Households Allocation of the Next Generation of Digital Money

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Abstract

This paper develops a general equilibrium model to examine how households may allocate their portfolios across central bank digital currencies (CBDCs), fintech-issued stablecoins, and traditional bank deposits in a foreseeable digital monetary environment. Household decisions are driven by convenience-adjusted returns, defined as the sum of financial yields and nonpecuniary liquidity benefits. The model shows that households reallocate wealth toward the instrument offering the highest combined return. We extend the framework to incorporate stablecoin supply constraints, endogenous redemption risk, and nonlinear network effects, identifying conditions under which stablecoins may either dominate or be displaced by CBDCs. Numerical simulations illustrate how small changes in convenience yields can trigger abrupt shifts in household portfolios, highlighting the potential for tipping points in digital money adoption. Our findings emphasize that the comparative convenience of money-like instruments is as influential as their financial returns in determining equilibrium asset shares. Policy implications include the importance of CBDC design in advancing monetary sovereignty and financial inclusion, the need for stablecoin reserve transparency, and the effects of monetary competition on deposit rates and banking system stability. These results contribute to ongoing debates on digital money architecture, monetary policy transmission, and regulatory frameworks for a resilient and inclusive financial ecosystem.

Keywords: CBDC; Stablecoins; Digital Payments; Household Portfolio Choice; General Equilibrium; Monetary Policy Transmission.

JEL Classification: E42; E44; E58; G21; O33

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Contents

List of Tables

List of Figures

I promise nothing complete
Moby Dick
Herman Melville

1 Introduction

This paper anticipates a foreseeable future in which households allocate their wealth across a range of money-like instruments to settle transactions. These include central bank digital currencies (CBDCs), fintech-issued stablecoins, traditional bank deposits, tokenized deposits, and platform-based credits. While these instruments often serve similar monetary functions, they differ in legal status, technological infrastructure, privacy, and settlement finality. As digital payment ecosystems evolve, their coexistence introduces new challenges for monetary policy transmission, financial intermediation, and regulatory design.

To study these dynamics, we develop a general equilibrium model in which households optimize their portfolios over competing monetary instruments based on convenience-adjusted returns—that is, the sum of financial yields and nonpecuniary liquidity services. The model incorporates balance sheet interactions across commercial banks, stablecoin issuers, and the central bank, capturing how household preferences affect equilibrium asset shares, interest rate spreads, and systemic conditions. We characterize the conditions under which certain instruments dominate, coexist, or trigger tipping points in portfolio allocation.

By grounding digital monetary competition in a formal macro-financial framework, this paper contributes to debates on CBDC design, the regulatory treatment of stablecoins, and the long-term stability of a multi-instrument monetary system.

This paper is structured as follows. After a brief summary of the literature in Section 2, Section 3 presents a taxonomy of current and future money-like instruments, and their pros and cons. Section 4 documents the payment flows and transaction mechanism available to households while Section 6 documents the impact os digitalization on the balance sheets of banks and non-financial intermediaries. Section 7 present a general equilibrium model with money-like instruments and some results on households allocation of money-like instruments and Section 8 presents various model extensions. Section 9 shows how the analytical framework developed in this paper intersects directly with the evolving regulatory architecture of the European Union, the U.S. and the U.K.. Section 10 concludes.

2 Literature Review

The evolution of digital monetary instruments has spurred a growing body of research examining the implications of CBDCs, stablecoins, and digital payment systems on monetary policy, financial intermediation, and systemic stability. This section reviews the main strands of relevant literature, with a focus on recent contributions that align with the themes of this paper.

A foundational strand of the literature explores the macroeconomic and financial implications of CBDCs. Brunnermeier et al. (2019) analyze how CBDCs may reshape the banking system and monetary transmission, while Fernández-Villaverde et al. (2021) examine trade-offs in CBDC design related to privacy, inclusion, and financial stability. Andolfatto

(2021) and Keister and Sanches (2022) study the effects of interest-bearing CBDCs on bank funding and credit provision. More recently, Ahner et al. (2024) and Carapella et al. (2024) provide comprehensive frameworks for assessing the financial stability implications of CBDC issuance.

The role of stablecoins has also received significant attention. Adrian and Mancini-Griffoli (2019, 2021) and Adrian (2022) highlight the risks of monetary fragmentation and loss of sovereignty posed by widespread stablecoin adoption. Committee on Payments and Market Infrastructures (2020), International Monetary Fund (2022b), Ahmed and Aldasoro (2025) and Fiedler et al. (2023) provide empirical evidence on the fragility of stablecoins under stress, while Chiu and Monnet (2024) explore the interaction between CBDC design and stablecoin usage in decentralized finance (DeFi) ecosystems. Finally, Carapella (2025) shows how stablecoin regulation can impact the stability of traditional financial institutions.

Recent theoretical advances have laid the groundwork for modeling household portfolio allocation across money-like instruments using convenience-adjusted returns within a general equilibrium (GE) framework. Our model builds directly on this foundation. Schilling et al. (2024) and Davoodalhosseini (2022) develop GE models in which households allocate across CBDC, deposits, and other liquid assets based on liquidity services and convenience yields. These models serve as a direct foundation for our framework, which incorporates similar arbitrage conditions and balance-sheet interactions. Chiu and Monnet (2024) extend this approach to a distributed ledger technology (DLT) setting, comparing stablecoins, tokenized deposits, and CBDC. Their analysis of public versus private money creation and its implications for household portfolios closely parallels our treatment of instrument competition. Andolfatto (2021) and Keister and Sanches (2022) also feature GE environments where households choose between CBDC and deposits, with implications for bank intermediation and monetary policy. These models share our emphasis on convenience-adjusted returns and zero-profit conditions for financial intermediaries.

From a broader currency-competition perspective, Benigno et al. (2022) and Brunnermeier et al. (2019) provide conceptual frameworks for understanding monetary competition in multi-instrument environments. While less focused on balance-sheet mechanics, their treatment of liquidity and return trade-offs aligns with our theoretical structure.

In the context of monetary policy, Woodford (2001) and Benigno et al. (2022) examine unconventional policy tools in environments without government bond markets. Panetta (2022, 2023, 2025) emphasizes the importance of CBDC design in preserving monetary sovereignty and financial stability, advocating for a public anchor in digital finance.

Together, these contributions inform the structure of the model developed in this paper, which integrates CBDC, stablecoins, and bank deposits into a unified framework for analyzing household portfolio allocation and monetary policy transmission in a digital environment.

This paper advances the theoretical and policy discourse on digital money by developing the first general equilibrium model that jointly incorporates central bank digital currencies (CBDCs), bank deposits, and fintech-issued stablecoins into household portfolio choice. Unlike prior models that typically focus on the CBDC–deposit tradeoff, our framework integrates stablecoins as a third asset class, enabling a unified analysis of public and private digital monies. Building on foundational work by Andolfatto (2021), Keister and Sanches (2022), Davoodalhosseini (2022) and Schilling et al. (2024) , we extend the concept of convenience-adjusted returns by introducing endogenous redemption risk and nonlinear network effects—features that are absent in earlier literature.

Our model captures dynamic fragility and tipping-point behavior in portfolio allocation, showing how small changes in convenience yields can lead to abrupt reallocations across instruments. This complements insights from Chiu and Monnet (2024), who explore digital money in distributed ledger environments, and bridges the gap with the shadow banking literature, particularly the run-like dynamics emphasized by Gorton and Metrick (2012). By embedding currency competition into a balance-sheet-consistent macro-financial framework, we link household choices to the financial positions of banks, stablecoin issuers, and the central bank.

Furthermore, the model provides micro-founded conditions under which CBDCs dominate, coexist with, or are displaced by stablecoins, offering policy-relevant insights into the effects of CBDC remuneration, holding limits, and reserve transparency. In doing so, it operationalizes design-sensitive parameters such as programmability, privacy, and interoperability, thereby enabling comparative statics and policy experiments. Overall, this paper contributes a tractable yet comprehensive tool for assessing monetary competition, financial stability, and regulatory design in a digital ecosystem.

3 Monetary Financial Instruments

The architecture of money and payments has undergone significant transformation in recent decades. While traditional forms such as physical cash and commercial bank deposits remain foundational, they are increasingly complemented—and in some cases challenged—by digital innovations. CBDC, stablecoins, and platform-based balances now represent prominent contenders in the evolving monetary landscape. These instruments differ in terms of issuer, legal status, technological design, and settlement properties. This section provides a taxonomy of money-like instruments and situates them within a framework suitable for general equilibrium analysis.

Central Bank Instruments

Central banks have historically issued physical cash as a liability, serving as the cornerstone of monetary systems. Cash is universally accepted, anonymous, and provides settlement finality. In response to the digital age's demands, central banks are exploring or implementing CBDCs. These digital liabilities can be either account-based or token-based, offering programmability and traceability. While CBDCs aim to maintain the central bank's control over monetary policy, they also introduce new challenges related to privacy, financial stability, and the potential disintermediation of commercial banks.

Bank Money

Commercial banks create deposit money through lending activities. These deposits, while widely accepted and supported by payment infrastructure, carry counterparty risk and are subject to confidence dynamics—particularly during periods of financial stress. They, redeemable in central bank money and backedfrom deposit insurance, can be **Commercial**

Bank Deposits – accessible through cards, mobile apps, etc. – and **Tokenized Deposits** –digital tokens transferable on permissioned Distributed Ledger Technology (DLT) networks.

E-money

E-money (electronic money) represents a digitally stored monetary value issued by regulated institutions, typically on a prepaid basis and redeemable at par. Unlike stablecoins – which may rely on reserves or other assets and are exposed to market risk – e-money is fully backed by fiat currency and held in segregated accounts. Its convenience stems from broad merchant acceptance, seamless integration with mobile platforms, and low transaction costs. While e-money generally does not pay interest, its high usability often justifies household adoption. These instruments combine mobile accessibility with peer-to-peer functionality, though they lack yield-bearing features. Regulatory clarity and strong consumer protections shape their role in household portfolios, particularly in jurisdictions where CBDCs are not yet available.[1]

Stablecoins

Stablecoins are digital tokens pegged to fiat currencies and are typically backed by reserves such as bank deposits, securities, cryptocurrencies or CBDCs. They can be collateralized (e.g., USD Coin, Tether) or uncollateralized/algorithmic (e.g., TerraUSD, Ampleforth) in nature. We assume that they are issued by Non-Financial Intermediaries (NFIs) or Fintech companies, which have an obligation towards investors. Stablecoins offer benefits like faster transactions and reduced costs, making them attractive for cross-border payments. However, their growth has raised concerns regarding regulatory oversight, financial stability, and the potential for runs on these instruments during periods of market stress.[2]

Stablecoins share structural features with pre-crisis shadow banking instruments such as money market funds (MMFs) and repo-backed liabilities. Both promise par convertibility, rely on short-duration liquid assets, and function as near-money substitutes outside the traditional regulatory perimeter. Like MMFs, stablecoins aim to maintain a stable value while investing in high-quality assets, yet they lack equivalent prudential safeguards such as

[1] In the euro area, e-money is regulated under the Electronic Money Directive (EMD2), with firms like PayPal Europe and Revolut issuing euro-denominated e-money backed by safeguarded funds. In the United States, e-money-like instruments are issued by licensed money transmitters such as Venmo and Cash App, which hold customer funds in custodial accounts at commercial banks

[2] Stablecoins differ from e-money not only from a technological standpoint—as they are based on **distributed ledger technology (DLT)**—but also from a regulatory perspective. In the EU regulatory framework, **e-money** is defined under Directive 2009/110/EC (EMD2) as electronically stored monetary value issued upon receipt of funds, representing a claim on the issuer, and redeemable at par. It must be issued by a licensed e-money institution (EMI) or credit institution and is typically recorded in centralized systems. In contrast, **e-money tokens (EMTs)**—as defined under Regulation (EU) 2023/1114 (MiCAR)—are a subclass of crypto-assets that replicate the economic function of e-money but are issued and transferred using DLT. EMTs must also be issued by EMIs and are pegged to a single fiat currency, with mandatory par-value redemption rights. More broadly, **stablecoins** include both EMTs and **asset-referenced tokens (ARTs)**. ARTs are backed by a basket of assets (e.g., currencies, commodities, crypto-assets), may be issued by non-bank entities, and are subject to distinct prudential and conduct-of-business requirements under MiCAR. While EMTs are functionally equivalent to e-money but DLT-native, ARTs are more akin to investment instruments with broader use cases and higher systemic risk potential.

liquidity buffers, redemption gates, and access to central bank backstops. This resemblance raises systemic concerns: sudden redemption shocks can force asset liquidation, propagate stress to the banking system, and trigger contagion across financial markets. As with shadow banking, the absence of robust oversight amplifies run risk and financial fragility, particularly if stablecoins grow to intermediate significant payment volumes or savings behavior. These parallels underscore the need for regulatory frameworks that align stablecoin oversight with the systemic importance of their monetary function. These structural similarities have led many observers to classify certain stablecoin arrangements as a modern form of "shadow money."[3] As regulators seek to balance innovation with monetary stability, a key challenge lies in determining whether stablecoins should be treated as payment instruments, investment funds, or synthetic deposits—and whether they warrant regulation analogous to that applied to MMFs or bank liabilities.

Platform Balance Money

Platform balances are internal digital credits issued by large technology or e-commerce firms (e.g., Amazon, Apple, PayPal) within closed-loop ecosystems. Users fund these balances by transferring fiat money to the platform, which is held in custodial accounts. The credits can only be used within the platform and are not legal tender, transferable, or redeemable externally.

From a financial economics perspective, platform balances provide high convenience yields due to seamless integration with e-commerce, loyalty programs, and user interfaces. However, they carry counterparty risk and are not subject to the prudential oversight applied to banks or e-money institutions. Their monetary status is therefore limited to internal use, and their role in household portfolios is constrained by their lack of fungibility and legal protection.

In the model, platform balances can be incorporated as a fourth money-like instrument, offering high convenience but zero financial yield and limited liquidity. Their inclusion would introduce additional segmentation in household payment choices and highlight the trade-off between convenience and monetary integrity in digital ecosystems.

Stablecoins issued by networks and platforms

Credit card networks (e.g., Visa, Mastercard) and large digital platforms (e.g., PayPal, Amazon, Meta) have strong incentives to issue stablecoins as a strategic response to token-based infrastructures offering instant settlement, programmability, and global interoperability. For card networks, stablecoins can reduce interchange fees, eliminate chargeback risks, and enable low-value, high-frequency transactions such as micropayments. Their existing compliance infrastructure (AML/KYC) and regulatory credibility position them well to issue fiat-referenced tokens under emerging legal frameworks. These instruments would exhibit high convenience yields (θ_j) due to broad merchant acceptance, brand trust, and integration with existing wallets and APIs.

[3] See, for instance, Gorton and Metrick (2012) on the parallels between repo-backed shadow banking and money substitutes, and more recently, discussions by the Financial Stability Board (2020) and Bank for International Settlements (2021) on the potential systemic impact of stablecoins and their resemblance to shadow money.

For digital platforms, stablecoins extend closed-loop balances into transferable, programmable instruments, enhancing liquidity and user engagement across shopping, streaming, and financial services. They also strengthen ecosystem lock-in through reward programs and embedded financial features. From a balance sheet perspective, platform-issued stablecoins resemble synthetic liabilities backed by cash or custodial deposits, similar to existing stablecoins but with broader utility.

In both cases, stablecoin issuance serves as both a payments innovation and a mechanism for strategic control over the digital finance interface. When convenience yields are sufficiently high due to integration and usability, households may reallocate wealth toward these instruments even without explicit interest payments.

Table 1 provides a side-by-side comparison of key attributes across six categories of money-like instruments: cash, CBDC, bank deposits, e-money, stablecoins, and platform balances. It highlights differences in issuer type, legal status, privacy, interest-bearing capacity, and settlement finality. Notably, only cash is fully anonymous and legal tender, while CBDC offers potential programmability and public trust. Bank deposits remain interest-bearing and widely accepted, but are exposed to bank risk. E-money, by contrast, is a regulated digital claim fully backed by fiat currency and safeguarded through strict redemption rights, offering households a stable and convenient alternative in jurisdictions without CBDC. Stablecoins and platform balances, both issued by private firms, lack legal tender status and finality, with platform balances being confined to closed ecosystems. The table underscores the trade-offs between convenience, safety, and regulatory oversight in the evolving digital money landscape.

'Settlement finality' refers to the point at which a payment becomes irreversible and unconditional. It is crucial for financial stability and risk management: instruments like cash and CBDC offer immediate finality, while deposits, e-money, stablecoins and platform balances may involve delays or counterparty risk, making settlement less certain.

While Table 1 classifies stablecoins as non-interest-bearing and low-privacy instruments, this characterization reflects the most common custodial implementations.

Convenience-Adjusted Returns and Household Preferences

While these monetary instruments differ in issuer type, settlement mechanism, and technological form, their role in household portfolios is ultimately determined by their relative attractiveness as stores of value and media of exchange. We model this attractiveness through the concept of a *convenience-adjusted return*, defined as the sum of an instrument's financial yield and the nonpecuniary benefits it provides in facilitating transactions.

Formally, let i_j denote the nominal return on instrument $j \in \{cash, e, c, D, S, p\}$ – where *cash* stands for central bank money, e for e-money, c for CBDC, D for deposits, S for stablecoins, and p for platform balances – and θ_j its convenience yield, reflecting liquidity, accessibility, programmability, or privacy. The household evaluates each asset based on the convenience-adjusted return:

$$r_j = i_j + \theta_j, \tag{1}$$

Table 1: Comparison of Monetary Instruments

Feature	Cash	CBDC	Bank Deposits	E-money	Stablecoins	Platform Balances
Issuer	Central Bank	Central Bank	Commercial Bank	Regulated Firms	Private Firms	Private Firms
Form	Physical	Digital	Digital	Digital	Digital	Digital
Legal Tender	Yes	Possibly[a]	No	No	No	No
Privacy	High	Variable	Low	Low	Low[b]	Low
Interest-Bearing	No	Possibly[c]	Yes	No	No[d]	No
Settlement Finality	Yes	Yes	No	No	No	No

Note. *(a)* Possibly legal tender to reflect the fact that its legal status varies across jurisdictions. While some central banks may grant CBDC full legal tender status (e.g., China's e-CNY), others may not (e.g., the Bahamas' Sand Dollar). Thus, CBDC is a central bank liability with potential legal tender status, but such status is not universally established and depends on national legislation and policy choices. See Appendix A.3 for a more in-depth look at CBDC legal status. *(b)* When used in peer-to-peer DeFi environments, stablecoins may provide higher degrees of transactional privacy, depending on the protocol design and user behavior. These features blur the boundaries between traditional classifications and highlight the evolving nature of digital money. *(c)* See Appendix A.3 for a more in-depth look at CBDC remuneration. *(d)* In practice, some stablecoins—particularly those integrated into decentralized finance (DeFi) protocols—can offer interest-like returns through staking or lending mechanisms. See Appendix A.4 for a more in-depth look at stablecoin interest mechanisms.

Household portfolio allocation then depends on relative values of r_j across instruments. In equilibrium, assets that offer higher convenience yields can compensate for lower or even zero financial returns, as in the case of cash or CBDC.

This concept provides a unified lens to compare traditional and digital money-like instruments in a general equilibrium setting.

Monetary Flow Representation

All in all, the integration of traditional monetary instruments with digital innovations has led to a more complex and interconnected financial ecosystem. While these developments offer enhanced efficiency and inclusivity, they also present new challenges related to regulation, financial stability, and the role of central banks. Future research should focus on developing frameworks that balance innovation with oversight, ensuring a stable and equitable financial system for all participants.

Figure 1 illustrates the monetary flows across key sectors of the payment ecosystem. Households allocate funds among cash, CBDC, bank deposits, stablecoins, and platform balances. For simplicity, e-money is excluded, though it can be considered a distinct category closely related to stablecoins. Banks intermediate deposits and issue loans, maintaining reserves at the central bank, while non-financial intermediaries issue stablecoins backed by reserves or bank deposits. The figure shows how money-like instruments circulate between households, banks, the central bank, and non-financial intermediaries, highlighting their interdependencies and the settlement layers involved. This schematic underscores the complexity of modern payment systems and the potential for shifts in household preferences to affect the balance sheets of both financial and non-financial actors.

