform.

Privacy is the fourth core design dimension. A spectrum runs from strong anonymity (cash-like) to full identification and observability. Privacy has indirect effects on intermediation: a highly private CBDC may attract users who value discretion, potentially marginally increasing deposit outflows; a fully identified system may deter some usage, keeping more funds in banks. For stability and supervision, greater observability provides earlier warning of stress and facilitates AML/CFT compliance and targeted interventions, while full anonymity limits authorities' visibility into the distribution of flows and complicates crisis management (Mancini-Griffoli et al., 2019). The policy design implications are significant: strong anonymity complicates enforcement of per-person holding caps and tiered remuneration, since users could fragment holdings across multiple wallets; conversely, identity-linked wallets make such tools credible (Bindseil, 2020). From an inclusion and trust standpoint, however, privacy repeatedly emerges as a top determinant of public acceptance: robust privacy for low-value transactions can materially raise willingness to adopt among law-abiding users who fear surveillance, while preserving traceability for large-value activity addresses social harms (Choi et al., 2025). Tiered privacy thus appears a promising compromise.

The policy decision matrix in [Table 1](#) reflects these tensions. If minimizing disintermediation and run risk is paramount, design leans toward non-interest remuneration (or modest, flexible tiers), meaningful holding limits, two-tier intermediation, and privacy calibrated to preserve oversight. If enhancing monetary control and expanding the toolset at the lower bound are priorities, interest-bearing CBDC with broad access is advantageous, but must be coupled with limits or remuneration tiers to contain funding shifts and with privacy choices that maintain enforceability. In practice, central banks gravitate to “balanced” bundles—for example, modest (possibly tiered) interest, per-user caps, a two-tier architecture, and tiered privacy that offers cash-like protections for small payments while requiring identity for larger transactions—an approach consistent with ongoing investigations of a digital euro (Auer et al., 2023).

In sum, CBDC design is a multi-objective optimization problem under institutional, technological, and political constraints. No single configuration simultaneously maximizes intermediation, stability, policy efficacy, and public acceptance. The literature counsels explicit prioritization—clarifying tolerable degrees of disintermediation, the desired strength of transmission improvements, the minimum level of privacy

compatible with regulation—and iterative calibration. Given path dependence and expectation formation, initial choices matter; yet many parameters (remuneration, limits, privacy thresholds) can be adjusted over time. Pilots, consultations, and phased rollouts are therefore warranted to accumulate operational evidence and refine the balance among competing goals, in line with the comparative logic summarized here.

Conclusion

Central Bank Digital Currencies represent a seminal innovation in the evolution of money – one that offers significant potential benefits but also poses non-trivial challenges across economic, technical, and societal dimensions. This systematic literature review has examined the state of CBDC research from 2022 to 2025, highlighting key findings and debates in areas including the impact on banking and financial stability, implications for monetary policy transmission, technical design choices (architecture and privacy), the need for supporting regulatory frameworks, and the prospects for financial inclusion and public adoption.

Several broad conclusions emerge:

First, CBDC design and policy outcomes are inextricably linked. The way a CBDC is structured – whether it pays interest, how it involves intermediaries, whether it enforces holding limits or privacy protections – fundamentally shapes its economic effects. There is no one-size-fits-all CBDC: each feature entails trade-offs (as summarized in Section 9’s comparative matrix). Central banks must therefore tailor their CBDC designs to the specific objectives they prioritize, be it preventing bank disintermediation, maximizing monetary policy efficacy, or ensuring broad public uptake. A clear lesson from the literature is that design choices should be guided by a well-defined policy vision. For example, if the primary goal is to improve payments efficiency and inclusion without disrupting the financial system, a two-tier, non-interest-bearing CBDC with holding limits and strong privacy for small transactions would align well. Conversely, if the goal is to enhance monetary policy tools in a cash-light economy, some form of interest-bearing CBDC might be introduced, but with safeguards like tiered remuneration and close regulatory oversight to manage stability risks.

