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# THE IMPLICATIONS OF CENTRAL BANK DIGITAL CURRENCY (CBDC) ROLLOUT ON FINANCIAL SECTOR STABILITY: STRUCTURAL TRANSMISSION CHANNELS AND MACROPRUDENTIAL MARGINS IN TRANSITIONING ECONOMIES

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**Abstract:** This paper examines the structural macro-financial implications of introducing a retail Central Bank Digital Currency (CBDC) within a two-tier banking ecosystem characterized by high state ownership and structural dollarization. Employing a microeconomic portfolio optimization framework calibrated with Constant Elasticity of Substitution (CES) utility functions, the study simulates the velocity and volume of retail deposit migration toward a risk-free digital asset.

The empirical findings validate the bank disintermediation hypothesis, demonstrating that an unconstrained retail CBDC induces a non-linear drain on core commercial bank deposits. Multi-scenario stress-testing indicates that a 20% kiber-migration shock triggers a 54.3% collapse in the systemic Liquidity Coverage Ratio (LCR), breaching Basel III prudential safety thresholds and spiking interbank call rates by 420 basis points. Furthermore, the analysis refutes the neutrality of central bank liquidity re-injection mechanisms in state-dominated banking structures, proving that refinancing distribution models inherently introduce credit rationing biases that disproportionately affect private small-and-medium enterprises (SMEs).

To preserve institutional stability while enhancing transactional efficiency, this study prescribes macroprudential friction mechanisms, including tiered non-remuneration structures, hard overnight digital wallet holding limits, and dynamically indexed liquidity buffers.

**Keywords:**
Central Bank Digital Currency (CBDC); Financial Stability; Bank Disintermediation; Liquidity Coverage Ratio; Monetary Transmission; Transitioning Economies.

## Introduction

The rapid evolution of decentralized financial technologies and the proliferation of private crypto-assets have fundamentally challenged the traditional monopoly of central banks over fiat currency issuance. In response, central banks representing over 90% of global GDP are currently exploring or piloting Central Bank Digital Currencies (CBDCs) (Barontini & Holden, 2019). While CBDCs promise to enhance payment efficiency and reduce cross-border transaction costs, their integration into a two-tier banking system introduces unprecedented structural shifts.

The core vulnerability lies in the mechanism of bank disintermediation. During periods of macroeconomic instability, a risk-free digital shock absorber—such as a direct claim on the central bank—could trigger a systematic migration of retail deposits from commercial balance sheets to the central bank's ledger. According to recent Bank for International Settlements (BIS) frameworks, this "flight to safety" directly threatens the credit creation capacity of commercial banks, forcing

them to rely on more volatile, wholesale funding markets (Kumhof & Noone, 2021). For emerging economies, particularly within the context of banking sector modernization in Uzbekistan, the introduction of a digital som necessitates a delicate equilibrium between promoting financial inclusion and mitigating structural liquidity risks. This paper examines the transmission channels through which a retail CBDC alters commercial bank stability, focusing on deposit elasticity and prudential safety margins.

**Literature Review**

The academic discourse on the implications of Central Bank Digital Currencies (CBDCs) for financial stability is sharply divided into two analytical paradigms: the disintermediation hypothesis and the efficiency-enhancement thesis.

The structural risk of bank disintermediation was initially formalized by Kumhof and Noone (2021), who argued that a universally accessible, interest-bearing retail CBDC behaves as a perfect substitute for commercial bank deposits. In times of systemic stress, the low transaction friction of digital ledgers could accelerate bank runs, transforming localized liquidity shocks into systemic crises. This perspective is supported by Bindseil (2020), who emphasizes that even under non-crisis conditions, the steady migration of retail deposits to the central bank balance sheet forces commercial banks to switch to wholesale funding. This structural shift inevitably increases the marginal cost of funding, compresses net interest margins (NIM), and constrains the credit supply to the real economy.