All in all, Figure 1 emphasizes interdependencies between households, banks, central bank and NFIs, and highlights how shifts in household preferences (e.g., moving from deposits to stablecoins) can propagate through the system.

As far as issuance of stablecoins backed by bank deposit, NFIs issue stablecoins by receiving fiat funds from users and depositing them into custodial bank accounts. They mint stablecoin tokens 1:1 against these deposits, creating private digital claims fully backed by commercial bank money. Users can redeem stablecoins for fiat, with the NFI burning tokens and returning funds from its reserves. While bank deposits provide liquidity, this structure exposes stablecoins to issuer and banking risks, as reserves depend on the solvency of both the NFI and its banking partners.

When households spend stablecoins: they transfer them directly to merchants or other users on the blockchain and no redemption is involved. When households redeem stablecoins send their stablecoins back to the issuing NFI (e.g., a fintech stablecoin provider). The NFI then pays out an equivalent amount of fiat funds — often by crediting a bank deposit account, transferring CBDC (if allowed), or wiring funds to another account. The NFI burns or retires the redeemed stablecoins, reducing their supply.

Redemptions represent the mechanism ensuring stablecoins' peg and convertibility. They expose stablecoins to run risk: if many households simultaneously redeem (e.g., fearing solvency issues at the NFI), the issuer must liquidate collateral to pay out — which can create systemic risk (as we discuss in Section **??**). The redemption channel links stablecoins back to central bank money or bank deposits, reinforcing their monetary status as private claims.

Finally, the arrow from Banks to NFI reflects that the backing assets for stablecoins are provided by the banking sector.

Dashed arrows show collateral and optional platform balances, to show how platforms like Amazon handle user funds. Platform balances act like private IOUs confined within a closed ecosystem, allowing rapid, frictionless internal payments — but they lack the legal status, portability, and safety of central bank money or insured bank deposits.

Platforms (e.g., Amazon, Apple, PayPal) create internal digital credits by receiving funds from households, which they store in custodial bank accounts or liquid investments. These credits represent unsecured claims on the platform's balance sheet and can only be spent within the platform's closed-loop system. Platform balances are neither legal tender nor transferable outside the platform, relying entirely on the platform's solvency. Settlement with external merchants requires the platform to move funds through the banking system or, potentially, stablecoin rails, highlighting their dependence on traditional financial infrastructure.

For the sake of completeness, we also incorporate government and firms. The government issues bonds, which may serve as collateral for NFI in the issuance of stablecoins (shown in the dashed circle). Nonetheless, the proposed framework remains applicable in the absence of such instruments, provided that NFI backs its stablecoins with either commercial bank deposits or central bank reserves.

The figure includes a direct credit channel from non-financial intermediaries (NFIs) to firms, representing loans denominated and disbursed in stablecoins. Through this link, firms can obtain financing outside the traditional banking sector, using stablecoins as both the loan principal and repayment medium. This channel enables firms to bypass bank intermediation, potentially reducing reliance on bank credit but increasing exposure to stablecoin liquidity and valuation risks. It highlights the emergence of stablecoins not only as payment instruments but also as vehicles for corporate borrowing, introducing new dynamics into credit markets and monetary transmission.

Stablecoin lending works through decentralized finance (DeFi) protocols and centralized exchanges (CEX). In DeFi, firms or individuals borrow stablecoins by posting crypto collateral (e.g., Ethereum, Bitcoin) on smart contracts; the protocol automatically manages loans, interest, and liquidations without intermediaries. In centralized exchanges (CEX) or centralized lenders, firms enter agreements directly with the platform, which lends stablecoins in exchange for collateral or credit terms, and handles custody, interest payments, and potential margin calls off-chain. Both models allow firms to raise funding in stablecoins outside the traditional banking system.

4 Transaction Flows Across Monetary Instruments

This section builds on the typology of instruments introduced in Section 3, examining how households use various monetary assets to settle transactions. We map the flow of funds across institutional layers and identify frictions associated with intermediaries, settlement systems, and redemption. Figure 1 formalizes these institutional layers, with arrows denoting monetary transfers between households, commercial banks, non-financial intermediaries, platforms, and the central bank. Dashed arrows represent reserve flows and collateral movements. Tokenized deposits are introduced as programmable, DLT-based liabilities of banks.

We classify household payment instruments based on their medium, intermediary structure, settlement characteristics, and the form of value received by the merchant. Table 2 provides a comparative overview, including both traditional and emerging instruments—such as cash, CBDC, bank deposits, e-money, stablecoins, platform balances, and tokenized deposits. While cash and CBDC offer final settlement with minimal intermediation, other instruments introduce varying degrees of delay, counterparty risk, and legal complexity. E-money sits in between deposits and stablecoins: like deposits, it is backed one-to-one by fiat and issued by licensed intermediaries, but like stablecoins, it circulates on private ledgers and does not constitute legal tender.

Tokenized deposits and stablecoins occupy an intermediate position between legacy bank payments and CBDC in terms of speed, trust, and programmability. Compared to e-money, stablecoins involve more fragile reserve arrangements and higher redemption risk, while e-money benefits from strict segregation of backing funds and regulatory oversight. Stablecoins and platform balances rely on private issuers and decentralized or internal ledgers, often lacking legal tender status. Tokenized deposits represent a hybrid innovation: issued by regulated banks and recorded on distributed ledgers, they combine the legal safeguards of traditional deposits with the programmability and interoperability of blockchain-based systems. These trade-offs influence household choices across dimensions such as speed, trust, privacy, and interoperability.

We analyze the role of intermediaries in transmitting value from payer to payee. Each payment medium is embedded within a distinct risk and settlement framework. Commercial banks clear deposits via Real-Time Gross Settlement (RTGS), Automated Clearing House (ACH) networks, or batch-based settlement systems; stablecoin issuers operate on DLT

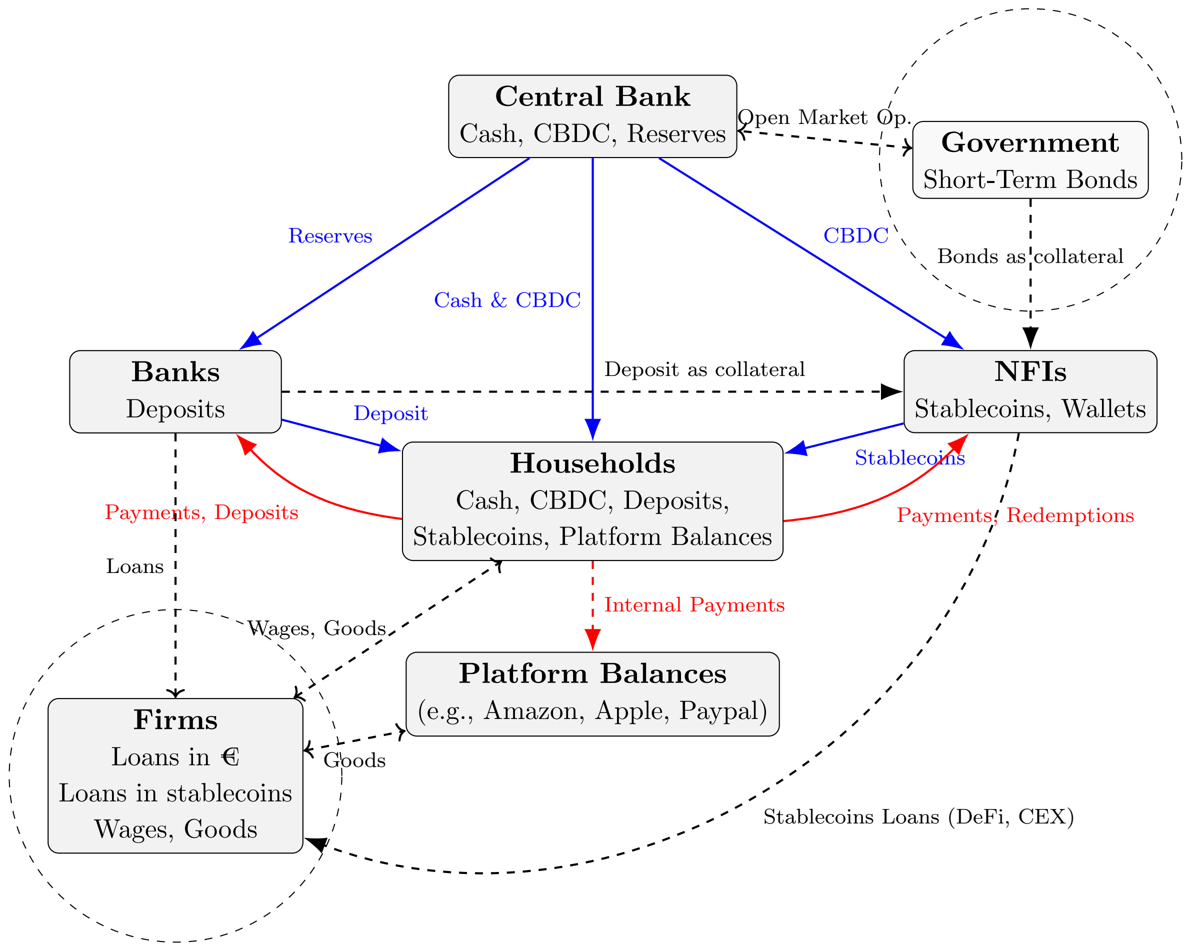

Figure 1: Monetary Flow Representation

Note. This schematic illustrates monetary flows among households, banks, the central bank, and non-financial intermediaries. Households allocate funds across cash, CBDC, bank deposits, stablecoins, and platform balances; flows connect through deposit-taking banks, stablecoin issuers backed by reserves or deposits, and central bank liabilities. Deposits include tokenized deposits, which are issued by banks and operate on distributed ledger infrastructure; these instruments represent an emerging hybrid form of money that combines the safety of traditional bank deposits with the programmability and interoperability of digital tokens. It highlights the layered settlement structures and the interdependencies shaping modern payment ecosystems. Dashed arrows show collateral and optional platform balances, if you want to show how platforms like Amazon handle user funds. "Redemptions" between NFIs issuing stablecoins and households refer to the process where households exchange stablecoins back to the issuer (NFI) to redeem them for traditional money — e.g., central bank money (CBDC or cash) or bank deposits. We include government bonds as potential collateral for stablecoin issuance by NFI, though the framework remains valid if stablecoins are instead backed by bank deposits or central bank reserves. We also include firms to close the payment ecosystem with Households, Banks, Platforms and NFIs.

networks backed by reserves or collateral; e-money issuers process transfers on proprietary or centralized ledgers, offering near-final settlement backed by safeguarded fiat funds; platform balances settle internally without external clearing. Trade-offs arise between settlement speed, credit risk, and user convenience.[4]

Settlement finality varies across instruments and institutional configurations. Cash and CBDC offer immediate and irrevocable settlement. In contrast, stablecoins and tokenized deposits involve off-chain redemption processes, introducing an additional layer of complexity. E-money achieves near-final settlement on issuer-ledgers, but unlike CBDC or cash, settlement depends on the solvency and operational integrity of the licensed e-money institution. We define "near-finality" for on-chain instruments to emphasize that programmability and reversibility—though offering flexibility—can undermine the clarity and trust associated with monetary finality.

4.1 Economic Drivers of Household Payment Choice

This section interprets household payment behavior through the lens of financial economics. Each payment instrument can be viewed as a liquidity service asset, offering a combination of financial return and nonpecuniary convenience. Households allocate payment flows to maximize utility, choosing the instrument with the highest convenience-adjusted return, defined as the sum of its financial yield and its convenience yield, as defined by definition 1 of Section 3 . The convenience yield captures features such as ease of use, liquidity, privacy, settlement speed, and interoperability. We organize the discussion by grouping instruments into three categories: public money, bank-based instruments, and private digital money and summarize the economic characteristics of each payment channel:

Public Money

Cash

Cash transactions involve the direct transfer of central bank liabilities. They are peer-to-peer, anonymous, and settlement is immediate. However, they are constrained by physical proximity and are unsuitable for digital commerce.

CBDC

CBDC payments are executed via digital wallets linked to the central bank ledger. They offer finality, programmability, and zero credit risk. However, adoption depends on infrastructure availability and potential policy-imposed limits on holdings or usage.

[4] Real-Time Gross Settlement (RTGS) systems settle individual transactions immediately and irrevocably, typically between financial institutions. Automated Clearing House (ACH) systems, by contrast, process payments in batches, often with a delay of one or more business days. More broadly, batch-based settlement systems group multiple transactions together and settle them at fixed intervals, usually on a net basis, offering efficiency at the cost of speed and settlement finality.

Table 2: Household Payment Channels by Medium and Flow

Payment Type	Medium Used	Intermediaries	Settlement Type	Merchant Receives
Cash	Physical currency	None	Final (immediate)	Cash
CBDC	Digital tokens	CBDC wallet provider	Final (central bank ledger)	CBDC in wallet
Bank Transfer	Bank deposits	Commercial banks	Delayed or instant	Bank deposit
Card Payment	Bank deposits	Banks + Card network	Delayed (clearing)	Bank deposit
E-Money	Prepaid digital value fully backed by fiat	Licensed issuers + wallet provider	Near-final (issuer ledger)	E-money credit or bank deposit
Stablecoins	Private tokens	Issuers + blockchain	Near-final (token transfer)	Stablecoins
Platform Balance	Internal credits	Fintech / Platform	Internal	Platform credit or transfer
Tokenized Deposits	Bank-issued tokens on DLT	Commercial banks + DLT infrastructure	Near-final (on-chain trasfer, off-chain redemptions)	Bank deposit or tokenized claim

Note. The Table classifies common retail payment types along three dimensions: (i) *Monetary instrument used* — the payment medium may be a physical asset (cash), a central bank liability (CBDC), a commercial bank claim (deposit or tokenized deposit), a regulated prepaid claim (e-money), a privately issued digital token (stablecoin), or a proprietary platform credit. (ii) *Intermediaries involved* — transactions are processed and settled via different intermediaries: central banks (for CBDC or reserves), commercial banks (for deposits and tokenized deposits), non-financial entities or fintechs (for stablecoins), licensed e-money institutions (for e-money), or platform operators (for internal balances). (iii) *Settlement and finality* — "Final" settlement implies irrevocable transfer on physical or central bank balance sheets (e.g., cash or CBDC); "Near-final" refers to transfers recorded on issuer or DLT ledgers with potential redemption delays (e.g., e-money, stablecoins, tokenized deposits); "Delayed" settlement applies to legacy banking rails with netting or clearing lags (e.g., cards or ACH transfers). E-money differs from stablecoins in that it is fully backed by segregated fiat deposits and issued by licensed e-money institutions under strict regulation, whereas stablecoins may rely on more fragile reserve arrangements and often operate in less comprehensive regulatory frameworks. Tokenized deposits are DLT-based liabilities of commercial banks that preserve deposit safety while enabling programmable, on-chain payments. Platform balances refer to internal credits within closed-loop ecosystems (e.g., Amazon, PayPal) that lack legal tender status and portability. All payments are assumed to be denominated in the same domestic unit of account.

Bank Deposit-Based Payment Channels

Payments involving bank-held monetary assets may be executed through various channels. Bank deposits serve as the underlying monetary medium and can be transferred via **bank transfers**, **card payments**, or emerging **fast-payment rails**. **Tokenized deposits**, while also liabilities of commercial banks, are transferred on distributed ledger infrastructure and may offer programmable features. **Credit card payments**, though functionally distinct, are typically settled by drawing against bank deposit balances and thus rely on the same monetary medium, albeit with additional layers of credit intermediation and fee structures. Deposits retain these key characteristics that play a crucial role in determining their high convenience yield, θ_D;

- They are interest-bearing and insured (where applicable).
- They are redeemable at par and backed by the issuing bank's balance sheet.
- They are subject to the prudential regulation.

Bank Transfers as Legacy Deposit Infrastructure

Before the emergence of fast payment systems, most retail bank transfers operated on legacy infrastructure such as RTGS, ACH networks, or batch-based settlement systems. These systems typically involve processing delays, limited operating hours, and multi-day settlement cycles, particularly for interbank or cross-border transactions. While adequate for low-frequency transfers and business payments, such mechanisms offer limited convenience in real-time retail use cases. Consequently, the liquidity services (convenience yields) associated with deposit-based payments under these systems are lower, especially compared to more immediate or programmable alternatives. This provides a baseline against which the rise of fast payment rails can be understood.

Retail fast payment systems

Retail fast payment systems such as Brazil's PIX, India's UPI, and the EU's TIPS infrastructure play a significant role in shaping the convenience profile of existing assets. These systems allow instant, low-cost settlement of deposit-based payments through public digital infrastructure, thereby increasing the transactional utility of commercial bank deposits. In the model, this effect is captured through a higher convenience yield, θ_D, which improves the relative attractiveness of deposits in household portfolios—particularly for small-value, high-frequency transactions. All in all, a fast payment system like TIPS raises the liquidity value of bank deposits and, through an increase in deposit convenience yield, may reduce demand for CBDC or stablecoins in retail payments, enhance deposit stickiness, strengthen monetary policy transmission through the banking system.

Tokenized deposits

Tokenized deposits represent a novel form of digital money that combines the legal and institutional features of traditional bank deposits with the technological advantages of blockchain infrastructure. Unlike stablecoins, which are typically issued by non-bank entities and backed by off-chain reserves, tokenized deposits are issued by regulated commercial banks and represent direct claims on deposit accounts. They are recorded on distributed ledgers and can be transferred peer-to-peer, enabling programmable payments and atomic settlement. From an economic perspective, tokenized deposits retain the core characteristics of conventional deposits.

However, their programmability and interoperability with decentralized finance (DeFi) platforms introduce new dimensions of convenience and functionality. This enhances their *convenience yield*, θ_{TD}, relative to traditional deposits, particularly in use cases involving automated payments, escrow services, or cross-border transactions. In the context of household portfolio allocation, tokenized deposits may compete directly with both stablecoins and CBDCs. Their appeal depends on:

- The extent of their integration into digital wallets and payment platforms.
- The regulatory clarity surrounding their issuance and use.
- The perceived safety and liquidity of the issuing bank.

If tokenized deposits offer higher convenience-adjusted returns than stablecoins or CBDCs, households may reallocate funds toward them, especially in jurisdictions where digital banking infrastructure is mature. Their emergence also has implications for monetary policy transmission and financial stability, as they may preserve the role of commercial banks in a digital monetary ecosystem while enabling innovation in payment services.

Credit card

Credit card payments are a form of deferred settlement, where the issuing bank extends short-term credit to the household. Transactions are typically processed through card networks (e.g., Visa, Mastercard), with settlement occurring between the merchant's acquiring bank and the cardholder's issuing bank.

- **Features:** Credit cards offer convenience, fraud protection, and rewards programs. They also provide liquidity through revolving credit, allowing households to smooth consumption over time;
- **Limitations:** Credit cards involve interest charges if balances are not paid in full, and may include annual fees. They also introduce credit risk for issuers and potential over-indebtedness for users.

Economically, credit cards introduce intertemporal consumption smoothing, with households weighing immediate liquidity against future repayment costs. From a financial economics perspective, credit cards combine a payment function with a credit instrument. They introduce intertemporal trade-offs in household utility maximization, where the marginal utility of current consumption is weighed against future repayment obligations. The effective cost of using credit cards depends on the interest rate, repayment behavior, and any associated fees or rewards.

Private Money

E-money

E-money combines high liquidity with strong regulatory backing, as it is fully redeemable at par and widely accepted by merchants and platforms. Its programmability is limited compared to blockchain-based instruments: while some conditional features (e.g., scheduled payments, APIs) exist at the platform level, it lacks the composability of smart contracts. Privacy is generally low to medium, reflecting compliance with KYC/AML requirements and issuer-ledger visibility. Convenience remains high, driven by mobile integration, peer-to-peer functionality, and low transaction costs, making e-money an attractive option for households even in the absence of interest-bearing features.