Second, a cautious, incremental approach is favored by both research and practice. Many central banks, informed by academic and policy studies, are opting for designs that minimize potential negative impacts. This often means implementing CBDCs that complement, rather than replace, existing financial intermediaries and money. For instance, rather than a “big bang” introduction of a direct, universally accessible CBDC that could instantly disintermediate banks, most plans envision a phased rollout with caps on usage and involvement of private-sector intermediaries (banks or payment service providers). The literature supports this graduated approach; modeling work (e.g., Hoffmann et al. (2023); Kumhof and Noone (2021)) suggests that introducing a CBDC with prudent design (limits, tiering, etc.) yields most of the benefits (like improved payments and resilience) while greatly reducing risks to financial stability and credit provision. Empirical evidence from early pilots (such as the Bahamas, Eastern Caribbean, China’s trials) also indicates that adoption builds slowly and trust must be earned, reinforcing the wisdom of starting on a modest scale and adjusting design as needed.

Third, interdisciplinary coordination is essential. Implementing a CBDC is not purely a monetary project or a technical upgrade; it requires harmonization of economic policy, legal frameworks, and technological infrastructure. We saw that regulatory clarity is crucial – laws may need updating to authorize CBDCs and protect users (for privacy, consumer rights). Internationally, coordination can help mitigate spillovers (for example, agreements on cross-border use of CBDCs can prevent unintended export of instability or excessive capital flows) (Assenmacher and Bindseil, 2021). Technologically, a secure, scalable system must be built, often by leveraging expertise from private partners or open source collaborative efforts; the literature points to successful prototypes (like Project Aurum for two-tier CBDC, or mBridge for cross-border payments)

as models where central banks partnered with tech firms and each other. This underscores that central banks should not operate in silos when developing CBDCs: consultation with commercial banks, fintechs, academics, and the public is vital to design a currency that is both functional and trusted. Many studies (e.g., Tang and Si (2025)) explicitly recommend public-private collaboration and iterative testing, and indeed this is the path observed in practice (e.g., the ECB's multi-year investigation phase with stakeholder input, or the US Federal Reserve's request for public comment on CBDC).

Fourth, public trust and user adoption are the linchpin of success. No matter how elegant the theoretical design, a CBDC will only achieve its aims if people actually use it. The research consistently identifies trust factors – particularly privacy, security, and ease of use – as decisive for adoption (Mancini-Griffoli et al., 2019). This has two implications: (a) CBDC projects must prioritize a high-quality user experience (akin to the best private payment apps) and communicate clearly how data will be handled and protected; (b) central banks might consider non-technological measures to foster trust, such as public education campaigns, maintaining optionality (keeping cash in circulation so people don't feel forced), and even legal commitments (for instance, enshrining certain privacy protections or limits on central bank use of transaction data in law to alleviate concerns). The literature on financial inclusion (e.g., Bijlsma et al. (2021); Yusifov (2024)) suggests that a well-designed CBDC can broaden access especially if it reaches those not well-served by banks. However, achieving that requires extra effort – such as offline functionality for remote areas, simplicity for those with low digital literacy, and perhaps integrating with mobile phone platforms widely used by unbanked populations (Auer et al., 2022a). In short, the human element – trust and usability – should be front and center.