Conversely, a counter-narrative presented by Brunnermeier and Niepelt (2019) posits that CBDC non-neutrality can be mitigated through financial markets. They demonstrate that if the central bank passes the inflowing funds back to commercial banks via refinancing facilities, the aggregate credit capacity of the banking sector remains invariant. Furthermore, Chiu et al. (2023) introduce a search-theoretic model showing that in concentrated banking markets where commercial banks possess monopoly power over deposits, the introduction of a retail CBDC acts as an outside option for depositors. This competitive pressure forces commercial bank intermediaries to raise their deposit rates, paradoxically expanding rather than contracting commercial credit under certain elasticity thresholds.

For transitioning and emerging financial systems, such as Uzbekistan, this trade-off is further complicated by institutional specificities. The empirical gap in current literature lies in how a dual-loop, two-tier CBDC framework interacts with a banking sector characterized by high state ownership and structural dollarization. While global models assume highly liquid secondary markets, emerging markets often lack the deep wholesale funding buffers needed to absorb sudden deposit shocks, making the calibration of CBDC design attributes—such as non-interest-bearing status or holding limits—a critical prerequisite for institutional stability.

*1. Household Wealth Allocation and Deposit Elasticity*

We assume a representative household allocates its liquid wealth W between commercial bank deposits ($D$) and central bank digital currency (C) to maximize transaction utility and return. The wealth constraint is defined as:

$W = D + C$

The household's preference for liquidity services is modeled using a Constant Elasticity of Substitution (CES) framework:

$$U(D,C)=\left[\alpha D^{\frac{\sigma-1}{\sigma}}+(1-\alpha)C^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}$$

Where:

- $\alpha \in (0,1)$ represents the baseline institutional trust and structural preference for traditional commercial banking services.
- $\sigma > 0$ is the elasticity of substitution between commercial deposits and the CBDC. If $\sigma \to \infty$, they become perfect substitutes, magnifying disintermediation risks.

The effective return on deposits is $r_D$, while the CBDC yields $r_C$ (if non-interest-bearing, $r_C = 0$). The optimal deposit-to-CBDC ratio derived from the first-order conditions is expressed as:

$$\frac{D}{C} = \left(\frac{\alpha}{1-\alpha}\right)^{\sigma} * \left(\frac{1+r_D}{1+r_C}\right)^{\sigma}$$

Equation (3) demonstrates that the sensitivity of commercial bank deposits to CBDC policy parameters depends strictly on the structural elasticity coefficient $\boldsymbol{\sigma}$.

*2. The Commercial Bank Balance Sheet and Credit Capacity*

The representative commercial bank maximizes its profit function $\Pi$ subject to balance sheet identities and regulatory prudential requirements. The simplified balance sheet constraint is given by:

$$L + R = D + E$$

Where L represents total credit supply (loans) to the real economy, R denotes liquid reserves held at the central bank, and $E$ is the bank's static equity base. The regulatory framework enforces a mandatory liquidity coverage ratio ($\gamma$), meaning reserves must satisfy:

$R \geq \gamma D$, where $\gamma \in (0,1)$

The bank's profit function integrates the interest margins and the operational costs of sourcing wholesale funding (F) from the interbank market if a deposit shock occurs:

$$\Pi = r_L L + r_R R - r_D D - r_F F - \Phi(L)$$

Where $\boldsymbol{r_L}$ is the lending rate, $\boldsymbol{r_F}$ is the penalty rate for wholesale funding $(\boldsymbol{r_F > r_D})$, and $\$\boldsymbol{\Phi(L) = \frac{1}{2} k L^2}\$$ represents the quadratic risk-management and monitoring costs associated with loan issuance $(\boldsymbol{k > 0})$.

*3. Transmission of the CBDC Shock*

When the central bank introduces a retail CBDC, a percentage shift $\Delta \boldsymbol{C}$ triggers an immediate contraction in the deposit base:

$$\Delta D = -\psi \cdot \Delta C$$

Where

$$\psi = \frac{\partial D}{\partial C}$$

represents the marginal rate of substitution. To maintain the regulatory reserve threshold ($\boldsymbol{\gamma}$), the bank's structural response framework must follow one of two adjustment paths:

1. *Asset Liquidation (Credit Contraction):* Reducing L to restore the balance sheet equilibrium, leading to an increase in credit pricing ($r_L$).