Stablecoins

Stablecoin payments occur on blockchain networks and are settled via token transfers. They offer speed and global reach but are exposed to legal uncertainty, redemption risk, and potential volatility in peg stability.

As previously noted, major credit card networks and platform-based financial services – keen on expanding their roles in digital currency issuance –have begun piloting or launching proprietary stablecoins.[5] In these cases, stablecoins function as transferable extensions of platform balances, combining on-chain liquidity with embedded ecosystem features such as loyalty integration and user retention. While potentially offering high convenience yields, they raise additional concerns about monetary fragmentation, redemption frictions, and reserve transparency.

Platform Balances

Platform-based payments (e.g., Apple Pay, Amazon Pay) operate within closed-loop systems. They are fast and user-friendly but lack legal tender status and are confined to the issuing platform's ecosystem.

Portfolio Implications

Table 3 summarizes the influence of interest-bearing status, liquidity, prorammability and privacy on the convenience yield of money-like instruments. Instruments such as tokenized deposits and stablecoins exhibit high programmability and liquidity, boosting their convenience yield despite the absence of financial interest. In contrast, traditional deposits gain from interest payments and regulatory backing, while public forms like CBDC and cash offer

[5]Visa and Mastercard have both explored stablecoin-related initiatives. Visa has piloted USDC-based settlement with Crypto.com, while Mastercard has partnered with blockchain firms to enable stablecoin-based transfers and on-chain payments. PayPal has launched *PayPal USD (PYUSD)*, a U.S. dollar-pegged stablecoin issued in partnership with Paxos Trust Company, currently integrated into PayPal and Venmo. Meta previously proposed Diem (originally Libra), a platform-native stablecoin intended for use across its social platforms, though the project was ultimately discontinued due to regulatory concerns. These examples illustrate how both credit networks and platforms are extending their payments infrastructure into the tokenized domain, blurring the lines between traditional payment rails and digital money issuance.

finality and trust. The relative strengths across these dimensions help explain the portfolio choices observed in equilibrium. For example, the introduction of fast-payment infrastructure can raise θ_D, making deposits more attractive relative to stablecoins or CBDC. Conversely, increases in θ_S from DeFi integration or mobile usability can shift allocations toward stablecoins. These dynamics drive portfolio substitution and highlight the role of design, access, and infrastructure in shaping monetary competition.

Table 3: Convenience Features of Money-Like Instruments

Instrument	**Interest** i_j	**Liquidity**	**Programmability**	**Privacy**	**Typical** θ_j
Cash	0	Medium	None	High	Medium
CBDC	0	High	High	Low–Medium	High
Bank Deposit (Legacy)	> 0	Medium	Low	Low	Medium
Bank Deposit (Fast Rail)	> 0	High	Low	Low	High
Tokenized Deposit	> 0	High	High	Low–Medium	High
E-Money	0	High	Medium	Low–Medium	High
Stablecoin	0	High	High	Medium–High	High
Platform Balance	0	Medium–High	Medium	Low	Medium–High

Note: The Table summarizes qualitative assessments of the attributes that contribute to each instrument's convenience yield, θ_j. "Interest" is the nominal return. "Liquidity" refers to ease of transfer and broad acceptability. "Programmability" captures the ability to encode automated payments or smart contracts. "Privacy" reflects transactional anonymity or pseudonymity. Instruments are compared based on typical implementations; specific features may vary across jurisdictions or issuers.

Summary of Stablecoins Pegged to Domestic and Foreign Assets

This subsection highlights how the denomination and composition of stablecoin reserves domestically or abroad shape their macro-financial implications.

- **Domestic-currency pegged stablecoins** (e.g., euro-backed) typically hold local bank deposits or short-term sovereign debt as backing. They can reinforce monetary policy transmission if reserves remain within the jurisdiction and issuers are well-regulated.

- **Foreign-currency pegged stablecoins** (e.g., USD-backed) introduce de facto currency substitution in domestic markets. Their circulation reduces demand for local currency assets, increases FX mismatches, and can weaken monetary sovereignty.

- The risks are particularly acute in emerging markets, where adoption of foreign-denominated stablecoins may amplify exchange rate volatility, cross-border spillovers, and external vulnerabilities.

Summary of Cross-Border Payments and FX Risk

This subsection examines how digital monetary instruments interact with international payments and foreign exchange exposures.

- Traditional correspondent banking channels are slow, costly, and involve multiple intermediaries. By contrast, **stablecoins and tokenized deposits** enable rapid cross-border transfers, often outside formal banking systems.

- For domestic-currency instruments, international use requires either foreign exchange conversion at entry/exit or non-resident acceptance of liabilities. Current CBDC designs remain focused on domestic use, though pilot projects such as mBridge and Icebreaker test multilateral interoperability.

- Widespread use of **foreign-denominated stablecoins** in international transactions may encourage currency substitution, regulatory arbitrage, and unhedged FX exposures. These issues are most pronounced in emerging markets, where USD-backed stablecoins are increasingly used for remittances, e-commerce, and peer-to-peer transfers.

Overall, both subsections underscore that the currency denomination of stablecoins and their cross-border use have critical implications for monetary sovereignty, financial stability, and international policy coordination.

4.2 Stablecoins Pegged to Domestic and Foreign Assets

Stablecoins differ not only in technical architecture (custodial vs. algorithmic), but also in the denomination and composition of their reserve assets. From a balance sheet perspective, the liability side consists of stablecoins held by users, while the asset side includes backing instruments such as bank deposits, short-term securities, or central bank reserves. The location and denomination of these reserves – domestic or foreign – have important implications for monetary transmission, exchange rate exposure, and financial stability.

Stablecoins pegged to domestic fiat currencies (e.g., euro- or peso-backed tokens) typically hold local-currency bank deposits or short-term sovereign assets. These arrangements may reinforce domestic monetary policy transmission if issuers are well-regulated and reserves are held within the jurisdiction. In contrast, stablecoins pegged to foreign currencies (e.g., USD) and backed by foreign assets introduce de facto currency substitution, particularly in emerging markets. On the issuer's balance sheet, this exposes households to FX mismatches unless assets and liabilities are perfectly aligned.

The use of foreign-denominated stablecoins as transaction media in domestic markets can undermine monetary sovereignty, reduce demand for local-currency instruments, and contribute to external vulnerabilities. These risks are heightened when such stablecoins circulate outside the regulatory perimeter or when reserve transparency is weak. As noted in the IMF's Global Financial Stability Report, large-scale adoption of stablecoins with foreign backing in underdeveloped currency regimes could amplify exchange rate volatility and cross-border spillovers (International Monetary Fund, 2022a).

4.3 Cross-Border Payments and FX Risk

Digital monetary instruments increasingly intersect with cross-border payment use cases, raising questions about foreign exchange (FX) conversion, capital mobility, and legal jurisdiction. Traditional cross-border transactions using correspondent banking networks involve multiple intermediaries, high fees, and delayed settlement. In contrast, stablecoins and tokenized deposits can move across borders rapidly, often outside formal banking channels.

However, the denomination of instruments in domestic currency implies that international use requires either (i) FX conversion at entry/exit points, or (ii) acceptance of foreign-denominated liabilities by non-residents. CBDCs are currently designed for domestic use, though pilot programs (e.g., mBridge, Project Icebreaker) explore cross-border interoperability under multilateral governance.

From a financial stability perspective, stablecoins and platform-issued tokens used internationally may create new channels for currency substitution, regulatory arbitrage, or unhedged FX exposures. These risks are especially acute in emerging markets where dollar-backed stablecoins may crowd out local currency instruments.[6] In our framework, FX-denominated stablecoins would introduce an additional layer of portfolio choice complexity, with households balancing convenience, expected returns, and exchange rate risk.

5 Banks' and NFIs' Balance Sheets

Household portfolio allocations ultimately map into the balance sheets of intermediaries. This section specifies the structure of commercial banks and non-financial intermediaries (NFIs), highlighting their contrasting roles in credit creation, liquidity transformation, and financial stability.

5.1 Commercial Banks

Banks accept deposits and extend credit. Their simplified balance sheet is:

$$L + R = D,$$

where L denotes loans to the real sector, R reserves at the central bank, and D deposits issued to households. Deposits are redeemable at par into central bank money. Under perfect competition, bank profits are zero, and the lending rate i_L adjusts such that:

$$(1 + i_L)L = (1 + i_D)D,$$

with i_D the deposit rate. Thus, changes in household demand for deposits affect loan supply one-for-one through the balance sheet constraint.

[6] Examples include the use of USDT and USDC in informal remittance corridors across Latin America, West Africa, and Southeast Asia, where dollar-backed stablecoins are increasingly used as substitutes for local currencies in peer-to-peer transactions and e-commerce. In some cases, platforms and mobile apps allow users to hold balances and make payments directly in stablecoins, bypassing traditional banks and FX controls (Aldasoro et al., 2025; ECB Crypto-Assets Task Force, 2020).

5.2 Non-Financial Intermediaries (NFIs)

NFIs represent fintech platforms issuing stablecoins. Their balance sheet is:

$$R^S = S,$$

where S denotes stablecoins in circulation and R^S central bank reserves held as backing. Unlike banks, NFIs do not issue credit: they repackage central bank reserves into stablecoins. Redemption at par requires full backing, but fragility arises if reserves are insufficient or perceived as opaque, creating run dynamics akin to money market funds.

5.3 Comparative Structures

Table 4 summarizes the balance sheets of the central bank, commercial banks, and NFIs. The key asymmetry is that banks create new credit, while NFIs cannot. This difference underpins their distinct roles in household portfolios and systemic stability.

Table 4: Balance Sheets of Central Bank, Banks, and NFIs

	Central Bank	Banks	NFIs
Assets	Loans to gov't/others	Loans L	Reserves R^S
Liabilities	Reserves, CBDC, cash	Deposits D	Stablecoins S

5.4 Implications

The coexistence of banks and NFIs has three important consequences:

1. **Credit creation:** Banks expand balance sheets by issuing deposits and lending, whereas NFIs merely transform reserves into stablecoins.

2. **Fragility:** Stablecoins are exposed to redemption runs if reserve quality or transparency is questioned.

3. **Policy transmission:** Central bank remuneration of reserves passes through banks to deposits, but for NFIs it affects stablecoin issuance and redemption risk.

These contrasts are summarized in Table 5, which highlights how balance sheet structures translate into systemic implications.

In sum, banks and NFIs occupy distinct positions in the monetary system. Banks underpin credit creation and monetary policy transmission, while NFIs reshape liquidity provision and introduce new fragility channels. The design of CBDCs and the regulation of stablecoins therefore have direct implications for both credit intermediation and financial stability.

Table 5: Balance Sheet Structures and Their Implications

	Banks	**NFIs (Stablecoin Issuers)**
Credit creation	Create deposits and extend loans to real sector	No credit creation; stablecoins backed by reserves
Redeemability	Deposits redeemable at par in central bank money	Stablecoins redeemable if reserves are adequate and transparent
Fragility	Exposed to bank runs, mitigated by deposit insurance and LOLR	Exposed to redemption runs, with no built-in public backstop
Policy transmission	Reserve remuneration shapes deposit rates and loan supply	Reserve remuneration affects stablecoin issuance and perceived stability

6 Impact on Banks' and NFIs' balance sheets

The preceding sections examined the characteristics of monetary instruments and the channels through which they circulate in the economy. Households allocate their portfolios based on convenience-adjusted returns, and execute payments through diverse settlement mechanisms involving banks, platforms, stablecoin issuers, and the central bank.

This section shifts focus from individual behavior to institutional structure. Specifically, we analyze how the use and circulation of various money-like instruments affect the balance sheets of financial and non-financial actors. Each instrument—whether a bank deposit, CBDC, stablecoin, or platform balance—corresponds to a distinct liability on the issuer's balance sheet and requires backing assets, liquidity buffers, or collateral arrangements on the asset side.

Understanding these balance sheet configurations is critical for evaluating systemic risk, regulatory oversight, monetary control, and the feasibility of large-scale adoption of digital money. The analysis also highlights how new instruments, such as tokenized deposits and platform-issued stablecoins, may blur traditional institutional boundaries between payment providers, deposit-takers, and money issuers.

The varied impacts of digital currencies necessitate robust regulatory frameworks. Jurisdictions worldwide are grappling with how to classify and regulate digital currencies, focusing on consumer protection, financial stability, anti-money laundering (AML), and combating the financing of terrorism (CFT). Regulations like MiCA in the EU aim to provide clarity, treating certain digital currencies as e-money tokens or asset-referenced tokens.

The future financial ecosystem will likely see a coexistence of traditional banking, digital currencies, and potentially CBDCs. Commercial banks will need to adapt by embracing digital innovation, potentially integrating digital currency services into their offerings, and collaborating with fintech firms. Non-financial intermediaries will continue to seek the most efficient and cost-effective ways to manage their finances, with digital currencies offering a compelling alternative for certain use cases.

The introduction of digital currencies – whether stablecoins, CBDCs, or platform-issued tokens – is a transformative force for the balance sheets of commercial banks and non-financial intermediaries. For banks, the primary challenge lies in managing potential deposit outflows, evolving funding structures, and navigating new liquidity and capital requirements, alongside the systemic risks associated with digital currency runs. For non-financial intermediaries, digital currencies promise enhanced efficiency in payments and treasury management but introduce new operational and counterparty risks. The distinction between domestic and foreign currency pegs adds layers of complexity, particularly concerning monetary sovereignty and financial stability in emerging markets. Ultimately, the long-term consequences will be shaped by the ongoing evolution of technology, market adoption, and, crucially, the development of comprehensive and adaptive regulatory frameworks that foster innovation while mitigating risks. This version integrates the impact of CBDCs and platform firms' payment systems alongside stablecoins,

All in all, the rapid proliferation of digital currencies marks a significant evolution in the financial landscape. These innovations, whether pegged to fiat currencies or designed as digital assets by central banks, carry profound implications for the balance sheets of commercial banks and non-financial intermediaries. This Section explores these multifaceted consequences, highlighting the challenges and opportunities they present for the traditional financial system and the broader economy. Bouis et al. (2024) presents an extensive analysis of the impact of CBDC on banks' balance sheets.

6.1 Commercial Banks

The primary channels through which digital currencies affect commercial banks include deposit substitution, changes in funding structures, and shifts in asset composition.

Liabilities Side: Deposit Outflows and Funding Structure

- **Deposit Substitution:** The introduction of digital currencies offers individuals and corporations alternative means to hold and transfer value. If these entities opt to use stablecoins, CBDCs, or platform-issued digital tokens for payments, savings, or liquidity management, they may withdraw funds from traditional bank accounts, leading to a reduction in the deposit base of commercial banks.

- **Increased Funding Costs:** A decline in low-cost retail deposits forces banks to seek more expensive wholesale funding (e.g., interbank loans, bond issuance). This increases their overall cost of funding, potentially squeezing profit margins and impacting their ability to offer competitive lending rates.

- **Liquidity Management Challenges:** The shift from stable retail deposits to potentially more volatile digital currency-related liabilities can strain a bank's Liquidity Coverage Ratio (LCR) and Net Stable Funding Ratio (NSFR). Regulators often assign higher outflow rates to wholesale deposits, meaning banks holding digital currency reserves might need to hold more high-quality liquid assets (HQLA) to meet prudential requirements, even if the overall liquidity in the system remains unchanged.

- **Shift in Deposit Composition:** Even if banks become custodians for digital currency reserves, the nature of these deposits changes. They transform from diversified retail deposits into concentrated wholesale deposits, which are generally considered less stable and more susceptible to sudden withdrawals, especially during periods of market stress.

Assets Side: Lending Capacity and Asset Composition

- **Reduced Lending Capacity:** A shrinking deposit base directly translates to a reduced capacity for banks to extend new loans. This can curtail credit availability for businesses and consumers, potentially slowing economic growth.
- **Changes in Asset Allocation:** To back digital currency reserves or to compensate for deposit outflows, banks might be compelled to hold a larger proportion of their assets in HQLA, such as central bank reserves or government securities. While this enhances safety, these assets typically offer lower yields compared to loans, impacting the bank's net interest income and overall profitability.
- **New Revenue Streams (Opportunities):** Conversely, banks could leverage digital currencies as an opportunity. They might offer custody services for digital currencies, facilitate digital currency-based payments, or even issue their own "bank-issued digital currencies". This could open new revenue streams and allow them to retain some of the value chain in the digital asset space.

Capital Ratios and Financial Stability

- **Capital Adequacy:** While the direct impact on capital ratios might be less immediate, changes in asset composition (e.g., holding more low-risk HQLA) could, in some scenarios, improve risk-weighted asset (RWA) density. However, if digital currency-related activities introduce new operational or liquidity risks, banks might need to hold more capital.
- **Run Risk and Contagion:** A significant concern is the potential for "runs" on digital currencies. If an issuer is perceived as unstable or its reserves inadequate, a mass redemption could force the liquidation of underlying assets. If these assets are held at commercial banks, or if the liquidation impacts broader financial markets, it could create contagion and threaten the stability of the traditional banking system.

6.2 Non-Financial Intermediaries (NFI)

Non-financial intermediaries (NFIs), including businesses and platform firms, are increasingly adopting digital currencies for various operational purposes.

Operational Efficiency and Treasury Management

- **Faster and Cheaper Payments:** Digital currencies can significantly reduce the cost and time associated with domestic and cross-border payments. For businesses engaged in international trade, this means faster settlement, reduced foreign exchange conversion fees, and 24/7 availability, improving cash flow and operational efficiency.

- **Enhanced Treasury Management:** NFIs can use digital currencies for more agile treasury management. They can hold digital currencies as a liquid asset for immediate payment needs, potentially reducing the need for large balances in traditional bank accounts. This can optimize working capital.

- **Programmable Money and Smart Contracts:** Digital currencies enable programmable payments through smart contracts. This can automate supply chain finance, escrow services, and other business processes, leading to greater efficiency and reduced administrative overhead.

Balance Sheet Implications

- **Holding Digital Assets:** NFIs might begin to hold digital currencies directly on their balance sheets as a form of liquid asset. This introduces new considerations for accounting, auditing, and risk management related to digital asset custody and cybersecurity.

- **New Liabilities (for issuers):** If an NFI decides to issue its own digital currency, its balance sheet would reflect these digital currencies as liabilities, backed by corresponding reserves. This transforms the NFI into a quasi-financial entity, subject to new regulatory and operational burdens.

- **Access to New Markets/Financing:** For some NFIs, particularly those in emerging markets or with limited access to traditional banking services, digital currencies could offer new avenues for receiving payments or even accessing financing through decentralized finance (DeFi) protocols.

Risks

- **Counterparty Risk:** The stability of a digital currency depends entirely on the issuer's ability to maintain its peg and the quality of its reserves. NFIs holding digital currencies are exposed to the risk of de-pegging or issuer insolvency.

- **Regulatory Uncertainty:** The evolving regulatory landscape for digital currencies creates uncertainty for NFIs regarding compliance, tax implications, and legal status of their digital currency holdings or activities.

- **Cybersecurity Risks:** Holding and transacting with digital currencies exposes NFIs to new cybersecurity risks, including hacks, phishing, and smart contract vulnerabilities.

Summary

Table 6 summarizes the balance sheet configurations associated with different monetary instruments. For each instrument, we identify the issuer, the form of liability held by the household, and the typical structure of backing assets on the issuer's balance sheet. This mapping illustrates how digital monetary innovation transforms institutional roles. For example, stablecoin issuers resemble synthetic banks with reserve-backed liabilities, while tokenized deposits maintain commercial bank credit exposure but adopt distributed ledger infrastructure. These distinctions have important implications for risk transmission, regulatory classification, and monetary control.