Finally, the research indicates that CBDCs, if carefully implemented, can deliver on multiple policy objectives simultaneously. The thematic synthesis revealed potential in several domains: a retail CBDC can help shield the payments system and depositors in the event of bank failures (by offering an alternative liquidity source), support monetary policy (by providing a new transmission channel and possibly relaxing the zero lower bound), and increase payments efficiency and inclusion (by reducing costs and barriers in digital payments). For example, Keister and Monnet (2022) found that a well-designed CBDC could even enhance financial stability by improving information and offering contingent tools. Likewise, studies such as Chiu and Davoodalhosseini (2023) and Andolfatto (2021a) showed that under certain conditions, CBDC introduction need not crowd out bank lending and can even increase welfare by promoting competition. These positive outcomes are not guaranteed – they hinge on design and context – but they underscore that the oft-feared “CBDC trade-off” (between, say, inclusion and stability, or innovation and bank health) can be managed and partially resolved through smart policy choices. In summary, the emerging consensus in the literature is one of cautious optimism: CBDCs, when crafted with care, can modernize the monetary system and complement existing financial structures rather than destabilize them. The period from 2022 to 2025 has seen rapid learning and convergence on best practices – for instance, the notion of a “tiered” CBDC (with caps and differential interest) delivered via existing intermediaries has become a common vision among many central banks. There remain open questions and areas for further research, such as the geopolitical implications of major currency CBDCs, the technical scalability of systems under cyber-stress, or the behavioral responses of consumers and banks in a CBDC world (will banks innovate new models to compete? will cash usage significantly decline or persist as a privacy-preserving niche?). Ongoing pilot programs and the first real-world implementations (like Nigeria's eNaira, albeit off to a slow start, or China's expanding digital yuan trials) will provide valuable data to refine theories and designs. As central banks stand at the threshold of potentially issuing digital legal tender, this review's findings stress the importance of gradualism, adaptability, and communication. The introduction of a CBDC should be seen not as a single event but as the beginning of a new phase of monetary evolution – one in which policy will continually be

adjusted in light of experience, much as it has been with other innovations in central banking. By staying attuned to the themes and evidence highlighted in this review – from bank intermediation dynamics to public trust determinants – policymakers can steer CBDC development in a direction that bolsters the public interest. Central banking has always rested on trust and credibility; those foundations will be just as crucial in the digital currency era. With prudent design and clear-eyed management of trade-offs, CBDCs can be a powerful tool to advance the safety, efficiency, and inclusiveness of the financial system in the 21st century.



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References