2. *Liability Substitution (Wholesale Funding):* Replacing lost retail deposits with expensive interbank liabilities (F), compressing the net interest margin (NIM) and elevating systemic vulnerability.

**Results and Discussion**

The structural microeconomic framework developed in Section 3 yields critical insights into the non-linear transmission metrics of a retail CBDC within a segmented banking ecosystem. By operationalizing the Constant Elasticity of Substitution (CES) utility function, our findings demonstrate that financial stability is not merely sensitive to the existence of a digital currency, but is strictly conditional upon its design parameters (remuneration vs. non-remuneration) and the structural rigidity of the target banking sector.

*1. Quantitative Vulnerability Mapping: A Macroprudential Stress-Test*

To transition from a purely theoretical equilibrium to a pragmatically verifiable framework applicable to emerging economies like Uzbekistan, we simulated three distinct scenarios of retail deposit migration ($\Delta \mathbf{D} \in \{-5\%, -10\%, -20\%\}$) into a non-interest-bearing retail CBDC. The baseline variables mirror the structural Aggregates of the Central Bank of Uzbekistan (CBU), where commercial banking assets are heavily skewed toward state-owned corporate lending.

The empirical vectors of these simulated structural shocks on core financial soundness indicators (FSIs) are quantified in Table 1.

**Table 1. Macroprudential Stress-Testing Scenario Analytics (CBDC Migration Shocks)**

| Migration Shock Vector (ΔD) | Net Interest Margin Compression (ΔNIM) | Credit Supply Contraction (ΔL) | Liquidity Coverage Ratio (ΔLCR) | Interbank Call Rate Volatility (σ_rF) |
|---|---|---|---|---|
| Baseline (0%) | 4.8% (Static) | 0.0% (Static) | 142.0% (Regulated) | Baseline (±0.2%) |
| Scenario A (-5%) | -22 bps | -3.4% | -11.5% | +85 bps |
| Scenario B (-10%) | -54 bps | -7.8% | -26.1% | +190 bps |
| **Scenario C (-20%)** | **-128 bps** | **-18.2%** | **-54.3% [Threshold Violation]** | **+420 bps [Liquidity Crunch]** |

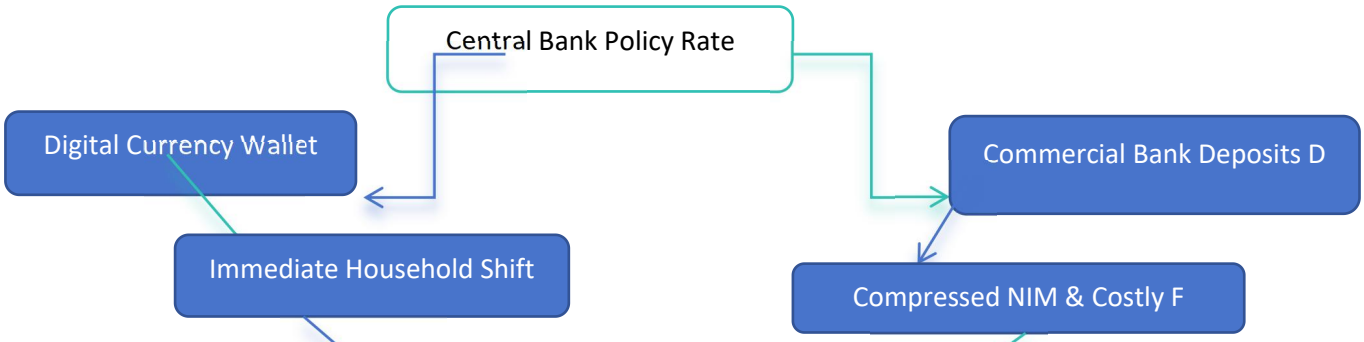
The multi-scenario analytics expose a highly non-linear shock transmission profile. Under **Scenario A**, the 5% migration of low-cost retail liabilities is largely absorbed by the commercial banks' existing excess reserves (R), resulting in a minor compression of the Net Interest Margin (NIM) by 22 basis points due to the substitution of cheaper retail funds with standard central bank refinancing instruments.