Table 6: Balance Sheet Implications of Money-Like Instruments

Instrument	**Issuer**	**Liability (Held by Household)**	**Backing Assets (on Issuer's Balance Sheet)**
Cash	Central Bank	Physical currency (cash)	Government bonds, FX reserves
CBDC	Central Bank	Digital central bank liability	Government bonds, FX reserves
Bank Deposit	Commercial Bank	Demand deposit	Loans to firms and households, reserves at central bank
Tokenized Deposit	Commercial Bank	DLT-based tokenized claim	Loans or HQLA (high-quality liquid assets), reserves
E-money	Licensed E-money Institution	Prepaid digital value redeemable at par	Segregated bank deposits (fully backed by fiat)
Stablecoin (Fiat-backed)	Fintech/NFI	Digital token pegged to fiat	Bank deposits, T-bills, cash, or other liquid assets
Platform Balance	Platform (e.g., tech firm)	Internal credit (non-transferable)	Custodial bank deposits or stablecoin holdings

Note: The table presents stylized balance sheet relationships between monetary instrument issuers and households. Liability refers to the monetary claim held by the user. Backing assets vary by institution type and regulatory framework. While central bank liabilities are typically backed by government securities or FX reserves, stablecoins may be backed by bank deposits or short-term securities of varying quality. Platform balances are internal credits backed by custodial holdings and are not legal tender.

7 The Model

7.1 General equilibrium model

Our theoretical framework follows the general equilibrium approach of Schilling et al. (2024) and Davoodalhosseini (2022), where households allocate wealth across money-like instruments to equalize convenience-adjusted returns. We present a simple, static-equilibrium framework that incorporates four "money-like" instruments—CBDC, bank deposits, NFI–issued stablecoins, and traditional bank reserves—and shows how they interact. For brevity, we make the following assumptions:

- households are endowed with an exogenous income stream, denoted by w—analogous to the fruit endowment à la Lucas—and there is no production;
- we abstract from cash holdings that, however, cash can be incorporated without loss of generality into the household budget constraint and the central bank's balance sheet. Its inclusion would introduce an additional no-arbitrage condition linking the interest rates across money-like instruments (see Appendix A.1);
- we abstract from digital tokens issued by platform firms. These instruments can be incorporated without loss of generality, but are typically best interpreted as digital representations of household deposits confined within closed-loop ecosystems;
- we do not include government bonds, although stablecoins are typically pegged to such assets. Instead, we assume that stablecoins are backed by central bank reserves, which serve as a proxy for government bonds due to their similar risk-free and liquid characteristics;
- we initially assume that the CBDC is remunerated at the policy reference rate. This assumption is later relaxed, allowing for a richer characterization of household portfolio choices.

The goal is to capture:

- How households choose among CBDC, bank deposits, and stablecoins;
- How banks and NFIs decide on issuance and balance-sheet composition;
- How the central bank (CB) manages CBDC issuance and reserves;
- Arbitrage conditions that tie all "currency-equivalent" instruments together.

Throughout, we work in a one-period, closed economy with a continuum of identical households, one consolidated banking sector, and one consolidated NFI-stablecoin issuer.

1.2 Setup: Agents, Assets, and Timing

Overview. Households allocate wealth across three "safe" money-like instruments: central bank digital currency (CBDC, denoted M^c), commercial bank deposits (D), and stablecoins issued by non-financial intermediaries (S). These assets differ in both financial return and nonpecuniary attributes, such as accessibility, platform integration, and liquidity services. Consistent with Andolfatto (2021) and Keister and Sanches (2022), we model household decisions as driven by the *convenience-adjusted return* of each instrument:

$$i_j + \theta_j,$$

where i_j is the nominal interest rate and θ_j is the convenience yield of asset $j \in \{D, S, c\}$. This concept captures the idea that a low-yielding instrument (e.g., CBDC) may still be attractive if it offers sufficiently high liquidity or usability.

In some institutional settings, nominal return differentials may follow the pattern:

$$i_D \leq i_S \leq i_C,$$

but this is not a general equilibrium condition. For example, a non-interest-bearing CBDC ($i_C = 0$) and fee-charging stablecoins ($i_S < 0$) may coexist with interest-bearing deposits ($i_D > 0$), as long as households are indifferent across instruments in terms of their total (financial plus convenience) return. Hence, the relevant equilibrium condition is:

$$i_D + \theta_D = i_S + \theta_S = i_C + \theta_C.$$

7.2 Setup: Agents, Assets, and Timing

Agents

We consider a closed economy with the following agents:

- **Households (H):** derives utility from consumption C and from holding three money-like assets for transactions – e.g. CBDC (digital central-bank money), denoted M^c, bank deposits, denoted D and stablecoins issued by non financial intermediaries (backed one-for-one by deposits or central bank reserves), denoted S.

- **Banks (B):** accept deposits D from households at rate r_D, borrow reserves from CB (or hold reserves) and issue new deposits, make loans L at rate r_L, pay an opportunity cost on reserves r_R (e.g., interest on excess reserves), and hold capital K subject to a leverage constraint.

- **Non-Financial Intermediaries (NFI):** issue stablecoins S, redeemable at par (1:1) for either CBDC or bank-deposit collateral, invest collateral (either CB reserves or high-grade, short-term bank deposits) and earn a small spread, and charge a "storage/fintech" service fee f_S per unit of S held.

- **Central Bank (CB):** Supplies CBDC M^c on demand at zero credit risk, sets the policy rate r^* (interest on reserves), holds bank reserves R as liabilities (bearing interest

$r_R = r^*$), keeps aggregate balance-sheet equality:

$$\underbrace{M^c + R}_{\text{Liabilities}} = \underbrace{\text{CB assets (e.g. government debt)}}_{\text{separate}}.$$

Agents' problem

Households

Households derive utility from consumption and the convenience services provided by different monetary instruments. These convenience services are aggregated into a composite liquidity index, which enters the utility function alongside consumption.

Let C_t denote real consumption at time t, and let $x_{j,t}$ denote the quantity of monetary asset $j \in \{D, S, M^c\}$ held at time t. The household maximizes expected lifetime utility:

$$\max_{\{C_t, D_t, S_t, M_t^c\}} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \, u(C_t, m_t), \tag{2}$$

where $\beta \in (0, 1)$ is the discount factor, and m_t is a CES (constant elasticity of substitution) aggregator over monetary instruments:

$$m_t = \left(\alpha_D D_t^{\frac{\sigma-1}{\sigma}} + \alpha_S S_t^{\frac{\sigma-1}{\sigma}} + \alpha_c (M_t^c)^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}}.$$

Here:

- $\alpha_j > 0$ denotes the weight (or convenience parameter) of instrument j in providing liquidity.
- $\sigma > 0$ is the elasticity of substitution among instruments.
- m_t captures the total convenience (liquidity) service from holding monetary assets.

The household faces a per-period budget constraint:

$$C_t + D_t + S_t + M_t^c \leq (1 + i_{D,t})D_{t-1} + (1 + i_{S,t})S_{t-1} + (1 + i_{c,t})M_{t-1}^c + \omega_t,$$

where:

- $i_{j,t}$ is the return on asset $j \in \{D, S, M^c\}$ between $t-1$ and t.
- ω_t denotes real endowment income received at time t.

Let Λ_t be the Lagrange multiplier on the budget constraint. The Lagrangian for this problem is:

$$\begin{aligned}\mathcal{L} = \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \Big[u(c_t, m_t) + \Lambda_t \Big(&(1 + i_{D,t})D_{t-1} + (1 + i_{S,t})S_{t-1} \\ &+ (1 + i_{c,t})M_{t-1}^c + \omega_t - C_t - D_t - S_t - M_t^c \Big) \Big]\end{aligned}$$

We define $\partial u/\partial c_t = u_c$ and $\partial u/\partial m_t = u_m$ and obtain the first-order conditions (FOCs) with respect to consumption and asset holdings:

Consumption:

$$u_c = \Lambda_t$$

Asset holdings: Dividing both sides of each FOC by u_c and using the envelope condition $\Lambda_t = u_c$ yields the convenience-adjusted arbitrage conditions:

$$\frac{u_m}{u_c} \cdot \frac{\partial m_t}{\partial x_{j,t}} = 1 - \frac{\beta \mathbb{E}_t \left[\Lambda_{t+1}(1 + i_{j,t+1})\right]}{\Lambda_t}$$

These conditions describe the trade-off between consuming today versus gaining financial return and liquidity benefits from holding money-like assets define, for each monetary instrument $j \in \{D, S, M^c\}$, the endogenous convenience yield as:

$$\theta_j \equiv \frac{u_m}{u_c} \cdot \frac{\partial m_t}{\partial x_{j,t}},$$

which allows us to write:

$$\boxed{\theta_j = 1 - \beta \mathbb{E}_t \left[\frac{\Lambda_{t+1}}{\Lambda_t}(1 + i_j)\right]}$$

Under deterministic consumption or certainty equivalence, the marginal utility ratio simplifies:

$$\frac{\Lambda_{t+1}}{\Lambda_t} \approx \frac{u_c(c_{t+1})}{u_c(c_t)} \approx \frac{1}{1 + \psi}$$

for a subjective discount rate ψ such that $\beta = \frac{1}{1+\psi}$. Then, taking expectations and inverting:

$$\mathbb{E}_t \left[\frac{\Lambda_t}{\Lambda_{t+1}}\right] \approx 1 + \psi$$

Hence, rearranging yields the convenience-adjusted return condition:

$$\boxed{i_j + \theta_j \approx \psi = \frac{1}{\beta} - 1}$$

This provides a microfounded justification for the reduced-form arbitrage condition:[7]

$$i_D + \theta_D = i_S + \theta_S = i_c + \theta_c$$

In this framework, the household's choice over deposits, stablecoins, and CBDC depends on both their financial return and their contribution to the overall liquidity aggregate m_t. The

[7] This approximation assumes low interest rates, stable consumption, and either log or CRRA utility. In stochastic settings, the exact expression retains the marginal utility ratio inside the expectation, but the logic of convenience-adjusted return equalization still applies.

CES structure allows for imperfect substitution: if one instrument becomes less convenient or pays a lower return, households may partially reallocate toward others depending on the elasticity σ.

The interaction between issuer design choices and household preferences determines the equilibrium distribution of monetary assets. Sectoral outcomes are jointly shaped by competition among issuers, regulatory constraints, and the relative convenience of each instrument. Design, risk, and access features directly influence the liquidity weights α_j, which in turn govern usage patterns and portfolio shares:

- **Banking Sector:** Supplies D_t in response to convenience-adjusted return and elasticity of substitution. Portfolio share determined by α_D and σ.
- **NFI Sector:** Competes for liquidity share S_t. Must ensure operational reliability and regulatory compliance (e.g., capital backing, audits).
- **Central Bank:** Provides M_t^c, setting i_c and design features to influence its share. Higher α_c implies stronger baseline preference for CBDC.

Issuer competition and household substitution jointly determine sectoral outcomes. Design, risk, and access influence liquidity weights α_j and usage patterns.

Banking Sector: Banks take in deposits D, keep reserves R at the central bank, and make loans L. Their balance sheet (one-period) is:

$$\underbrace{L + R}_{\text{Assets}} = \underbrace{D + K}_{\text{Liabilities + Equity}},$$

where K is equity (capital). Banks face: Reserve requirement:

$$R = \rho D, \quad 0 \leq \rho < 1.$$

Capital (leverage) constraint:

$$L \leq \kappa K,$$

for some $\kappa > 1$. Loan demand from firms or households (exogenous or determined in a credit market). For simplicity, suppose banks make L up to what they can fund (i.e., $L = D - R + K$), subject to the leverage constraint. Bank profit (Π_B):

$$\Pi_B = i_L L + i_R R - i_D D - \gamma K.$$

i_L is the loan rate. $i_R = r^*$ is interest on reserves. i_D is the deposit rate. γ is the cost of capital (return demanded by shareholders). Banks choose D (hence $R = \rho D$) and L (subject to $L \leq \kappa K$) to maximize Π_B, given i_L, i_D, i_R, ρ, κ, and γ.

A typical outcome: If i_L is high enough relative to i_D and i_R, banks expand lending until the capital constraint binds. Deposit rate i_D is set at or just below the arbitrage level $(i_S + \theta_S) - \theta_D$ so that banks attract deposits but do not lose funding to stablecoins. In equilibrium, deposit-funded lending satisfies:

$$L = (1 - \rho)D \quad \text{and} \quad L = \kappa K \quad \Longrightarrow \quad D = \frac{\kappa}{1 - \rho} K,$$

so higher capital or a lower reserve ratio expands deposits (all else equal).

NFI Stablecoin Issuer: The NFI issues S units of stablecoin, backed 100% by an asset A which can be either:

- CB reserves (earning r^*), or
- High-grade, short-term bank deposits (earning i_D).

Let the NFI pool collateral into a mix $A = R_S + D_S$, where:

$$R_S + D_S = S,$$

with weights β_R and β_D such that

$$R_S = \beta_R S, \quad D_S = \beta_D S, \quad \beta_R + \beta_D = 1.$$

NFI profit (Π_{NFI}):

$$\Pi_{NFI} \; = \; \underbrace{i_R R_S \; + \; i_D D_S}_{\text{interest on collateral}} - (1 + i_S) S \; - \; \underbrace{f_S S}_{\text{service/tech fee}} \; .$$

But since each S must pay out i_S and a fee f_S, and collateral yields either $i_R = r^*$ or i_D, the NFI chooses β_R, β_D to maximize profits.

In particular: If $r^* > i_D$, the NFI will prefer $\beta_R = 1$ (hold CB reserves). Then $\Pi_{NFI} = (r^* - i_S - f_S) S$. In reality, the NFI might hold a mix (e.g. to meet redemption requests quickly, it holds some deposits). But to simplify, assume it holds only reserves: $\beta_R = 1$. Hence,

$$\Pi_{NFI} \; = \; \big(r^* \; - \; i_S \; - \; f_S\big) \, S.$$

In a perfectly competitive NFI market, $\Pi_{NFI} = 0$. That pins down:

$$i_S \; = \; r^* \; - \; f_S. \tag{NFI-ZP}$$

Central Bank: The CB issues CBDC at face value. It sets $r^* = i_c$ (interest on CBDC and on reserves). Aggregate CBDC holdings are M^c. Aggregate reserves R satisfy:

$$R \; = \; \underbrace{\rho \, D}_{\text{bank-required reserves}} \; + R_S,$$

where $R_S = S$ (if the NFI holds only CB reserves as collateral). In equilibrium, the CB's balance-sheet constraint is simply:

$$\underbrace{M^c + R}_{\text{Liabilities}} \; = \; \underbrace{\text{Public debt (or other assets)}}_{\text{fixed}}.$$

We take the CB's asset side as exogenous (e.g. net purchases of government bonds). The CB adjusts M^c endogenously to satisfy the public's demand for CBDC given i_c.

7.3 Equilibrium Conditions

We now summarize the key equilibrium relationships that jointly determine the allocation of monetary assets across households and the behavior of issuing institutions. The unknowns of the model include:

$$(C, M^c, D, S, R, L, K, R_S, R_B, \theta_c, \theta_D, \theta_S, i_c, i_D, i_S, i_L). \tag{3}$$

Household optimization. Households choose their portfolio allocation across CBDC (M^c), deposits (D), and stablecoins (S) to maximize utility derived from consumption and liquidity services. In equilibrium, they equalize convenience-adjusted returns:

$$i_c + \theta_c = i_D + \theta_D = i_S + \theta_S. \tag{FOC-arb}$$

This condition ensures that no arbitrage opportunities persist across money-like instruments, even if nominal interest rates differ.

An equivalent formulation replaces deposits with tokenized deposits (TD) and lets θ_j depend on a feature vector $\theta(\mathbf{f_j})$; the corresponding parity and share system, including a softmax allocation rule for imperfect substitution, are detailed in Appendix 7.5.

Household budget constraint. Total consumption and asset holdings must equal available resources:

$$C + M^c + D + S = w + (1 + i_D)D_{-1} + (1 + i_S)S_{-1} + (1 + i_c)M^c_{-1}. \tag{4}$$

In a stationary equilibrium, we normalize $D_{-1} = D$, $S_{-1} = S$, and $M^c_{-1} = M^c$.

Bank balance sheet and profit condition. Banks take in deposits D, hold reserves $R = \rho D$, and issue loans L. The bank's balance sheet and constraints are:

$$L + R = D + K, \qquad L \leq \kappa K. \tag{5}$$

Bank profits are given by:

$$\Pi_B = i_L L + i_R R - i_D D - \gamma K, \tag{6}$$

where i_L is the loan rate, $i_R = r^*$ is the interest on reserves, and γ is the required return on equity. Under perfect competition, banks earn zero profit and choose i_D to remain competitive with other instruments.

Deposit pricing condition. Banks set the deposit rate i_D to ensure deposits remain attractive relative to CBDC and stablecoins, given their respective convenience yields. From the household arbitrage condition:

$$i_D = i_c + \theta_c - \theta_D = i_S + \theta_S - \theta_D. \tag{Bank-pricing}$$

This ensures that deposits provide a comparable convenience-adjusted return. Deposit rates remain bounded below by institutional and behavioral norms—typically assumed to be weakly positive.

Stablecoin issuer zero-profit condition. Assuming the NFI holds only central bank reserves as collateral, the stablecoin return must satisfy:

$$i_S = r^* - f_S. \tag{NFI-ZP}$$

Here f_S is the per-unit user fee charged by the issuer. This condition arises from perfect competition among stablecoin issuers, which drives economic profits to zero.

CBDC–Stablecoin coexistence condition. Combining the FOC-arb condition with NFI-ZP and $i_c = 0$, we obtain:

$$i_c + \theta_c = i_S + \theta_S = r^* - f_S + \theta_S \quad \Rightarrow \quad f_S = r^* + \theta_S - \theta_c. \tag{CBDC-arb}$$

This relationship determines the maximum fee an NFI can charge without losing market share to CBDC. If $f_S > \theta_S - \theta_c$, CBDC dominates; if $f_S < \theta_S - \theta_c$, stablecoins dominate. Equality implies coexistence.

Loan market clearing and bank capital condition. Given $L = \kappa K$, the zero-profit condition for banks pins down the loan rate i_L:

$$\Pi_B = i_L \kappa K + r^* \rho D - i_D D - \gamma K = 0. \tag{7}$$

Substituting $D = \frac{\kappa}{1-\rho} K$ yields:

$$\kappa i_L + \frac{\kappa \rho}{1-\rho} r^* - \frac{\kappa}{1-\rho} i_D - \gamma = 0. \tag{Bank-ZP}$$

This condition determines the loan rate i_L as a function of bank parameters and interest rates.

Asset allocation. In equilibrium, households split nominal wealth across instruments such that:

$$i_j + \theta_j = \psi \quad \text{for each } j \in \{c, D, S\}. \tag{8}$$

The exact portfolio shares depend on the utility function and substitution elasticity across assets. Under CES preferences or softmax allocation, assets with higher convenience-adjusted returns receive larger shares, but perfect substitution is not required.

Summary. The model equilibrium is characterized by:

- Equalization of convenience-adjusted returns across CBDC, deposits, and stablecoins.
- Zero profit conditions for banks and NFIs.

- Consistent allocation of wealth, reserves, and loans given reserve requirements and capital constraints.
- The central bank's balance sheet adjusts CBDC issuance endogenously to meet public demand.

Putting It All Together

Fix exogenous parameters: $\psi, \rho, \kappa, \gamma, \theta_c, \theta_D, \theta_S, f_S$. Assume $i_c = 0$, $\theta_c > 0$, $\theta_D > 0$, and $\theta_S > \theta_D$.

- **NFI zero-profit condition:**
$$i_S = r^* - f_S \tag{9}$$
- **Household arbitrage condition:**
$$i_D + \theta_D = i_S + \theta_S \Rightarrow i_D = r^* - f_S + \theta_S - \theta_D \tag{10}$$
- **CBDC–Stablecoin coexistence condition:**
$$i_c + \theta_c = i_S + \theta_S \Rightarrow 0 + \theta_c = r^* - f_S + \theta_S \Rightarrow f_S = r^* + \theta_S - \theta_c \tag{11}$$
- **Bank deposit pricing:**
Banks set i_D to remain competitive:
$$i_D = r^* - f_S + \theta_S - \theta_D = r^* - (\theta_S - \theta_c) + \theta_S - \theta_D = r^* - \Delta \tag{12}$$
where $\Delta = \theta_S - \theta_c + \theta_S - \theta_D$. To ensure $i_D \leq r^*$, we require $\Delta \geq 0$, which implies $\theta_D \geq \theta_c$.
- **Loan market clearing:**
Given $L = \kappa K$, the zero-profit condition for banks pins down the loan rate i_L:
$$\kappa i_L + \frac{\kappa\rho}{1-\rho} r^* - \frac{\kappa}{1-\rho} i_D - \gamma = 0 \tag{13}$$
- **Asset allocation:**
Households allocate nominal wealth W across M^c, D, S such that:
$$i_j + \theta_j = \psi \quad \text{for each } j \in \{c, D, S\} \tag{14}$$
In a symmetric interior solution, the portfolio shares are approximately equal:
$$M^c = D = S = \frac{W}{3} \tag{15}$$
up to second-order effects.