- Andolfatto, D. (2021a). Assessing The Impact Of Central Bank Digital Currency On Private Banks. *The Economic Journal*, 131:525–540.
- Andolfatto, D. (2021b). On The Necessity and Desirability Of A Central Bank Digital Currency. In Niepelt, D., editor, *Central Bank Digital Currency: Considerations, Projects, Outlook*. CEPR Press, London.
- Assenmacher, K., Berentsen, A., Brand, C., and Lamersdorf, N. (2021). A Unified Framework For CBDC Design: Remuneration, Collateral Haircuts and Quantity Constraints. *European Central Bank*, (2578).
- Assenmacher, K. and Bindseil, U. (2021). The Eurosystem's Digital Euro Project: Preparing For A Digital Future. In Niepelt, D., editor, *Central Bank Digital Currency: Considerations, Projects, Outlook*. CEPR Press, London.
- Auer, R., Banka, H., Boakye-Adjei, N. Y., Faragallah, A., Frost, J., Natarajan, H., and Prenio, J. (2022a). *Central Bank Digital Currencies: A New Tool In The Financial Inclusion Toolkit? Technical Report No 41*.
- Auer, R., Cornelli, G., and Frost, J. (2023). Rise of the Central Bank Digital Currencies. *International Journal of Central Banking*, 19(4):185–214.
- Auer, R., Doerr, S., Frost, J., Gambacorta, L., and Shin, H. S. (2021). Central Bank Digital Currencies and Data In The Digital Age: A Triple Imperative. In Niepelt, D., editor, *Central Bank Digital Currency: Considerations, Projects, Outlook*. CEPR Press, London.
- Auer, R., Frost, J., Gambacorta, L., Monnet, C., Rice, T., and Shin, H. S. (2022b). Central Bank Digital Currencies: Motives, Economic Implications, and the Research Frontier. *Annual Review Of Economics*, 14(1):697–721.
- Barr, M. S., Harris, A. A., Menand, L., and Xu, W. M. (2020). Building the Payment System of the Future: How Central Banks Can Improve Payments to Enhance Financial Inclusion. *University of Michigan Center on Finance, Law & Policy*, (3).
- Beckmann, L., Debener, J., Hark, P. F., and Pfungsten, A. (2024). CBDC and The Shadow Of Bank Disintermediation: US Stock Market Insights On Threats and Remedies. *Finance Research Letters*, 67(105868):105868.
- Bijlsma, M., van der Cruijssen, C., Jonker, N., and Reijerink, J. (2021). What Triggers Consumer Adoption Of CBDC? *De Nederlandsche Bank*, (709).
- Bindseil, U. (2020). Tiered CBDC and The Financial System. Working paper series - European Central Bank, (2351).
- Bindseil, U. and Senner, R. (2025). Modeling Central Bank Digital Currencies. *Journal of Economic Surveys*.
- Bitter, L. (2024). Banking Crises Under a Central Bank Digital Currency (CBDC). *Jahrbucher für Nationalökonomie und Statistik*.
- Boar, C. and Wehri, A. (2021). Ready, Steady, Go? - Results Of The Third BIS Survey On Central Bank Digital Currency. *Bank for International Settlements (BIS) Papers*, (114).
- Bordo, M. D. and Levin, A. T. (2019). Digital Cash: Principles & Practical Steps. Working paper series (National Bureau of Economic Research), (25455).
- Chang, H., Grinberg, F., Gornicka, L., Miccoli, M. M., and Tan, B. (2023). Central Bank Digital Currency and Bank Disintermediation in a Portfolio Choice Model. *International Monetary Fund Working Paper*, (23/236).
- Chiu, J. and Davoodalhosseini, S. M. (2023). Central Bank Digital Currency and Banking: Macroeconomic Benefits Of A Cash-Like Design. *Management science*, 69(11):6708–6730.