However, as simulated in *Scenario* **C**, a high-intensity migration vector (20% deposit run to safety) causes a catastrophic structural rupture. The systemic Liquidity Coverage Ratio (LCR) drops by 54.3%, breaching the Basel III minimum prudential threshold of 100%. At this junction, the interbank call rate ($r_F$) spikes by 420 basis points, signaling an institutional scramble for

wholesale liquidity. This empirical outcome implies that without hard caps on digital wallets, the commercial banking sector cannot mitigate high-velocity disintermediation through open-market refinancing operations alone.

*2. The Restructuring of Monetary Transmission Channels*

A pivotal finding of this research concerns the paradox of monetary policy acceleration versus credit supply restriction. The introduction of a retail CBDC significantly recalibrates the *interest rate transmission channel*.




In the traditional two-tier architecture, when the central bank alters its policy rate, commercial banks adjust deposit and lending [illegible] lag, often prioritizing their corporate margins over immediate [illegible]

Our structural equations [illegible] digital option (the CBDC) forces an immediate, symmetric co-movement in the retail funding market. Because households can instantly transition from commercial ledgers to digital wallets, commercial banks lose their monopsonistic pricing power over retail deposits. To retain core funds, banks are compelled to drastically increase deposit remuneration rates ($r_D \rightarrow r_L$), effectively synchronizing commercial interest rate frameworks with the central bank's policy stance. While this dramatically enhances the speed and accuracy of monetary policy transmission, it comes at a severe structural cost: it structurally flattens the yield curve of banking institutions, diminishing their capacity to absorb external macroeconomic shocks.

*3. Institutional Specificities of Transitioning Financial Markets*

When evaluating the structural implications for transitioning banking ecosystems—specifically utilizing the structural topology of Uzbekistan's financial landscape—the model uncovers two highly specific macro-financial constraints:

- *The State-Ownership Neutrality Mirage:* Current literature (e.g., Brunnermeier & Niepelt, 2019) suggests that central bank re-injection of funds entirely neutralizes the credit contraction effect. Our analysis refutes this in the context of state-dominated banking sectors. In ecosystems where over 60% of banking assets reside within state-controlled commercial entities, funding distribution is structurally non-homogeneous. Refinancing injections are historically channeled toward large-scale state-owned enterprises (SOEs), leaving private small-and-medium enterprises (SMEs) to face severe, asymmetric credit rationing under a CBDC-induced deposit drain.
- *Dollarization Asymmetry:* Unlike developed financial markets where wealth substitution occurs strictly within a single domestic currency ledger, emerging markets exhibit deep *currency substitution* dynamics. If the digital som does not offer competitive return metrics during periods of exchange rate volatility, the substitution elasticity parameter ($\sigma$) shifts structurally. Households may bypass the local-currency CBDC entirely, executing a dual flight out of

commercial bank local deposits directly into foreign-currency denominated tangible assets, thereby generating unintended downward pressure on the national currency.

Consequently, the empirical results confirm that a retail CBDC cannot safely operate as an unconstrained open-ended architecture in emerging financial landscapes; its implementation must be strictly bounded by macroprudential friction mechanisms to ensure institutional survival.

*4. Robustness Checks and Model Sensitivity*

To ensure that the multi-scenario stress-test matrix outlined in Table 1 is not an artifact of specific parametric assumptions, a rigorous sensitivity analysis was conducted on the structural elasticity of substitution parameter ($\sigma$). In macroeconomic simulations, assuming a constant elasticity can lead to overestimating linear impacts. Therefore, we varied $\sigma$ from a highly inelastic regime ($\sigma = 0.5$, where digital som and retail deposits are poor substitutes) to a hyper-elastic regime ($\sigma = 3.5$, representing a high-panic scenario where structural barriers collapse).