- **Institutional behavior:**
  - Banks choose D and K consistent with $L = \kappa K$.
  - NFIs choose S such that the zero-profit condition holds.
  - The central bank adjusts M^c to meet household demand at the given θ_c.

This setup provides a tractable baseline for comparative statics and policy analysis, allowing for endogenous responses of interest rates, portfolio shares, and institutional balance sheets to changes in convenience yields, fees, and regulatory parameters.

7.4 Interpretation and Comparative Statics

Relative convenience

If θ_S (stablecoin convenience) rises—say, because more merchants accept it—then f_S must rise (via competition) to keep $i_S + \theta_S = r^* + \theta_c$. Equivalently, NFIs can charge higher fees. If they cannot, then stablecoin holdings S explode (households dump CBDC) until the NFI raises f_S.

Central-bank policy rate r^* changes

When r^* goes up, $i_S = r^* - f_S$ rises in lockstep. Then to keep $i_D + \theta_D = i_S + \theta_S$, banks must raise i_D. Consequently, loan rates i_L also adjust via Bank-ZP.

Reserve requirement ρ or capital ratio κ

A higher ρ (banks forced to hold more reserves per deposit) raises banks' cost of funding (because reserves earn r^*, but loans earn i_L), so to keep $\Pi_B = 0$, they raise i_L. That pushes up loan rates and reduces equilibrium lending.

Introduction of CBDC (raising θ_c from zero)

If the CB adds convenience features (e.g., anonymity layers, programmable wallets), $\theta_c > 0$. Then stablecoins lose comparative advantage. Indeed, from CBDC-arb, we need $f_S = \theta_S - \theta_c$. Raising θ_c forces f_S down or else stablecoins lose parity. If NFIs cannot reduce f_S, households switch into CBDC, shrinking S.

Competition among NFIs

If multiple NFIs issue competing stablecoins, competition drives $f_S \downarrow$ until $f_S = \theta_S - \theta_c$. If competition is fierce, f_S approaches zero, and $i_S \to r^*$. In that case, banks must pay roughly $i_D \approx r^* - (\theta_S - \theta_D)$ to preserve convenience parity. If $\theta_S - \theta_D$ is large, banks are forced to pay almost r^* on deposits, squeezing net interest margin.

7.5 Feature-Driven Convenience Yields, Shares, and Design-Driven Dominance

Households choose portfolio holdings across three money–like instruments: CBDC (M_c), stablecoins (S), and tokenized deposits (TD).[8] We retain the notion of convenience-adjusted returns $r_j \equiv i_j + \theta_j$ for $j \in \{c, S, TD\}$, where i_j is the financial yield and θ_j captures nonpecuniary benefits.[9]

Tokenized deposits (TD) can be considered a digital extension of retail deposits and instant payments, but they can also incorporate programmability features such as conditional payments and smart contract support.

Feature vector and return salience.

For each instrument $j \in \{c, S, TD\}$ define a feature vector $\mathbf{f}_j \equiv \big(L_j,\, P_j,\, V_j,\, i_j\big)$, where:

- L_j = *liquidity/acceptance* (speed, breadth of acceptance, settlement frictions);
- P_j = *programmability* (smart-contract support, conditional payments, composability);
- V_j = *privacy* (degree of anonymity/pseudonymity, data minimization);
- i_j = *pecuniary return.*

We allow for *return salience*, whereby a fraction of the financial yield contributes to perceived convenience (e.g., users over-weight yield differences in payment apps). This is captured by a weight on i_j inside the convenience aggregator. Setting that weight to zero eliminates salience and avoids any double counting of i_j.

Feature-driven convenience yield

Let the convenience yield be a CES aggregator of features:

$$\theta_j(\mathbf{f}_j) = \Big(\omega_L\, L_j^{\rho} + \omega_P\, P_j^{\rho} + \omega_V\, V_j^{\rho} + \omega_R\, i_j^{\rho}\Big)^{1/\rho}, \qquad \omega_\ell \geq 0, \sum_{\ell \in \{L,P,V,R\}} \omega_\ell = 1,\ \rho \in \mathbb{R}. \quad (16)$$

Here ω_R governs *return salience* inside convenience.[10] Alternatively, a linear form $\theta_j = \sum_\ell \tilde{\omega}_\ell f_{j,\ell}$ or a nested CES (liquidity/programmability vs. privacy) can be used without changing the results.

Remark on *return salience* inside convenience Including i_j inside $\theta_j(\cdot)$ via $\omega_R > 0$ models *salience* (users perceive yield as part of convenience). If you prefer the canonical separation, set $\omega_R = 0$ so that $r_j = i_j + \theta_j(L_j, P_j, V_j)$.

[8] Tokenized deposits are bank-issued, DLT-based claims that inherit the safety of deposits and add programmability/interoperability on ledger. See the taxonomy and discussion in Section 3 of the paper.

[9] See the baseline arbitrage and household FOCs in Sections 7.1–7.3, where $i_c + \theta_c = i_D + \theta_D = i_S + \theta_S$. Our extension replaces D with TD in the choice set and makes θ_j depend on observable features.

[10] If $\omega_R = 0$, the convenience yield is purely nonpecuniary (L, P, V), and $r_j = i_j + \theta_j$ coincides with the baseline interpretation in Sections 7.1–7.3. If $0 < \omega_R \ll 1$, the model allows mild salience of yield in the perceived convenience.

Preferences and liquidity services

Let m_t be the CES aggregator of monetary services across instruments, as in the baseline model, but with *instrument weights determined by features*:[11]

$$m_t = \Big(\alpha_c(\mathbf{f}_c)\, M_{c,t}^{\frac{\sigma-1}{\sigma}} + \alpha_S(\mathbf{f}_S)\, S_t^{\frac{\sigma-1}{\sigma}} + \alpha_{TD}(\mathbf{f}_{TD})\, TD_t^{\frac{\sigma-1}{\sigma}}\Big)^{\frac{\sigma}{\sigma-1}}, \quad \sigma > 0, \tag{17}$$

$$\alpha_j(\mathbf{f}_j) \equiv \big[\theta_j(\mathbf{f}_j)\big]^{\kappa}, \quad \kappa > 0. \tag{18}$$

Households maximize $E_0 \sum_{t=0}^{\infty} \beta^t\, u(C_t, m_t)$ subject to the budget constraint, as in the baseline, with $r_j = i_j + \theta_j$ entering the Euler/FOC conditions. [12] [1]

Household problem and arbitrage

Problem and FOCs

Under certainty equivalence (or in steady state), the convenience-adjusted parity conditions become

$$i_c + \theta_c(\mathbf{f}_c) = i_S + \theta_S(\mathbf{f}_S) = i_{TD} + \theta_{TD}(\mathbf{f}_{TD}) \equiv \psi, \tag{19}$$

with ψ pinned down by preferences/discounting.[13]

Shares / imperfect substitution

For empirical implementation or imperfect substitution, adopt a softmax share rule:

$$\eta_j = \frac{\exp\{\, r_j \,\}}{\exp\{\, r_c \,\} + \exp\{\, r_S \,\} + \exp\{\, r_{TD} \,\}}, \qquad r_j \equiv i_j + \theta_j(\mathbf{f}_j). \tag{20}$$

Small increases in any feature (e.g. higher P_{TD} from better APIs) raise θ_{TD} and thus η_{TD}, ceteris paribus.

Institutional returns

We retain the sectoral pricing blocks with minor adaptations:

Stablecoin issuer (NFI): $i_S = r^* - f_S$ (zero-profit with reserve collateral); (21)

Tokenized deposits (bank): $i_{TD} = i_D - \phi_{TD}$, $\phi_{TD} \geq 0$ (tokenization cost/spread); (22)

CBDC/Reserves (CB): $i_c = r^*$ (or tiered as per design).

Tokenized deposits inherit deposit safety/insurance and add programmability, typically implying $\theta_{TD} > \theta_D$ when P_{TD} and L_{TD} are high; this matches the qualitative comparisons

[11] In the baseline, instrument weights α_j are structural shifters of liquidity services. Here we endogenize them from features.

[12] See Section 7.1 for the Lagrangian and FOCs. The marginal liquidity service $u_m/u_c \cdot \partial m_t/\partial x_{j,t}$ yields the *endogenous convenience* term θ_j; here that term varies with (L, P, V, i) via $\alpha_j(\mathbf{f}_j)$.

[13] This mirrors the baseline equalization of convenience-adjusted returns.

reported in your monetary instrument tables. Note that i_D denotes the conventional deposit rate in the baseline model, while i_{TD} is the rate on tokenized deposits after accounting for tokenization costs ϕ_{TD}.

Equilibrium

Definition

Given feature vectors $\{\mathbf{f}_c, \mathbf{f}_S, \mathbf{f}_{TD}\}$ and policy/fee parameters $\{r^*, f_S, \phi_{TD}\}$, an equilibrium consists of (i_c, i_S, i_{TD}), portfolio shares $(\eta_c, \eta_S, \eta_{TD})$, and quantities (M_c, S, TD) such that:

1. Households solve the program above; (19) or (20) holds.
2. Institutional zero-profit/pricing conditions hold: (21)–(22).
3. Market clearing for each instrument (supplies meet $\Omega_j = \eta_j W$).

Here, W denotes aggregate spendable wealth/resources, and Ω_j is the equilibrium quantity (supply/demand met) for instrument j.

Comparative statics (qualitative)

- **Programmability lead:** If P_{TD} rises (bank/industry rails with smart contracts), then θ_{TD} increases and η_{TD} rises; tokenized deposits displace S/c unless f_S falls or P_c (CBDC programmability) improves.
- **Privacy edge:** If V_c increases (privacy-enhancing CBDC design), θ_c rises; by (19) or (20), CBDC gains share and caps f_S (since $i_S = r^* - f_S$).
- **Liquidity rails:** Faster deposit/token rails (TIPS/instant payments) shift L_{TD} up, raising θ_{TD} and reducing demand for S unless L_S (DLT rails, on/off-ramps) improves commensurately.

Phase diagrams and dominance regions

Boundary logic

Figure 2 illustrates dominance regions based on convenience–adjusted returns $r_j = i_j + \theta_j$. Boundaries are where two instruments tie; regions show which instrument offers the highest r_j. Labels: **A** = CBDC dominance; **B** = Tokenized Deposits dominance; **C** = Stablecoins dominance.

Connection to phase diagrams

Convenience-adjusted return parity conditions ($r_j = i_j + \theta_j$) determine dominance regions across instruments.

Left panel: (P_c, P_{TD}) The three boundaries correspond to $r_c = r_S$ (vertical), $r_{TD} = r_S$ (horizontal), and $r_c = r_{TD}$ (oblique). These lines partition the space into regions A (CBDC dominance), B (tokenized-deposit dominance), and C (stablecoin dominance). Economically:

- Increasing P_c (CBDC programmability) raises θ_c, shifting the $r_c = r_S$ boundary rightward and expanding region A.
- Increasing P_{TD} raises θ_{TD}, pushing the $r_{TD} = r_S$ boundary upward and expanding region B.
- The oblique boundary $r_c = r_{TD}$ reflects joint sensitivity to both P_c and P_{TD}.

Right panel: (L_{TD}, f_S) The three boundaries correspond to $r_c = r_{TD}$ (vertical), $r_c = r_S$ (horizontal), and $r_{TD} = r_S$ (downward-sloping). Like in the left panel, these lines partition the space into regions A (CBDC dominance), B (tokenized-deposit dominance), and C (stablecoin dominance). Economically:

- The stablecoin boundary is :

  $$r_{TD} = r_S \iff f_S = r^* + \theta_S - (i_{TD} + \theta_{TD}(L_{TD})),$$

  which is downward sloping because higher L_{TD} increases θ_{TD}, requiring lower f_S for stablecoins to remain competitive.
- The horizontal boundary $r_c = r_S$ shows that as θ_c rises (e.g., via privacy or programmability improvements), stablecoins must reduce f_S to maintain parity.
- The vertical boundary $r_c = r_{TD}$ indicates that CBDC vs deposit competition is insensitive to f_S, depending only on θ_c and θ_{TD}.

Interpretation These diagrams provide a visual summary of how feature improvements and fee adjustments shift household preferences across instruments, highlighting the design levers available to policymakers and private issuers.

Special case: Zero-Interest CBDC ($i_c = 0$)

We consider the case in which CBDC pays zero interest, $i_c = 0$, while households continue to choose money-like assets based on convenience-adjusted returns $r_j = i_j + \theta_j$, $j \in \{c, S, TD\}$, where θ_j collects nonpecuniary benefits (liquidity, programmability, privacy). Let $\theta_c \equiv \Theta(L_c, P_c, V_c)$ be the CBDC convenience yield implied by its design features.

Arbitrage with $i_c = 0$

In an interior allocation (or as a pricing parity condition), equalization of convenience-adjusted returns becomes

$$i_c + \theta_c \;=\; i_{TD} + \theta_{TD} \;=\; i_S + \theta_S \quad \Rightarrow \quad \theta_c \;=\; i_{TD} + \theta_{TD} \;=\; i_S + \theta_S. \tag{23}$$

Hence CBDC competes purely via θ_c.

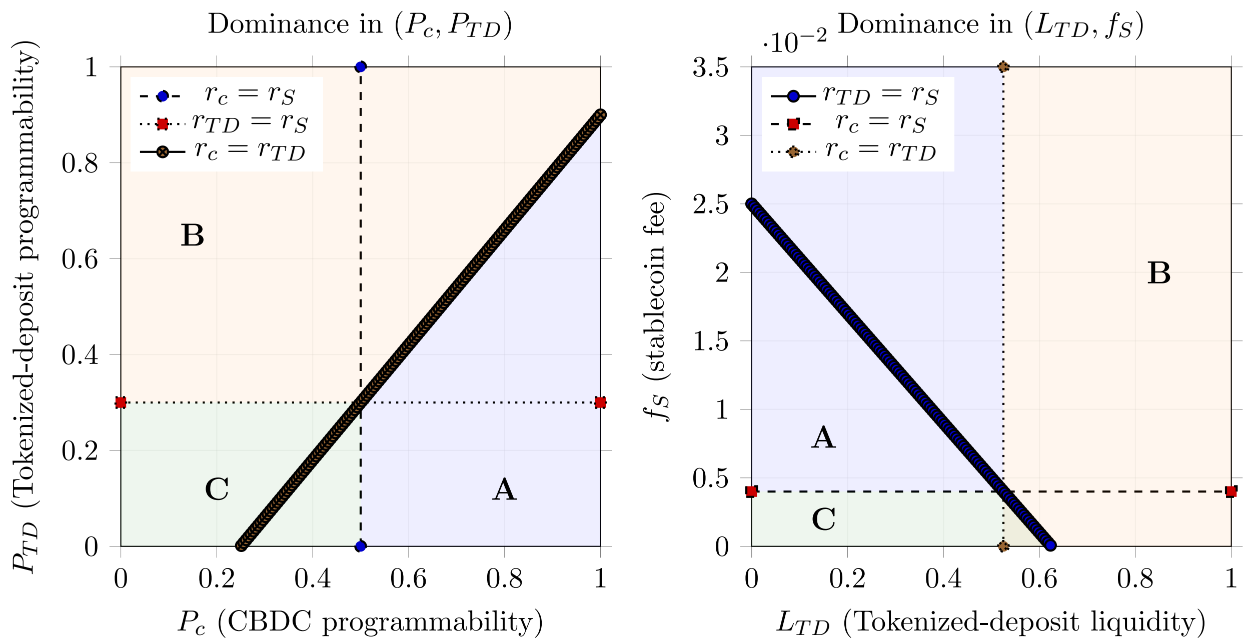

Figure 2: Phase diagrams showing dominance regions based on convenience-adjusted returns ($r_j = i_j + \theta_j$). **Left panel** (P_c, P_{TD}): Indifference boundaries where $r_c = r_S$ (vertical), $r_{TD} = r_S$ (horizontal), and $r_c = r_{TD}$ (oblique). These lines partition the space into regions A (CBDC dominance), B (tokenized-deposit dominance), and C (stablecoin dominance). Increasing P_c raises θ_c and shifts the vertical boundary rightward; increasing P_{TD} raises θ_{TD} and shifts the horizontal boundary upward. **Right panel** (L_{TD}, f_S): Boundaries where $r_{TD} = r_S$ (downward sloping), $r_c = r_S$ (horizontal), and $r_c = r_{TD}$ (vertical). The $r_{TD} = r_S$ boundary is downward because higher deposit liquidity L_{TD} increases θ_{TD}, so stablecoins must reduce f_S to sustain parity. The horizontal CBDC boundary shows that f_S must fall as θ_c rises, while the vertical line indicates that CBDC vs deposit competition is insensitive to f_S. Parameters are illustrative and satisfy the model's parity conditions.

Pricing Implications

Let tokenized deposits earn i_{TD} and stablecoins earn $i_S = r^* - f_S$ (policy rate r^* net of fee f_S). Then (23) implies

$$\text{(Deposit pricing)} \quad i_{TD} \;=\; \theta_c - \theta_{TD}, \tag{24}$$

$$\text{(Stablecoin fee cap)} \quad f_S \;=\; r^* + \theta_S - \theta_c. \tag{25}$$

Equation (25) pins down the maximum fee consistent with coexistence. If operational/competition constraints impose $f_S \geq 0$, then (25) implies the *coexistence threshold*

$$\theta_c \;\leq\; r^* + \theta_S, \qquad \text{otherwise stablecoins are dominated (require } f_S < 0). \tag{26}$$

Analogously, (24) links the deposit rate to CBDC convenience. If i_{TD} must satisfy feasibility/zero-profit bounds (bank sector), those bounds translate into admissible ranges for $\theta_c - \theta_{TD}$.

Dominance logic and design levers.

- **CBDC dominance**: As θ_c rises (via L_c, P_c, V_c improvements), the CBDC parity line shifts up. If $\theta_c \geq r^* + \theta_S$, then any nonnegative f_S fails to match CBDC (*stablecoins vanish*). Similarly, if $\theta_c - \theta_{TD}$ exceeds the bank's feasible i_{TD}, tokenized deposits cannot match CBDC.

- **Coexistence**: When θ_c is intermediate, banks set $i_{TD} = \theta_c - \theta_{TD}$ and NFIs set $f_S = r^* + \theta_S - \theta_c$ so that $r_c = r_{TD} = r_S$; portfolio shares then follow substitution (e.g., softmax).

- **Stablecoin/TD dominance**: If θ_c is low (insufficient liquidity/programmability/privacy), households tilt toward the private instruments that deliver higher $i_j + \theta_j$.

7.6 Summary of the Model

The model describes a one-period general equilibrium in which households allocate wealth across three money-like assets—CBDC, bank deposits, and stablecoins—based on convenience-adjusted returns. The key equilibrium conditions are:

- **Households:** Maximize utility from consumption and liquidity. In equilibrium:

$$i_c + \theta_c = i_D + \theta_D = i_S + \theta_S = \psi$$

  where ψ is the subjective discount rate.

- **NFIs:** Issue stablecoins fully backed by central bank reserves. Under perfect competition:

$$i_S = r^* - f_S \quad \text{and} \quad f_S = \theta_S - \theta_c$$

- **Banks:** Accept deposits, hold reserves $R = \rho D$, and issue loans $L = \kappa K$. Zero-profit condition pins down:

$$i_L = \text{function of } i_D, r^*, \rho, \kappa, \gamma$$

- **Central Bank:** Sets the policy rate r^* and adjusts CBDC supply M^c to meet household demand at the given i_c or θ_c, depending on the design.