- Chiu, J., Davoodalhosseini, S. M., Jiang, J., and Zhu, Y. (2023). Bank Market Power and Central Bank Digital Currency: Theory and Quantitative Assessment. *The journal of political economy*, 131(5):1213–1248.
- Chiu, J. and Rivadeneyra, F. (2021). An Overview Of The Bank Of Canada CBDC project. In Niepelt, D., editor, *Central Bank Digital Currency: Considerations, Projects, Outlook*. CEPR Press, London.
- Choi, S., Kim, B., Kim, Y. S., and Kwon, O. (2025). Central Bank Digital Currency and Privacy: A Randomized Survey Experiment. *International Economic Review*, 66(2):823–847.
- Fernández-Villaverde, J. and Sanches, D. (2019). Can Currency Competition Work? *Journal Of Monetary Economics*, 106:1–15.
- Fernández-Villaverde, J., Sanches, D., Schilling, L., and Uhlig, H. (2021). Central Bank Digital Currency: Central Banking For All? *Review Of Economic Dynamics*, 41:225–242.
- Ferrari Minesso, M., Mehl, A., and Stracca, L. (2022). Central Bank Digital Currency In An Open Economy. *Journal of Monetary Economics*, 127:54–68.
- Garratt, R., Yu, J., and Zhu, H. (2022). How Central Bank Digital Currency Design Choices Impact Monetary Policy Pass-Through and Market Composition. Available at SSRN 4004341.
- Gorton, G. B. and Zhang, J. Y. (2022). The Orkney Slew and Central Bank Digital Currencies. *Harvard National Security Journal*, 14(1):1–48.
- Hoffmann, P., Ahnert, T., Leonello, A., and Porcellacchia, D. (2023). Central Bank Digital Currency and Financial Stability. Available at SSRN 4361136.
- Hong Kong Monetary Authority (HKMA) (2022). Project Aurum A Prototype for Two-tier Central Bank Digital Currency (CBDC). Technical report, Bank for International Settlements (BIS).
- Infante, S., Kim, K., Orlik, A., Silva, A. F., and Tetlow, R. J. (2023). Retail Central Bank Digital Currencies: Implications For Banking and Financial Stability. *Federal Reserve Board Finance and Economics Discussion Series*, (2023-072).
- Jiang, J. and Zhu, Y. (2021). Monetary Policy Pass-Through with Central Bank Digital Currency. *Bank of Canada*, (2021-10).
- Keister, T. and Monnet, C. (2022). Central Bank Digital Currency: Stability and Information. *Journal of Economic Dynamics & Control*, 142(104501):104501.
- Keister, T. and Sanches, D. (2023). Should Central Banks Issue Digital Currency? *The Review of Economic Studies*, 90:404–431.
- Kumhof, M. and Noone, C. (2021). Central Bank Digital Currencies – Design Principles For Financial Stability. *Economic analysis and policy*, 71:553–572.
- Lei, W. C. and Wang, X. (2024). Impacts of Central Bank Digital Currency on Regional Economic Integration: Evidence from the Greater Bay Area of China. *Chinese Economy*, 57(5):415–428.
- Li, J. (2023). Predicting The Demand For Central Bank Digital Currency: A Structural Analysis with Survey Data. *Journal of monetary economics*, 134:73–85.
- Mancini-Griffoli, T., Peria, M. S. M., Agur, I., Ari, A., Kiff, J., Popescu, A., and Rochon, C. (2019). Casting Light On Central Bank Digital Currency. *International Monetary Fund*, (18/08).
- Meaning, J., Dyson, B., Barker, J., and Clayton, E. (2018). Broadening Narrow Money: Monetary Policy with A Central Bank Digital Currency. *Bank Of England*, (724).
- Niepelt, D. (2020). Monetary Policy With Reserves and CBDC: Optimality, Equivalence, and Politics. *Centre for Economic Policy Research*, (DP15457).
- Nyffenegger, R. (2024). Central Bank Digital Currency and Bank Intermediation: Medium Of Exchange vs. Savings Vehicle. *European Economic Review*, 170(104890):104890.
- Paul, P., Ulate, M., and Wu, J. C. (2025). A Macroeconomic Model Of Central Bank Digital Currency. Technical Report w33968, National Bureau of Economic Research, Cambridge, MA.
- Popescu, M. A. (2022). Cross-Border Central Bank Digital Currencies, Bank Runs and Capital Flows Volatility. *IMF Working Papers*, (WP/22/83).
- Schilling, L., Fernández-Villaverde, J., and Uhlig, H. (2021). Facing The Central Bank Digital Currency Trilemma. In Niepelt, D., editor, *Central Bank Digital Currency: Considerations, Projects, Outlook*, chapter 6, pages 45–50. CEPR Press, London, England.
- Shafranova, K., Navolska, N., and Koldovskiy, A. (2024). Navigating the digital frontier: a comparative examination of Central Bank Digital Currency (CBDC) and the Quantum Financial System (QFS). *SocioEconomic Challenges*, 8(1):90–111.
- Surpiah, S., Septria, F., and Pravitasari, A. (2025). The Future of Central Bank Digital Currencies (CBDCs): Implications for Monetary Policy. *Jurnal Akuntansi, Ekonomi dan Manajemen Bisnis*, 5(1):355–363.
- Tang, Q. and Si, Y.-W. (2025). Central Bank Digital Currencies: A Survey. *arXiv [econ.GN]*.
- Whited, T. M., Wu, Y., and Xiao, K. (2023). Will Central Bank Digital Currency Disintermediate Banks? Available at SSRN 4112644.

Yusifov, A. (2024). The Evolution Of Digital Currencies: From Private Innovation To Central Bank Implementation - A Comprehensive Analysis Of CBDC Development. *Agora International Journal of Economical Sciences*, 18(2):387–399.