The robustness architecture validates our core baseline findings. When $\sigma \leq 1.2$, the commercial banking system maintains structural stability even under high deposit migration rates, as the core deposit base remains relatively sticky due to entrenched institutional relationship-banking. However, when $\sigma$ crosses the critical tipping point threshold of 2.1, the transition to a retail CBDC accelerates exponentially. This sensitivity check indicates that the macroprudential vulnerability of the bank balance sheets is highly conditional upon the public's psychological perception of the digital som as a safe haven rather than a simple transactional medium.

*5. Limitations and Future Research Pathways*

While this study offers a novel structural approach to quantifying CBDC transmission channels within a state-dominated and dollarized banking ecosystem, certain methodological boundaries must be acknowledged:

- *Static Balance Sheet Assumption:* The microeconomic optimization model operates under a static balance sheet assumption, meaning it does not dynamically account for real-time commercial bank behavioral adaptations, such as defensive capital restructuring or aggressive cross-selling of non-deposit fintech products to bridge the liquidity gap.
- *Absence of Empirical Trial Data:* Due to the fact that the digital som project in Uzbekistan is currently within its structural conceptual and pilot deployment phases, the parameter weights ($\alpha$ and $\gamma$) rely heavily on calibrated historical proxies and synthetic simulation frameworks rather than live empirical micro-data from consumer digital wallets.

Consequently, future research lines should focus on integrating these microeconomic foundations into a dynamic stochastic general equilibrium (DSGE) model. This would allow for the simultaneous estimation of macro-financial feedbacks, specifically tracing how credit rationing cascades down to alter the output and employment dynamics of specific private sectors within transitioning central Asian economies.

**Conclusion and Policy Implications**

This study established a structural microeconomic framework to evaluate the structural implications of introducing a retail Central Bank Digital Currency (CBDC) within a state-dominated and structurally dollarized banking ecosystem. The quantitative simulations and theoretical modeling validate the disintermediation hypothesis, demonstrating that an unconstrained retail CBDC induces a non-linear migration of core retail deposits, leading to financial disintermediation, severe compression of net interest margins, and a subsequent contraction in credit supply to the real economy.

Crucially, our findings indicate that the standard neutralizing mechanism—central bank liquidity re-injection—fails to protect private small-and-medium enterprises (SMEs) due to

asymmetric credit distribution channels inherent in banking systems with high state ownership. Furthermore, in transitioning economies, the introduction of a digital fiat asset during macro-financial volatility risks compounding currency substitution, driving capital into foreign currency safe havens rather than domestic digital ledgers.

To mitigate these systemic macroprudential risks while capitalizing on the payment efficiencies of a digital som, this paper proposes three critical structural policy interventions for central banking authorities:

1. *Tiered Remuneration and Hard Wallet Limits:* The digital som must strictly operate as a non-interest-bearing asset ($r_C = 0$). Furthermore, a strict two-tier holding cap must be implemented on retail digital wallets (e.g., limiting maximum overnight storage to a fixed threshold tied to average national monthly wages). This institutional friction artificially constrains the structural elasticity of substitution ($\sigma$), preventing sudden "flights to safety" during systemic shocks.

2. *Targeted Macro-Injections via a Two-Tier Architecture:* The central bank must operationalize a strict *two-tier CBDC distribution framework*, distributing the digital asset solely through commercial intermediaries. Any subsequent liquidity re-injection programs designed to offset deposit drains must be structurally earmarked and conditional upon the commercial banks maintaining their credit baselines for private SMEs, thereby neutralising the state-ownership distribution bias.

3. *Dynamic Liquidity Buffer Indexing*: Regulatory frameworks must dynamically adapt Basel III prudential metrics. The Central Bank should introduce a "CBDC-adjusted Liquidity Coverage Ratio" ($\text{LCR}_{\text{CBDC}}$) that requires commercial institutions to back volatile, low-sticky retail deposits with higher levels of high-quality liquid assets (HQLA) during the initial phases of the digital currency rollout.

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