- **Portfolio Allocation:** Households distribute wealth across assets according to their convenience-adjusted returns. Under CES preferences, imperfect substitution allows for interior solutions.

- **Market Clearing:** All financial markets clear, and institutional balance sheets are consistent with reserve and capital constraints.

This summary provides a compact reference for the model's structure and is intended to support the interpretation of simulations and policy experiments in subsequent sections.

Key Takeaways

- **Convenience-adjusted parity:** In equilibrium, all money-like instruments must offer the same total return, combining financial yield and convenience:

$$i_c + \theta_c = i_D + \theta_D = i_S + \theta_S$$

- **CBDC vs. Stablecoins:** A well-designed CBDC with high convenience yield θ_c can displace stablecoins unless the latter offer superior usability or lower fees. The fee charged by NFIs is constrained by:

$$f_S = r^* + \theta_S - \theta_c$$

- **Bank competition and deposit rates:** Banks must offer deposit rates that match the convenience-adjusted returns of CBDC and stablecoins. This compresses their net interest margin, especially when $\theta_S - \theta_D$ is large.
- **Reserve and capital constraints:** Higher reserve requirements ρ or tighter capital constraints κ raise the cost of lending, pushing up loan rates and potentially reducing credit supply.
- **NFI profitability:** In a competitive environment, NFIs earn zero profit. Their fee f_S is pinned down by the gap between stablecoin and CBDC convenience yields.
- **Policy implications:** The central bank can influence portfolio allocation by adjusting θ_c through design features (e.g., privacy, programmability). This affects monetary transmission, financial stability, and inclusion.
- **Model extensibility:** The static framework provides a foundation for dynamic extensions, including adoption dynamics, stress scenarios, and welfare analysis under alternative digital money architectures.

7.7 Simulation

To illustrate the model's implications, we simulate a simple numerical example in which households allocate their financial wealth across CBDC, stablecoins, and bank deposits based on their respective *convenience-adjusted returns*:

$$r_j = i_j + \theta_j, \quad j \in \{c, S, D\}.$$

The simulation assumes that households distribute their portfolio shares using a softmax function, which ensures strictly positive and normalized weights:

$$\eta_j = \frac{e^{r_j}}{e^{r_c} + e^{r_S} + e^{r_D}}.$$

This functional form captures imperfect substitution and bounded reallocation elasticity, and reflects the intuition that households increasingly favor the asset offering the highest convenience-adjusted return, without immediately abandoning the others.

We fix the convenience yield of bank deposits at $\theta_D = 0.03$, and explore how changes in the convenience yields of CBDC (θ_c) and stablecoins (θ_S) affect equilibrium portfolio shares. We assume CBDC pays zero interest ($i_c = 0$), and that stablecoins incur a platform fee f_S, yielding $i_S = r^* - f_S$ with $r^* = 0.02$ and $f_S = 0.015$. Deposits earn a market-determined rate i_D set to ensure convenience-adjusted return parity, but held constant in the simulation for simplicity. The results are shown in Figure 3 – representing the simulation of Matlab script in Listing 2 in Appendix A.5.2, for the assumptions see there.

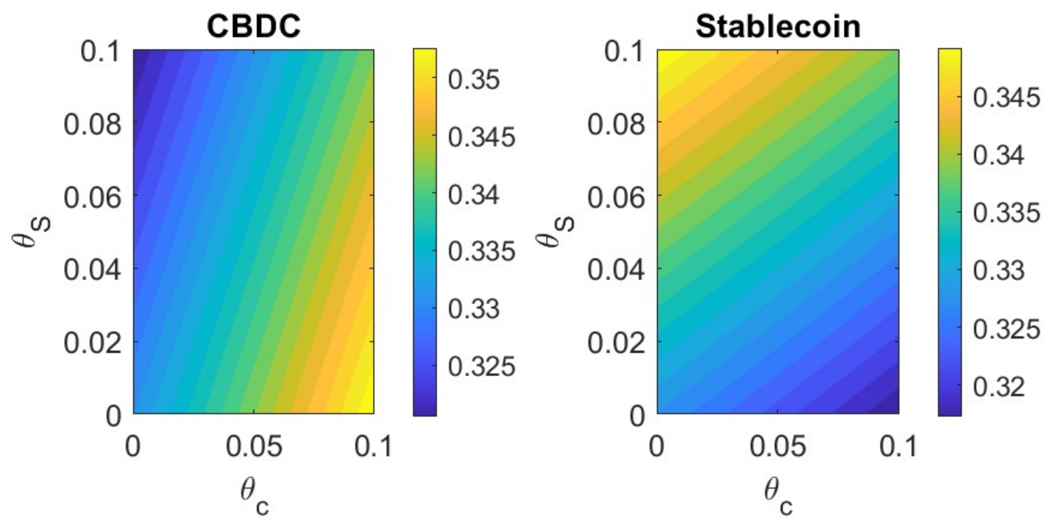

Figure 3: Equilibrium shares of CBDC and stablecoins as functions of their respective convenience yields, θ_c and θ_S. The left panel shows CBDC share increasing in θ_c and decreasing in θ_S. The right panel shows the mirror behavior for stablecoins. Even modest changes in convenience yield can induce large shifts in household portfolios.

The plots show how tipping points in portfolio allocation emerge: when the convenience-adjusted return of one instrument becomes marginally more attractive than the others, households reallocate abruptly. This nonlinear sensitivity underscores the strategic role of design features (e.g., programmability, privacy, integration) in shaping digital money adoption.

The simulation abstracts from general equilibrium feedback effects—such as interest rate responses, lending constraints, or bank behavior—but captures the essential mechanism: households equalize convenience-adjusted returns and tilt their portfolio toward the most attractive instruments. The framework provides a tractable tool for studying monetary design and competition in a digital environment. Our treatment of CBDC and stablecoin coexistence parallels the comparative analysis in Chiu and Monnet (2024), but can extend it by incorporating endogenous redemption risk (Section 8.3) and network effects (Section 8.4).

8 Extensions

This static framework can be extended in several directions:

8.1 CBDC with Holding Limits

Suppose the central bank imposes a holding cap on M^c, denoted by $\bar{M}^c$, set for example at €3,000 per account:

$$M^c \leq \bar{M}^c.$$

If the unconstrained optimum, denoted by an asterisk, satisfies $M^{c*} > \bar{M}^c$, the cap becomes binding and the household reallocates the excess balance to alternative instruments such as bank deposits or stablecoins. In other words, once the limit is reached, any additional demand for "safe" liquidity must be met through these substitutes. In this case, the arbitrage condition becomes:

$$i_c + \theta_c > \max\{i_D + \theta_D,\ i_S + \theta_S\}. \tag{arb. with capped CBDC}$$

The household sets $M^c = \bar{M}^c$ and chooses the remainder of the portfolio by maximizing utility subject to the new effective returns.

This introduces a kink in the convenience-adjusted return schedule and creates segmentation in money-like asset demand. The CBDC cap thus protects deposits and stablecoins from full displacement, and allows the central bank to retain control over CBDC expansion.

8.2 Stablecoins with constrained supply

Suppose that the supply of stablecoins is endogenously constrained or it is dependent on the state of the economy. We incorporate the macro-financial constraint on stablecoin supply from Section **??** into the portfolio allocation model, given by:

$$S_t = \vartheta R_t - \lambda_t(y_t), \tag{const. supply}$$

where S_t is the quantity of stablecoins available at time t, $\vartheta \in [0, 1]$ is the share of high-quality liquid assets (HQLA) in reserves R_t, $\lambda_t(y_t)$ is the redemption pressure, increasing in macroeconomic stress y_t.

In the baseline model, households allocate wealth across CBDC (M^c), deposits (D), and stablecoins (S) to equalize convenience-adjusted returns:

$$i_c + \theta_c = i_D + \theta_D = i_S + \theta_S \tag{FOC-arb}$$

However, if the stablecoin supply is constrained as in equation (const. supply), the household may not be able to hold the optimal amount S^* that satisfies FOC-arb. In this case, the arbitrage condition breaks down because the marginal utility of stablecoins exceed that of other instruments:

$$i_S + \theta_S > i_c + \theta_c = i_D + \theta_D \tag{arb. with capped S}$$

This inequality reflects a scarcity premium on stablecoins due to stress-induced redemption. Combining this with the stress constraint const. supply, the equilibrium allocation must now satisfy:

$$S_t = \min \{S^*, \vartheta R_t - \lambda_t(y_t)\}$$

where the term S^* refers to the optimal (unconstrained) quantity of stablecoins that households would like to hold in equilibrium, based on convenience-adjusted returns. This extension introduces state-contingent constraints on stablecoin availability. During periods of high macroeconomic stress ($y_t \uparrow$), redemption pressure $\lambda_t(y_t)$ increases, reducing S_t. This forces households to reallocate toward CBDC and deposits, potentially increasing demand for public money and altering monetary transmission. The model captures endogenous fragility and nonlinear portfolio shifts under stress.

8.3 Stablecoins with Credit Risk

If stablecoins are backed not by central bank reserves but by high-grade commercial paper, a repo basket, or lower-rated government bonds, then the associated return i_S may include a small credit spread. The model can be extended to incorporate this by introducing a modest risk premium. To capture the possibility that stablecoins may not be fully redeemable—due to issuer insolvency or insufficient reserves—we introduce a credit risk parameter into the framework.

Let $\pi \in [0, 1]$ denote the probability of default of the stablecoin issuer. The expected return on stablecoins is then:

$$\tilde{i}_S = (1 - \pi) \cdot i_S$$

where i_S is the nominal interest rate offered on stablecoins (e.g., $i_S = r^* - f_S$). The convenience-adjusted return for each instrument becomes:

$$\begin{aligned} r_c &= i_c + \theta_c \\ r_D &= i_D + \theta_D \\ r_S &= \tilde{i}_S + \theta_S = (1 - \pi) \cdot i_S + \theta_S \end{aligned}$$

This implies that an increase in π (perceived credit risk) reduces the attractiveness of stablecoins, shifting household portfolios toward CBDC and deposits.

8.4 Network Effects and Endogenous Convenience Yields

The role of adoption-driven convenience echoes the tipping-point dynamics emphasized in currency-competition models such as Benigno et al. (2022) and Brunnermeier et al. (2019). We extend the baseline model by allowing the convenience yields of CBDC and stablecoins to depend endogenously on their respective adoption levels, capturing network externalities and infrastructure investment. Specifically, let θ_c and θ_S be increasing functions of aggregate holdings M^c and S, respectively. This setup introduces the possibility of multiple equilibria or "money wars" between the central bank and non-financial intermediaries (NFIs).

We model convenience yields as saturating nonlinear functions:

$$\theta_c(\nu_c) = \theta_{c0} + \frac{a_c \nu_c^2}{1+\nu_c^2},$$
$$\theta_S(\nu_S) = \theta_{S0} + \frac{a_S \nu_S^2}{1+\nu_S^2},$$

where $\nu_c = M^c$, $\nu_S = S$ are the network effect parameters, θ_{c0}, θ_{S0} are base convenience yields, and a_c, a_S are scaling coefficients.

Households allocate wealth across CBDC, stablecoins, and deposits to equalize convenience-adjusted returns:

$$i_c + \theta_c(\nu_c) = i_D + \theta_D,$$
$$i_S + \theta_S(\nu_S) = i_D + \theta_D,$$
$$M^c + D + S = W = 1.$$

We assume households use a softmax allocation rule to determine portfolio shares:

$$\eta_j = \frac{e^{r_j}}{e^{r_c} + e^{r_S} + e^{r_D}}, \quad \text{for } j \in \{c, S, D\},$$

where $r_j = i_j + \theta_j$ is the convenience-adjusted return of asset j.

Figure 4 illustrates how nonlinear network effects influence household preferences and the equilibrium composition of money-like instruments. When ν_S is large, stablecoins benefit from stronger network externalities and may dominate household portfolios. Conversely, improvements in CBDC usability—such as enhanced privacy, interoperability, or user experience—that raise ν_c can shift the equilibrium toward CBDC. The model captures tipping points: small changes in convenience parameters can lead to abrupt reallocations in household portfolios.

8.5 Heterogeneous Agent Model

We extend the baseline framework to incorporate heterogeneity in household preferences over digital monetary instruments. This allows us to capture differences in attitudes toward CBDC and stablecoins across the population.

Two-Agent Case. Consider two representative household types:

- Agent A (CBDC-friendly): derives higher utility from holding CBDC.
- Agent B (Stablecoin-friendly): derives higher utility from holding stablecoins.

Each agent allocates wealth across CBDC, bank deposits and stablecoins, whose convenience-adjusted returns are

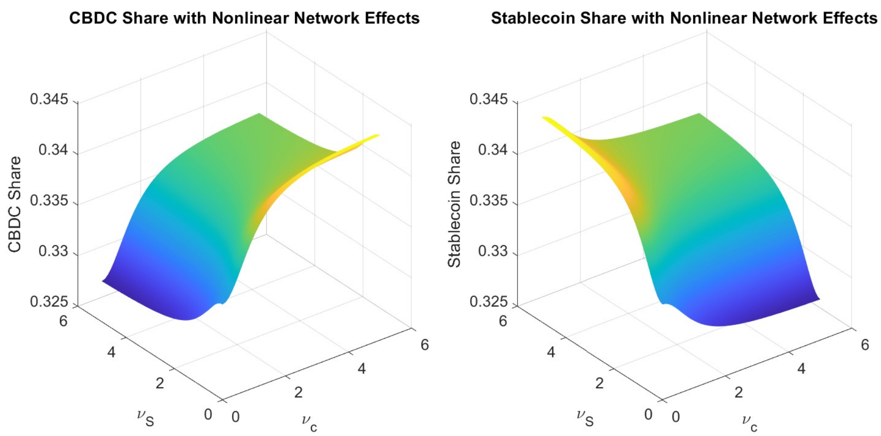

Figure 4: Equilibrium shares of CBDC and stablecoins as functions of their respective network effect parameters, ν_c and ν_S.

$$r_j = i_j + \theta_j(z) \quad j \in \{c, D, S\}, \quad z \in \{A, B\},$$

with $\theta_c(A) > \theta_c(B)$, $\theta_S(A) < \theta_S(B)$ and $\theta_D(A) = \theta_D(B)$. Hence, the CBDC-friendly agent A responds more strongly to increases in θ_c, while the stablecoin-friendly agent B to increases in θ_S.

Portfolio shares, η_j, are determined using a softmax function:

$$\eta_j = \frac{e^{i_j + \theta_j(z)}}{\sum_{k \in \{c,D,S\}} e^{i_k + \theta_k(z)}}$$

and the equilibium conditions are:

- The total demand for each instrument, Ω_j, is equal to the supply, where

$$\Omega_j = 0.5 \cdot \eta_j(A) + 0.5 \cdot \eta_j(B), \quad j \in (c, D, S)$$

- The convenience-adjusted returns are equalized across assets

$$i_D + \theta_D = i_c + 0.5 \cdot (\theta_c(A) + \theta_c(B)) = i_S + 0.5 \cdot (\theta_S(A) + \theta_S(B))$$

Remark. While the two-agent framework provides clear intuition about portfolio substitution between CBDC, deposits, and stablecoins, it can be naturally extended to a continuum of households. In that case, preferences are distributed smoothly across agents, and aggregate holdings are obtained by integrating individual portfolio shares. We develop this generalization in the next subsection.

From Two Agents to a Continuum of Households. The two-agent setup can be generalized to a continuum of households indexed by $\epsilon \in [0, 1]$. Preferences for CBDC and stablecoins vary smoothly with the heterogeneity parameter χ. Accordingly, convenience yields are distributed across households as:

$$\theta_c(\epsilon) = \bar{\theta}_c + (1-\epsilon)\chi, \qquad \theta_S(\epsilon) = \bar{\theta}_S + \epsilon\chi,$$

with the deposit yield θ_D taken as homogeneous across households.

In equilibrium, each household allocates wealth such that

$$i_c + \theta_c(\epsilon) = i_D + \theta_D = i_S + \theta_S(\epsilon).$$

Portfolio shares $\eta_c(\epsilon), \eta_D(\epsilon), \eta_S(\epsilon)$ follow a softmax rule consistent with the two-agent case:

$$\eta_j(\epsilon) = \frac{\exp\big(i_j + \theta_j(\epsilon)\big)}{\sum_{k\in\{c,D,S\}} \exp\big(i_k + \theta_k(\epsilon)\big)}.$$

Aggregate Holdings. Aggregate demand for each instrument is obtained by integrating across households:

$$\Omega_j = \int_0^1 \eta_j(\epsilon)\, d\epsilon, \qquad j \in \{c, D, S\}.$$

This formulation makes explicit how the two-agent framework extends to a continuum, capturing preference heterogeneity and its impact on the aggregate composition of household portfolios and the relative demand for CBDC, stablecoins, and deposits.

Equilibrium. An equilibrium is a set of interest rates $\{i_c, i_D, i_S\}$ and aggregate asset supplies $\{M^c, D, S\}$ such that:

1. **Agent Optimization:** Each agent $\epsilon \in [0,1]$ chooses portfolio shares $\{\eta_c(\epsilon), \eta_D(\epsilon), \eta_S(\epsilon)\}$ according to the softmax rule. This implies that convenience-adjusted returns influence, but do not perfectly equalize, at the individual level.

2. **Market Clearing:** The market clears for each asset:

$$\Omega_c = M^c, \quad \Omega_D = D, \quad \Omega_S = S.$$

3. **Pricing Consistency:** The convenience-adjusted returns are equalized across assets for each agent:

$$i_D + \theta_D = \int_0^1 (i_c + \theta_c(\epsilon))\, d\epsilon = \int_0^1 (i_S + \theta_S(\epsilon))\, d\epsilon.$$

This ensures that the aggregate demand for each asset clears the market, even though individual agents may hold different portfolios.

8.6 Multiple NFIs and Banks, and a Dynamic Extension

We extend the baseline framework to allow for multiple financial institutions and a dynamic environment.

Multiple NFIs and Banks. Suppose there are many identical non-financial intermediaries (NFIs) issuing stablecoins and competing in fees f_S. Under free entry and perfect competition, the equilibrium fee is driven down to the zero-profit condition:

$$f_S = r^* - i_S.$$

Similarly, assume multiple banks compete for household deposits. Competition drives the deposit rate i_D up to the point where banks just break even, subject to reserve and capital constraints. This compresses net interest margins and may affect lending capacity.

Dynamic Portfolio Allocation. In a dynamic setting, households choose their portfolio allocation over time, anticipating future returns and convenience yields. Let $x_{j,t}$ denote the holdings of asset $j \in \{c, D, S\}$ at time t. Households solve:

$$\max_{\{x_{j,t}\}} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left[u(C_t) + v(x_{c,t}, x_{D,t}, x_{S,t}) \right],$$

subject to intertemporal budget constraints and evolving convenience yields.

Bank and NFI Behavior. Banks dynamically choose deposit rates i_D, loan supply L_t, and reserve holdings R_t to maximize profits over time, subject to:

- Reserve requirement: $R_t = \rho D_t$,
- Capital constraint: $L_t \leq \kappa K_t$,
- Zero-profit condition: $\Pi_t^B = 0$.

NFIs dynamically manage their collateral portfolios (e.g., reserves or short-term deposits) and adjust stablecoin issuance S_t to meet household demand while satisfying:

$$\Pi_t^{\text{NFI}} = 0 \quad \Rightarrow \quad i_S = r^* - f_S.$$

8.7 Monetary Policy in a Digital environment

We now consider how monetary policy transmission operates in a digital financial environment in which stablecoins are interest-bearing, CBDC is tiered, and households allocate portfolios based on convenience-adjusted returns. The central bank sets the policy rate r^*, which governs the interest on reserves (i_R), CBDC (i_c), and indirectly influences deposit and stablecoin rates.

CBDC Design and Tiering. To mitigate disintermediation of the banking sector, the central bank implements a tiered CBDC structure:

$$i_c = \begin{cases} 0, & \text{if } M^c \leq \overline{M}^c, \\ -\gamma, & \text{if } M^c > \overline{M}^c, \end{cases}$$

where $\overline{M}^c$ is the holding threshold and $\gamma > 0$ is a penalty on excess CBDC balances. This design preserves CBDC's role as a payment medium while discouraging its use as a large-scale store of value.

Interest-Bearing Stablecoins. We now assume that stablecoins pay a nominal interest rate $i_S > 0$, which reflects the return on collateral minus any issuer costs or fees. In a competitive environment with zero profit, the stablecoin return satisfies:

$$i_S = \beta_R i_R + \beta_D i_D - f_S,$$

where β_R and β_D are the collateral shares invested in reserves and deposits, respectively, and f_S is the per-unit user fee. If the issuer holds only reserves, we recover the simple form $i_S = r^* - f_S$.

Portfolio Allocation and Transmission. Households allocate financial wealth to CBDC, deposits, and stablecoins by equalizing convenience-adjusted returns:

$$i_j + \theta_j = \psi \quad \text{for } j \in \{c, D, S\}.$$

An increase in the policy rate r^* raises the return on reserves, directly impacting i_S. Banks respond by adjusting i_D to remain competitive. In this setting, monetary policy transmits primarily through changes in the financial return of all instruments, rather than through CBDC alone.

When stablecoins are interest-bearing, their attractiveness becomes more sensitive to macro-financial conditions. A higher r^* increases i_S, which may draw household funds away from CBDC or deposits, depending on relative convenience yields.

Policy Design Tradeoffs. The presence of interest-bearing stablecoins strengthens the link between monetary policy and household portfolio decisions. However, it also complicates policy control, as stablecoin returns depend on issuer structure and collateral mix. Key tradeoffs include:

- **Transmission Strength**: When all instruments adjust with r^*, policy changes affect a broader set of assets and spending behavior.
- **Financial Stability**: Tiered CBDC and interest-bearing stablecoins mitigate large deposit outflows, but may increase balance sheet sensitivity of banks and issuers.
- **Issuer Competition**: NFIs offering attractive stablecoin returns may pressure banks to raise i_D, narrowing their net interest margins.
- **Convenience Dominance**: If one instrument offers significantly higher convenience yield (θ_j), households may allocate disproportionately regardless of small interest differences.

Implications. In this configuration, monetary policy regains potency through the financial yield channel, but only to the extent that convenience yields do not dominate. A well-designed CBDC must offer sufficient usability and liquidity to remain competitive, while issuer oversight is needed to ensure stablecoin rate-setting aligns with policy objectives and risk management standards. Hence, monetary policy operates through the design of digital instruments rather than through direct interest rate manipulation. The central bank influences household portfolio choices by adjusting the convenience yield of CBDC (e.g., through programmability, privacy, or interoperability) and by calibrating the threshold $\bar{M}^c$ and penalty γ.

The presence of non-interest-bearing stablecoins introduces a competitive floor to the effective return on money-like instruments. If stablecoins offer high convenience, they may dominate household portfolios unless CBDC is designed to match or exceed their utility. This dynamic can affect the demand for bank deposits and, by extension, the transmission of monetary policy through the banking system.

The presence of a tiered, non-interest-bearing CBDC alongside stablecoins that also offer financial return necessitates a rethinking of monetary policy implementation. Several key considerations emerge for policymakers:

- **Liquidity Management:** Central banks must closely monitor shifts in household portfolio preferences, as changes in perceived convenience yields can lead to abrupt reallocations among CBDC, bank deposits, and stablecoins.[14] Such reallocations may have significant implications for liquidity conditions and the effectiveness of monetary control.

- **Financial Stability:** The implementation of tiering mechanisms and holding limits on CBDC is essential to mitigate the risk of large-scale disintermediation of the banking sector. By discouraging excessive accumulation of CBDC, these measures help preserve the role of commercial banks in credit intermediation.

- **Financial Inclusion and Accessibility:** A well-designed CBDC that offers high convenience—such as ease of use, interoperability, and privacy—can enhance financial inclusion, particularly for underbanked populations. At the same time, the absence of interest on CBDC holdings ensures that it complements rather than competes with traditional deposit instruments.

- **Regulatory Oversight of Stablecoins:** Given their non-interest-bearing nature, stablecoins compete primarily on convenience and technological integration. To ensure systemic resilience, regulatory frameworks must enforce transparency of reserves, enforce redemption guarantees, and establish clear operational standards for issuers.

In summary, monetary policy in this environment is shaped less by interest rate differentials and more by the structural design of digital instruments and their associated convenience yields. The equilibrium allocation of household portfolios—and thus the transmission of monetary policy—depends critically on these non-pecuniary attributes.

[14] As highlighted by Cipollone (2025), excessive reliance on foreign stablecoins could undermine Europe's monetary sovereignty, reinforcing the need for a well-designed digital euro.

8.8 Cross-Border Payments, FX Risk, and Currency Substitution

Digital monetary instruments increasingly intersect with cross-border payment use cases, raising questions about foreign exchange (FX) risk, capital mobility, and monetary sovereignty. Traditional cross-border transactions via correspondent banking systems are typically slow and costly, involving multiple intermediaries and delayed net settlement. In contrast, stablecoins and tokenized deposits can be transferred rapidly across borders – often outside formal banking channels – creating opportunities for efficiency as well as new channels for regulatory arbitrage.

Stablecoins pegged to foreign currencies (e.g., USD) are already used in cross-border remittances and peer-to-peer payments, especially in emerging markets. These instruments may displace local currency usage, undermining domestic monetary transmission and increasing exposure to unhedged FX risk. For example, USDT and USDC are commonly used in informal remittance corridors across Latin America, West Africa, and Southeast Asia, where dollar-backed stablecoins substitute for local currencies in digital wallets and e-commerce platforms.

To formalize these dynamics, the model can be extended to include foreign-denominated money-like instruments in household portfolios. Let M^f represent a foreign-currency denominated stablecoin or tokenized deposit, with nominal return i_f and convenience yield θ_f. The household's effective convenience-adjusted return in domestic currency includes both the financial yield and the expected appreciation of the exchange rate:

$$r_f = (1 + i_f) \cdot \mathbb{E}\left[\frac{q_{t+1}}{q_t}\right] + \theta_f,$$

where q_t is the domestic currency price of foreign currency (i.e., the exchange rate). Households compare this to the adjusted returns of domestic instruments when allocating portfolios. A weakening domestic currency or declining domestic convenience yields can cause substitution into foreign-denominated stablecoins, accelerating capital flight or de facto dollarization.

This extension captures key dynamics of currency substitution and illustrates how digital money may amplify financial openness without accompanying policy tools. It also highlights the potential macro-financial risks of stablecoin adoption in jurisdictions with weak currencies or capital controls.

8.9 Policy Implications of Digitalization in Monetary Systems

The digitalization of money introduces profound implications for monetary sovereignty, financial stability, cross-border risk management, and regulatory design. Drawing on the analysis of payment instruments (Section 3), payment flows and transaction dynamics (Section 4), and impact on the balance sheets of financial and non-financial actors (Section 6), this section synthesizes the key policy considerations facing central banks and regulators in an evolving digital monetary ecosystem.

Monetary Sovereignty and Currency Substitution. The emergence of stablecoins pegged to foreign currencies poses material risks to domestic monetary sovereignty, especially in emerging markets. Dollar-denominated stablecoins can promote informal dollarization, weaken the demand for local currency instruments, and reduce the effectiveness of monetary policy. Policymakers may need to prioritize the issuance of domestic CBDCs or impose restrictions on foreign-pegged digital instruments to mitigate substitution risk.

Cross-Border Payment Efficiency vs. FX Exposure. While digital money enhances cross-border payment efficiency, it also creates new channels for regulatory arbitrage and unhedged FX exposure. Stablecoins and tokenized deposits enable fast international transactions but can bypass formal capital controls and prudential supervision. This calls for multilateral frameworks and shared standards governing interoperability, exchange, and compliance.

Bank Funding and Credit Provision. Digital currencies may disintermediate commercial banks by diverting deposits to CBDCs or stablecoins. This affects bank funding structures, lending capacity, and risk transformation functions. To preserve credit supply, central banks may need to cap CBDC holdings, provide liquidity backstops, or facilitate tokenized deposit issuance by banks. Balance sheet constraints (e.g., reserve requirements, capital ratios) remain key determinants of equilibrium lending.

Financial Stability and Run Risk. Stablecoins—especially those backed by opaque or volatile assets—pose run risks that can transmit stress across financial and crypto ecosystems. Domestic use of foreign-backed stablecoins can exacerbate such risks through FX mismatches. Clear redemption rights, high-quality reserves, and robust disclosure standards are essential to ensure stablecoin resilience. The monetary system's core should remain anchored in instruments with immediate and irrevocable settlement.

8.10 Key Takeaways

- **Convenience-adjusted returns drive portfolio allocation:** Households allocate wealth across CBDC, stablecoins, and deposits based on the sum of financial returns and nonpecuniary convenience yields. Even small changes in convenience can trigger large shifts in asset shares.
- **CBDC design is critical:** Features such as anonymity, programmability, and interoperability raise the convenience yield of CBDC, enhancing its competitiveness. Tiered remuneration structures help mitigate disintermediation risks.
- **Stablecoin dynamics are shaped by collateral, fees, and risk:** Stablecoin returns depend on reserve composition and platform fees. Supply constraints and credit risk introduce fragility and can lead to scarcity premia or abrupt portfolio reallocations.
- **Network effects can create tipping points:** Endogenous convenience yields that increase with adoption generate nonlinear dynamics and multiple equilibria. Small changes in preferences or design can lead to dominance of one instrument.

- **Heterogeneous preferences matter:** When agents differ in their valuation of CBDC and stablecoins, equilibrium interest rates must equalize convenience-adjusted returns on average. This leads to diverse portfolio compositions and richer policy trade-offs.
- **Monetary policy transmission is reshaped:** In a digital environment, policy operates through both interest rates and the structural design of instruments. The presence of interest-bearing stablecoins and tiered CBDC alters the channels and effectiveness of monetary control.
- **Institutional competition compresses margins:** Free entry among NFIs and banks drives fees and deposit rates toward no-arbitrage bounds, affecting profitability and lending capacity.
- **Cross-border and FX risks emerge:** Foreign-denominated stablecoins can substitute for local currency, raising concerns about monetary sovereignty and capital flight, especially in emerging markets.
- **Policy coordination is essential:** Regulatory frameworks must address transparency, redemption guarantees, and systemic risk. Central banks must balance innovation with financial stability and inclusion.

9 Regulatory Architecture

The coexistence of CBDCs, bank deposits, and stablecoins introduces complex regulatory challenges related to classification, oversight, and systemic stability. This section synthesizes how major jurisdictions—the European Union, the United States, and the United Kingdom—are addressing these issues and how their approaches intersect with the theoretical framework developed in this paper.

In the European Union, regulatory efforts have focused on harmonizing payment systems and establishing a comprehensive legal framework for digital assets. Initiatives such as SEPA and the Instant Payments Regulation have strengthened the convenience yield of bank deposits by ensuring interoperability and real-time settlement. The revised Payment Services Directives (PSD2 and forthcoming PSD3) expand open banking and enhance consumer protection, while the Markets in Crypto-Assets Regulation (MiCAR) introduces prudential standards for stablecoins, including reserve quality and redemption rights. Complementary measures such as the Financial Data Access Regulation (FIDAR) and the integration of the Electronic Money Directive into the new Payment Services Regulation further consolidate oversight. These developments aim to preserve monetary sovereignty and financial stability while enabling innovation, consistent with the model's prediction that well-regulated instruments can coexist when convenience and safety are maintained.

The United States presents a more fragmented regulatory landscape. Oversight is divided among multiple federal and state agencies, and stablecoin issuers operate under a patchwork of money transmitter licenses and federal guidance. Although the President's Working Group recommended prudential regulation for stablecoins, legislative progress has been slow. In response to systemic risk concerns, the GENIUS Act, introduced in 2025, proposes a unified federal framework requiring high-quality reserves, redemption guarantees, and centralized supervision. Meanwhile, the Federal Reserve has suspended work on a retail CBDC due to political and privacy concerns, shifting policy attention toward private digital money regulation. This fragmented approach heightens the fragility of private money and aligns with the model's insight that weak regulatory anchors amplify systemic risk and portfolio shifts under stress.

The United Kingdom has adopted a more integrated and forward-looking strategy. The Financial Services and Markets Act of 2023 brings fiat-backed stablecoins under the regulatory perimeter of the Financial Conduct Authority, imposing requirements on reserve quality, redemption rights, and operational resilience. The Bank of England and HM Treasury are exploring a platform-based retail CBDC, emphasizing interoperability, privacy, and the preservation of the two-tier banking system. Complementary initiatives, such as the Digital Securities Sandbox, aim to foster innovation under robust prudential safeguards. This approach reflects a balance between innovation and systemic stability, consistent with the model's emphasis on design features and institutional trust as determinants of convenience yields.

The analytical framework developed in this paper—centered on household portfolio allocation among CBDC, stablecoins, and bank deposits—offers a valuable lens through which to interpret the evolving regulatory architectures in the European Union, the United States, and the United Kingdom.

In the European Union, the regulatory environment is characterized by a high degree of institutional coordination and legal clarity. Regulations such as MiCAR, PSD2/PSD3, and the Instant Payments Regulation directly influence the convenience yields and risk profiles of digital instruments. The model's emphasis on convenience-adjusted returns aligns closely with the EU's strategy to enhance the attractiveness of regulated instruments—particularly bank deposits and prospective CBDCs—through interoperability, programmability, and consumer protection. The EU's approach supports the model's prediction that well-regulated public and private money can coexist in equilibrium, provided that convenience and safety are maintained.

In contrast, the United States presents a more fragmented regulatory landscape, where stablecoins operate under a patchwork of state and federal oversight. The absence of a comprehensive federal framework for digital assets, combined with the slow progress on CBDC development, reinforces the model's insights on the fragility of private money in the absence of credible public alternatives. The model's treatment of redemption risk and reserve quality is particularly relevant in the U.S. context, where stablecoin issuers face uncertainty around prudential standards and legal classification. This environment increases the likelihood of systemic stress and portfolio shifts, as captured in the model's simulations.

The United Kingdom occupies an intermediate position, combining regulatory agility with a strong emphasis on innovation and financial stability. The Bank of England's exploration of a platform-based CBDC and HM Treasury's proposed framework for stablecoins reflect a regulatory design that internalizes the trade-offs modeled in this paper—between convenience, safety, and monetary sovereignty. The U.K.'s emphasis on programmability, legal clarity, and public-private collaboration supports the model's prediction that digital money adoption hinges not only on financial yields but also on institutional trust and usability.

Together, these jurisdictions illustrate the model's broader implication: that the equilibrium composition of household portfolios—and the resilience of the digital payments ecosystem—depends critically on regulatory design, technological infrastructure, and the credibility of monetary institutions.

10 Conclusion

10.1 Directions for Future Research

While the model developed in this paper provides a useful starting point for analyzing household allocation across CBDCs, stablecoins, and bank deposits, several avenues for future research remain open.

First, the assumption of homogeneous representative agents limits the model's ability to capture the diversity of real-world behavior. In practice, preferences, technological access, and trust in digital instruments vary widely across individuals. Introducing heterogeneous agents would allow the model to better reflect observed adoption patterns and distributional effects. This paper partly explores agent heterogeneity in Section 8.5.

Second, the model assumes perfect convertibility between digital instruments. However, operational, regulatory, and liquidity risks – especially under market stress – may hinder immediate or frictionless conversion. Incorporating these frictions would improve the model's realism and its ability to simulate stress scenarios.

Third, the current framework is essentially static. Extending it to a dynamic, intertemporal setting would allow for the analysis of gradual adoption paths, transitional dynamics, and the role of expectations. These elements are central in monetary theory and in the diffusion of financial innovations, yet are only implicitly captured here through exogenous parameters.

Fourth, the model could be enriched by incorporating service fees and transaction costs – such as cardholder fees or merchant fees – which play a significant role in household and merchant payment choices. Benchmark data from existing payment systems could be used to calibrate these costs.

Finally, while the policy discussion emphasizes the potential of CBDCs to strengthen monetary sovereignty, it could be complemented by scenarios in which CBDCs might instead erode banking sector stability. This dual perspective would align with recent empirical and theoretical work (Auer et al., 2024).

As Melville writes in *Moby Dick* when describing the classification of whales: "I promise nothing complete." Likewise, this model is intentionally simple, and its value lies in providing a tractable foundation for further theoretical and empirical exploration.

10.2 Final Words

This paper develops a unified framework to analyze household portfolio allocation across CBDC, commercial bank deposits, and fintech-issued stablecoins. By modeling convenience-adjusted returns as the sum of financial yields and nonpecuniary benefits, we show that households allocate wealth toward the instrument offering the highest total return. Our results highlight the central role of convenience yields in shaping equilibrium outcomes, particularly in the presence of frictions, redemption risks, and network effects.

The analysis reveals that, under realistic assumptions about reserve quality, redemption costs, and regulatory constraints, CBDC and bank deposits tend to dominate stablecoins in equilibrium. CBDCs, as public liabilities with legal tender status and zero credit risk, offer a robust and resilient form of digital money. Bank deposits, supported by deposit insurance and mature infrastructure, continue to provide a stable and convenient medium for payments and savings. In contrast, stablecoins—despite their programmability and global reach—are exposed to fragility under stress, especially when backed by imperfect collateral or subject to redemption constraints.

Our simulations and comparative statics demonstrate that even modest improvements in the convenience yield of CBDC (e.g., through programmability, privacy, or interoperability) can significantly shift household preferences away from stablecoins. Similarly, regulatory enhancements to bank-based payment systems (e.g., instant payments, open banking) increase the attractiveness of deposits. These findings suggest that public and regulated private money can coexist and complement each other, but that the long-term viability of stablecoins depends critically on their ability to match the safety, transparency, and convenience of sovereign and bank-issued instruments.

In conclusion, the preference for CBDC and bank deposits in our model reflects not only their financial returns but also their institutional credibility and systemic integration. As digital money ecosystems evolve, policy design and regulatory clarity will be essential to ensure that innovation supports monetary sovereignty, financial inclusion, and macro-financial stability. These findings resonate with Panetta (2025) call for a central bank-led transformation of the digital monetary landscape.

Finally, the growing use of stablecoins and tokenized instruments in cross-border payments raises new challenges for monetary sovereignty and exchange rate management – particularly in emerging markets (International Monetary Fund, 2022a). When foreign-denominated stablecoins become de facto mediums of exchange, domestic monetary policy transmission may weaken, and currency substitution pressures may rise. These dynamics underscore the importance of international coordination in the regulation of digital assets, the design of interoperable CBDCs, and the development of trusted domestic alternatives that combine digital convenience with macroeconomic stability.

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A Appendix

A.1 The Model with Cash

By definition, cash is issued by the central bank, has no interest and a convenience yield, θ_{cash}. Its existence lowers demand for CBDC or stablecoins unless they offer higher convenience. The arbitrage condition now ties four instruments instead of three, ensuring coexistence depends on relative convenience yields. In summary:

- cash dominates if
$$\theta_{\text{cash}} > \theta_c = i_S + \theta_S = i_D + \theta_D.$$
In that case, households will not hold CBDC or other digital assets.
- If the central bank enhances the convenience yield of CBDC (e.g., by introducing privacy features), then CBDC can compete directly with cash.
- This setup allows the modeling of transitional dynamics from a cash-dominant to a digital-dominant system as a function of the θ-parameters and policy interest rates.

Households allocate wealth among:

- **Cash:** cash — zero interest, convenience yield θ_{cash}
- **CBDC:** M^c — zero interest, convenience yield θ_c
- **Deposits:** D — interest i_D, convenience yield θ_D
- **Stablecoins:** S — interest $i_S = r^* - f_S$, convenience yield θ_S

Households choose their allocation so that:

$$i_j + \theta_j = \text{equalized across all instruments}, \quad \text{for } j \in \{\text{cash}, c, D, S\}.$$

A.2 Household Welfare Analysis

We analyze household welfare within the monetary architecture introduced in the model, focusing on the allocation of payment instruments—CBDC (M^c), bank deposits (D), and stablecoins (S)—and their convenience-adjusted returns. The representative household maximizes utility derived from consumption and the liquidity services of monetary assets.

Utility Function and Budget Constraint: Households solve:

$$\max_{C,M^c,D,S} \quad u(C) + v(M^c) + v(D) + v(S) \tag{27}$$

subject to the budget constraint:

$$C + M^c + D + S = \omega + (1 + i_c)M^{c,-1} + (1 + i_D)D^{-1} + (1 + i_S)S^{-1} \tag{28}$$

Here, $u(C)$ is the utility from consumption and $v(x)$ is the utility from holding monetary instruments. The convenience yield of each instrument is defined as:

$$\theta_j = \frac{v_j'(x)}{u'(C)}, \quad j \in \{M^c, D, S\} \tag{29}$$

Households choose asset allocations to equalize convenience-adjusted returns:

$$i_c + \theta_c = i_D + \theta_D = i_S + \theta_S \tag{30}$$

Determinants of Welfare

Household welfare depends on:

- The level of consumption C, which is increasing in disposable income.
- The holdings of monetary assets and their liquidity services.
- The structure of convenience yields θ_j and returns i_j.
- Policy variables affecting the costs or availability of payment instruments.

Using the envelope theorem, the marginal effect of a policy variable ψ on utility is:

$$\frac{dU}{d\psi} = u'(C) \cdot \frac{dC}{d\psi} + \sum_j v_j'(x_j) \cdot \frac{dx_j}{d\psi} \tag{31}$$

This provides a framework to assess welfare changes under alternative monetary regimes.

Comparative Welfare Impacts: Numerical Illustration

We simulate welfare changes from three distinct policy interventions. Let baseline welfare be normalized to 0. All scenarios assume quasi-linear utility: $u(C) = C$ and $v(x_j) = \lambda_j \log(x_j)$, where λ_j scales the convenience yield of each instrument $j \in M^c, D, S$.

In the baseline, we assume $\lambda_{M^c} = 0.03$, $\lambda_D = 0.025$, $\lambda_S = 0.02$, and equal initial holdings of each instrument at 1 unit. We evaluate the change in utility under small policy shocks by computing the total utility difference:

$$\Delta U = \Delta C + \sum_j \lambda_j \log(x_j^{\text{new}}) - \sum_j \lambda_j \log(x_j^{\text{baseline}}) \tag{32}$$

1. **CBDC Holding Cap:** We impose a cap on CBDC holdings: $M^c \leq 0.5$. The household reallocates the excess CBDC holdings into D and S to satisfy the arbitrage condition. The reduced exposure to the high-convenience CBDC lowers overall utility. *Welfare impact:* $\Delta U = -0.012$
2. **Stablecoin Taxation:** We raise the user fee f_S, which lowers the effective return i_S and reduces optimal S holdings to 0.6. The household reallocates to D and M^c, but experiences a loss in convenience due to the lower weight on λ_S. *Welfare impact:* $\Delta U = -0.021$

3. **Reserve Requirement Increase:** We simulate a fall in i_D due to tighter reserve rules. As D becomes less attractive, optimal deposit holdings fall to 0.75, replaced partially by S and M^c. The loss in deposit convenience explains the drop in welfare. *Welfare impact:* $\Delta U = -0.008$

Conclusion

Household welfare depends critically on the structure and accessibility of money-like instruments. Policy interventions such as CBDC caps, stablecoin fees, or tighter reserve requirements can impair the household's ability to optimize its portfolio of liquidity. Welfare losses are driven by diminished convenience yields, reduced returns, or restrictions on access to preferred instruments. Carefully designed monetary policies must account for these effects when balancing financial stability and efficiency.

A.3 CBDC in the world

Table 7 summarizes the remuneration status of CBDCs across selected countries as of June 2025. It distinguishes between launched, piloted, and developmental projects, and whether the CBDC is interest-bearing (remunerated). While most live CBDCs—such as those in the Bahamas, Nigeria, and Jamaica—are non-remunerated, several jurisdictions (e.g., the EU, Sweden, and China) are exploring tiered or interest-bearing models to manage demand and avoid disintermediation. The remuneration feature is a key design choice that affects monetary policy transmission, financial stability, and the competitive landscape between public and private money.

Tiered CBDC refers to a structure in which the issuance, distribution, and usage of a CBDC are divided among different layers of participants. This model is often proposed to balance efficiency, scalability, and financial stability

Table 7: CBDC Remuneration and Legal Tender Status by Country (as of June 2025)

Country	**CBDC Name**	**Status**	**Remuneration**	**Legal Tender**
Bahamas	Sand Dollar	Launched	No	No
Nigeria	eNaira	Launched	No	No
Jamaica	JAM-DEX	Launched	No	No
Eastern Caribbean	DCash	Launched	No	No
China	e-CNY	Pilot	Planned	Yes
Sweden	e-krona	Pilot	Planned	Possibly
European Union	Digital Euro	Development	Planned (Tiered)	Possibly
India	Digital Rupee	Pilot	Undecided	Possibly
Brazil	Drex	Pilot	Undecided	Possibly
South Korea	Digital Won	Pilot	Undecided	Possibly
Canada	Digital Canadian Dollar	Development	Undecided	Possibly

A.4 Interest on Stablecoins

While most stablecoins are issued as non-interest-bearing instruments, there is a growing class of implementations that offer yield-like features through integrated financial services. These returns may arise through staking mechanisms, liquidity provision, lending platforms, or interest-sharing arrangements facilitated by custodial issuers. Such designs challenge the traditional view of stablecoins as passive digital payment tokens and raise regulatory, monetary, and competitive considerations.

Interest on stablecoins can take various forms:

- **DeFi-based yield:** Algorithmic stablecoins or fiat-backed tokens used in decentralized finance (DeFi) protocols can earn returns via lending pools (e.g., Aave, Compound), liquidity provision on automated market makers (e.g., Uniswap), or staking services. These yields are endogenous to protocol dynamics and subject to market risk, counterparty risk, and price volatility.
- **Custodial interest sharing:** Some centralized issuers may generate income from the reserves backing stablecoins (e.g., U.S. Treasuries or commercial paper) and offer partial interest distribution to users or platform partners. While the token itself remains non-interest-bearing on-chain, associated platforms (e.g., exchanges, wallets) may share returns with users as part of a broader service offering.
- **Tokenized money market funds:** Certain stablecoin-like instruments are structured to resemble money market fund shares, offering both price stability and interest accrual. These instruments may fall under distinct regulatory categories (e.g., as securities) and blur the boundary between payment token and investment product.

In the context of this model, such interest-bearing structures may influence household portfolio decisions by effectively raising the financial return i_S on stablecoins. However, this yield often comes with increased complexity, risk exposure, or reduced liquidity. Moreover, regulatory treatment may vary by jurisdiction, especially under frameworks like MiCAR (EU) or the Stablecoin TRUST Act (US), which distinguish between e-money tokens, asset-referenced tokens, and investment instruments. Table 8 summarizes the forms with examples of traded stablecoins.

A.5 Matlab script

A.5.1 Assumptions of Figure ?? and Listing 1: Stablecoin Collapse

The simulation in Listing 1 models the probability of stablecoin collapse under different macroeconomic stress scenarios. The following assumptions underpin the model:

1. **Time Horizon:** The simulation spans $T = 100$ periods, representing a stylized timeline of macroeconomic developments.
2. **Macroeconomic Stress (y_t):** The model introduces exogenous shocks to the economy through a stress variable y_t, which evolves in three phases:

Table 8: Interest and Yield Mechanisms Across Selected Stablecoins

Stablecoin	Issuer Type	Yield Mechanism	Notes
USDC	Custodial (Circle)	No direct interest; yield on reserves retained by issuer	Regulated under U.S. state money transmitter laws; reserve interest not shared with users
USDT	Custodial (Tether)	No direct yield; issuer earns interest on reserves	Backing includes cash equivalents and short-term securities; user yield only via third-party platforms
DAI	Decentralized (MakerDAO)	Protocol-level interest via stability fees, DSR (Dai Savings Rate)	Users can deposit DAI in DSR smart contract to earn interest; rate set by governance
PYUSD	Custodial (PayPal via Paxos)	No on-chain interest; potential off-chain yield sharing	Backed by USD reserves and Treasuries; integrated into PayPal/Venmo wallet ecosystem
sDAI, aUSDC	DeFi wrapper tokens	Yield accrues via lending protocols (e.g., Aave, Compound)	Tokenized claims on interest-bearing stablecoin deposits; smart-contract governed returns

Note: Most custodial stablecoins do not pay interest directly to users, although issuers may earn yield on reserves. In DeFi protocols, yield is protocol-determined and may involve credit and smart contract risk. Regulatory classification varies depending on structure and jurisdiction. The stablecoins listed represent a range of custodial and decentralized models. USDC and USDT are fiat-backed tokens issued by regulated entities. DAI is a crypto-collateralized stablecoin governed by MakerDAO. PYUSD is a fiat-backed token integrated into PayPal's ecosystem. sDAI and aUSDC are yield-bearing tokens used in DeFi protocols like Aave and Compound. Yield mechanisms vary based on whether the stablecoin is custodial, decentralized, or integrated into financial platforms.

- Periods 1–20: Random noise (normal conditions).
- Periods 21–40: Gradual increase in stress (e.g., interest rate volatility).
- Periods 41–60: Escalating fiscal stress.
- Periods 61–100: Persistent high stress.

3. **Reserve Quality (ϑ):** Two levels of reserve quality are considered:
   - Low quality: $\vartheta = 0.3$
   - High quality: $\vartheta = 0.9$

   This parameter reflects the share of high-quality liquid assets (HQLA) in the stablecoin's backing reserves.

4. **Redemption Pressure (λ_t):** Redemption demand is modeled as a nonlinear function of macroeconomic stress:

$$\lambda_t = \alpha \cdot x_t^{\zeta}$$

where α and ζ are parameters capturing the intensity and elasticity of redemptions. Two configurations are tested:

- High elasticity: $(\alpha = 20, \zeta = 2)$
- Low elasticity: $(\alpha = 10, \zeta = 1)$

5. **Stablecoin Supply (S_t):** The effective backing of stablecoins is given by:

$$S_t = \vartheta R_t - \lambda_t$$

where $R_t = 100$ is the nominal reserve level. This equation captures the idea that redemptions reduce the effective backing of stablecoins.

6. **Collapse Probability:** The probability of collapse is modeled using a logistic function:

$$\text{collapse\_prob}_t = \frac{1}{1 + \exp(S_t)}$$

This ensures that as S_t becomes negative (i.e., redemptions exceed reserves), the probability of collapse approaches 1.

7. **Scenarios:** The simulation evaluates four combinations of (ϑ, ζ) to illustrate how reserve quality and redemption elasticity jointly affect collapse risk.

Matlab script: Probability of Stablecoin collapse - Figure ??

```
% model_simulation.m
T = 100; % time horizon
x_shock = randn(T, 1).*.1;
x_shock(21:40) = linspace(0, 10, 20); % interest rate volatility shock
x_shock(41:60) = linspace(10, 20, 20); % fiscal stress
x_shock(61:end) = 20; % persistent stress

R_t = 100; % nominal reserves
theta_vals = [0.3, 0.9]; % low and high reserve quality
alpha_beta_vals = [20, 2; 10, 1]; % high and low redemption elasticity

collapse_probs = zeros(T, 4);

for i = 1:2
    theta = theta_vals(i);
    for j = 1:2
        alpha = alpha_beta_vals(j, 1);
        beta = alpha_beta_vals(j, 2);
        lambda_t = alpha * x_shock.^beta; % Demand for redemption,
            dependent on shock
        S_t = theta * R_t - lambda_t;     % Reserve coverage (theta*R_t)
            minus redemption demand (lambda_t)
        collapse_prob = 1 ./ (1 + exp(S_t)); % logistic function for
            collapse probability
        collapse_probs(:, 2*(i-1)+j) = collapse_prob;
```

```
    end
end
```

Listing 1: Probability of Stablecoin collapse under phases of shock - Figure **??**

A.5.2 Assumptions of Figure 3 and Listing 2: Portfolio Allocation

Listing 2 presents a numerical simulation of household portfolio allocation among three monetary instruments: central bank digital currency (CBDC), stablecoins, and bank deposits. The simulation is based on the concept of *convenience-adjusted returns*, which combine financial yields with nonpecuniary benefits. The following assumptions are made:

1. **Convenience-Adjusted Return:** For each instrument $j \in \{c, S, D\}$ (CBDC, stablecoin, deposit), the return is defined as:

$$r_j = i_j + \theta_j$$

   where i_j is the financial yield and θ_j is the convenience yield.

2. **Softmax Allocation Rule:** Households allocate their wealth across instruments using a softmax function, which ensures that all shares are positive and sum to one:

$$\eta_j = \frac{e^{r_j}}{e^{r_c} + e^{r_S} + e^{r_D}}$$

   This reflects the idea that households probabilistically favor instruments with higher convenience-adjusted returns.

3. **Fixed Parameters:**
   - Policy rate: $r^* = 0.02$
   - Deposit rate: $i_D = r^* - 0.005 = 0.015$
   - Stablecoin fee: $f_S = 0.01$, so $i_S = r^* - f_S = 0.01$
   - Deposit convenience yield: $\theta_D = 0.03$ (fixed)

4. **Convenience Yield Ranges:**
   - CBDC convenience yield θ_c varies from 0 to 0.1
   - Stablecoin convenience yield θ_S varies from 0 to 0.1

   These ranges are used to explore how changes in perceived convenience affect portfolio shares.

5. **Grid Simulation:** The simulation evaluates $n = 50$ values for each of θ_c and θ_S, resulting in a 50×50 grid of scenarios.

6. **Output:** For each (θ_c, θ_S) pair, the model computes the share of household wealth allocated to:

- CBDC
- Stablecoins
- Bank deposits

These shares are stored and visualized to identify tipping points in portfolio preferences.

Matlab script: model simulation - Figure 3

```
%% model_simulation.m: CBDC, Stablecoins, and Bank Deposits
clear; clc; close all;

%% Parameters
n = 50; % Number of points for convenience yield grids
r_star = 0.02; % Base policy rate (CBDC & reserves)
iD = r_star - 0.005; % deposit rate slightly below CBDC
fS = 0.01; % stablecoin fee (so iS = r_star - fS)

% Ranges of convenience yields
theta_c_range = linspace(0, 0.1, n); % CBDC convenience yield
theta_s_range = linspace(0, 0.1, n); % Stablecoin convenience yield

[ThetaC, ThetaS] = meshgrid(theta_c_range, theta_s_range);

%% Output storage
CBDC_share = zeros(n, n);
Stablecoin_share = zeros(n, n);
Deposit_share = zeros(n, n);

%% Loop over grid of (theta_c, theta_s) combinations
for i = 1:n
    for j = 1:n
        theta_c = ThetaC(j,i); % meshgrid ordering: rows by y-axis
        theta_s = ThetaS(j,i);
        theta_d = 0.03; % fixed deposit convenience

        Rc = r_star + theta_c;
        Rd = iD + theta_d;
        iS = r_star - fS;
        Rs = iS + theta_s;

        % Softmax allocation (exponential to reflect preference
           sensitivity)
        expRc = exp(Rc);
        expRd = exp(Rd);
        expRs = exp(Rs);
        total_exp = expRc + expRd + expRs;

        shareC = expRc / total_exp;
        shareD = expRd / total_exp;
        shareS = expRs / total_exp;

        % Store shares
```

```
        CBDC_share(j,i) = shareC;
        Deposit_share(j,i) = shareD;
        Stablecoin_share(j,i) = shareS;
    end
end
```

Listing 2: Equilibrium shares as functions of their convenience yields - Figure 3

A.5.3 Assumptions of Figure 4 and Listing 3: Nonlinear Network Effects

Listing 3 presents a simulation of household portfolio allocation across CBDC, stablecoins, and bank deposits, incorporating nonlinear network effects. The model assumes that the convenience yield of digital instruments increases with their adoption, capturing feedback loops in user preferences. The key assumptions are:

1. **Convenience-Adjusted Return:** For each instrument $j \in \{c, S, D\}$ (CBDC, stablecoin, deposit), the return is defined as:

$$r_j = i_j + \theta_j(\nu_j)$$

   where i_j is the financial yield and $\theta_j(\nu_j)$ is the convenience yield, which depends on a network effect parameter ν_j.

2. **Network Effects:** The convenience yields for CBDC and stablecoins are modeled as nonlinear, saturating functions of their respective network parameters:

$$\theta_c(\nu_c) = \theta_{c0} + \frac{a_c \cdot \nu_c^2}{1+\nu_c^2}, \quad \theta_S(\nu_S) = \theta_{S0} + \frac{a_S \cdot \nu_S^2}{1+\nu_S^2}$$

   where θ_{c0} and θ_{S0} are base convenience yields, and a_c, a_S are scaling parameters.

3. **Fixed Financial Returns:**
   - Policy rate: $r^* = 0.02$
   - Deposit rate: $i_D = r^* - 0.005 = 0.015$
   - Stablecoin fee: $f_S = 0.01$, so $i_S = r^* - f_S = 0.01$
   - Deposit convenience yield: $\theta_D = 0.03$ (fixed)

4. **Softmax Allocation Rule:** Households allocate wealth using a softmax function:

$$\eta_j = \frac{e^{R_j}}{e^{R_c} + e^{R_s} + e^{R_d}}$$

   This ensures that all shares are positive and sum to one, reflecting probabilistic preferences.

5. **Simulation Grid:** The simulation evaluates a 50×50 grid of values for ν_c and ν_S, each ranging from 0 to 5, to explore how network effects influence portfolio shares.

6. **Output:** For each (ν_c, ν_S) pair, the model computes the share of household wealth allocated to:

   - CBDC
   - Stablecoins
   - Bank deposits

   These shares are visualized to identify tipping points and dominance regions in digital money adoption.

Matlab script: Nonlinear Network Effects – Figure 4

```
% Nonlinear Network Effects on CBDC and Stablecoin Shares
clear; clc;

% Parameter ranges
nu_c_vals = linspace(0, 5, 50);
nu_s_vals = linspace(0, 5, 50);
[Nu_c, Nu_s] = meshgrid(nu_c_vals, nu_s_vals);

% Fixed parameters
r_star = 0.02;          % baseline interest rate
theta_c0 = 0.01;        % base convenience yield for CBDC
theta_s0 = 0.01;        % base convenience yield for stablecoin

% Nonlinear network effect functions (e.g., logistic or quadratic)
nonlinear_theta_c = @(nu_c) theta_c0 + 0.05 * nu_c.^2 ./ (1 + nu_c.^2);  %
    saturating
nonlinear_theta_s = @(nu_s) theta_s0 + 0.05 * nu_s.^2 ./ (1 + nu_s.^2);  %
    saturating

% Compute convenience-adjusted returns
theta_c = nonlinear_theta_c(Nu_c);
theta_s = nonlinear_theta_s(Nu_s);
ret_cbdc = r_star + theta_c;
ret_stable = r_star + theta_s;
ret_deposit = r_star; % fixed return for deposits

% Softmax allocation
exp_c = exp(ret_cbdc);
exp_s = exp(ret_stable);
exp_d = exp(ret_deposit);
total = exp_c + exp_s + exp_d;

share_cbdc = exp_c ./ total;
share_stable = exp_s ./ total;

% Plot CBDC share
% figure;
subplot(1,2,1)
surf(Nu_c, Nu_s, share_cbdc);
```

```
xlabel('\nu_c');
ylabel('\nu_S');
zlabel('CBDC Share');
title('CBDC Share with Nonlinear Network Effects');
shading interp;
set(gca,'Fontsize',12)

% Plot Stablecoin share
subplot(1,2,2)
surf(Nu_c, Nu_s, share_stable);
xlabel('\nu_c');
ylabel('\nu_S');
zlabel('Stablecoin Share');
title('Stablecoin Share with Nonlinear Network Effects');
shading interp;
set(gca,'Fontsize',12)
```

Listing 3: Nonlinear Network Effects on CBDC and Stablecoin Shares – Figure 4