Settlement-First Liquidity in a Full Balance-Sheet Economy: From Debt Structure and Timing to Eligibility-Targeted Policy

Abstract

A central insight from the Kalecki–Toporowski fable is that contracted debt service can be met out of *financial circulation* alone, provided sufficient liquidity is present or made present via selling claims, bank credit against claims, or central-bank purchases.[1] This note turns the chapter's two key arguments into (i) a deterministic, period-by-period minimum-liquidity requirement and (ii) a policy-sensitive transformation of that requirement given eligibility and targeting ("the fourth factor"). We state formulas, give a small worked example, and map each construct to the software modules and analytics used in your full balance-sheet simulator. We study the *minimum stock of money* required to settle outstanding debt commitments in an economy of mutually indebted agents (MIAs) with explicit balance sheets and dated cash-flow schedules. The *three factors* determining the period-t requirement are: (i) the size of dues, (ii) their cross-sectional distribution (net debtors vs. net creditors), and (iii) the timing/sequence of contracted payments. We then show how a *fourth factor*—the class of debt accepted by commercial banks as collateral or purchased by the central bank, and *from whom* liquidity is injected—mechanically lowers the period requirement by creating deposits at bottlenecks or by rescheduling dues. The framework is simulation-ready and integrates payment-system microstructure (RTGS/LSM) with full balance sheets for MIAs, banks, and the central bank.

1 Introduction

This paper puts *settlement* at center stage. In credit economies, the feasibility of debt service at a point in time depends not only on *how much* aggregate liquidity exists but *who has it* and *when it arrives* relative to due schedules. We formalize the period-t minimum-liquidity requirement $\bar{M}_t$ implied by (i) the size of dues, (ii) their distribution across MIAs, and (iii) the sequencing of interest and principal payments. We then derive a policy-adjusted counterpart $\bar{M}_t^{\text{policy}}$ that falls when banks/central banks make specific classes of claims liquid and target liquidity to payment bottlenecks.

Contribution. First, we provide a deterministic, settlement-first object $\bar{M}_t$ that mainstream monetary models typically abstract from in the cashless limit. Second, we show how *eligibility, haircuts, and counterparty choice*—the operational levers of banking and central banking—map into concrete reductions in $\bar{M}_t$ by either (i) deposit creation at net debtors due now or (ii) rescheduling dues when claims *on* those debtors are purchased. Third, we implement the framework in a full balance-sheet simulation that respects quadruple-entry accounting and payment-system timing.

[1] Concept and fable reconstructed and extended in *A Fable on Debt and Debt Management*. :contentReference[oaicite:0]index=0

Roadmap. Section 2 reviews related literatures. Section 3 states testable hypotheses. Section 4 details the methodology (agents, contracts, settlement engine, and policy menus). Section 5 (next) presents the analytical framework for $\bar{M}_t$ and $\bar{M}_t^{\text{policy}}$.

2 Literature review

2.1 Mainstream macro-finance

The New Keynesian "cashless limit" elegantly recovers policy transmission without transaction balances, but it suppresses dated settlement constraints and the distribution of dues [Woodford(2003)]. When finance is added via borrower net-worth constraints or intermediary balance sheets [Bernanke, Gertler and Gilc Gertler and Karadi(2011), Kiyotaki and Moore(1997)], models explain amplification and unconventional policy as spread management, yet still operate with aggregates that lack an explicit *period-t* settlement metric like $\bar{M}_t$.

2.2 Payment systems and intraday liquidity

The RTGS/LSM literature quantifies how sequencing, netting, and liquidity-saving mechanisms reduce settlement liquidity and resolve gridlock [Bech and Soramäki(2001), Martin and McAndrews(2008)]. It provides the micro-foundations for why timing matters (our factor iii), but typically treats banks as the only nodes and remains disconnected from macro debt structure and central-bank asset eligibility.

2.3 Heterodox, SFC, and operations

Stock–flow consistent (SFC) macro ensures full balance-sheet closure and financial reflux [Godley and Lavoie(2007)]. Post-Keynesian/Minskyan views and the Money View emphasize collateralized credit, liquidity hierarchies, and central banks as lenders/dealers of last resort [Mehrling(2011), Bindseil(2014)]. What is missing is a synthesis in which *eligibility/haircuts and counterparty targeting* translate into a *deterministic* reduction of the *dated* settlement requirement $\bar{M}_t$ for a given inherited debt structure.

2.4 Positioning

We supply that synthesis: (i) define $\bar{M}_t$ from size, distribution, and timing; (ii) derive $\bar{M}_t^{\text{policy}}$ from eligibility/targeting choices; and (iii) embed both in a full balance-sheet, settlement-first simulator.

3 Research hypotheses

H1 (Sequencing dominates levels). Holding debt stocks fixed, the time pattern of obligations explains a large share of variation in $\bar{M}_t$. LSM-style netting reduces $\bar{M}_t$ relative to plain RTGS.
H2 (Targeting beats totals). For a given liquidity injection ΔM, purchases/loans that create deposits at *imminent net debtors* (or reschedule claims *on* them) reduce $\bar{M}_t$ and missed payments more than untargeted purchases from distant net creditors.
H3 (Eligibility matters). Expanding collateral eligibility (with risk-appropriate haircuts) unlocks more settlement liquidity per unit ΔM by enabling bank credit exactly where constraints bind.
H4 (Concentration raises needs). Greater creditor concentration raises $\bar{M}_t$; targeted operations toward concentrated nodes are disproportionately effective.

H5 (Micro–macro substitutability). An LSM that reorders and offsets queued payments is a partial substitute for central-bank injections: $\bar{M}_t^{\mathrm{LSM}} \le \bar{M}_t^{\mathrm{RTGS}}$.
H6 (Cashless-limit divergence). With binding funding/collateral constraints, composition of purchases (sovereign vs. MBS/corporate/ABS vs. bank loans) produces materially different $\bar{M}_t^{\mathrm{policy}}$ paths and incidence, challenging cashless-limit equivalences.

4 Methodology

4.1 Agents and full balance sheets

Agents include: households (by income/wealth), firms (by sector/leverage), commercial banks (by size/funding mix), a consolidated general government, and the central bank. Each carries an explicit balance sheet (assets: deposits, reserves, loans, bonds, ABS/MBS; liabilities: deposits, loans, bonds; equity) with quadruple-entry posting.

4.2 Contracts and cash-flow schedules

We build a liability matrix $L_{ij}(\tau)$ with promised cash flows (coupon/principal) at dates τ, plus bank credit lines and repo terms (haircuts/margins). Securitization turns pools of L_{ij} into marketable claims (MBS/ABS) with tranche-specific timing.

4.3 Settlement engine and the minimal-liquidity problem

Payments settle on RTGS with an optional Liquidity-Saving Mechanism (LSM). At each t, we compute the minimum external liquidity needed to settle all dues given current balances and queued obligations. In implementation, this is a small linear program on a time-expanded flow network; the optimum is $\bar{M}_t$ under the chosen microstructure. Adding bank intraday credit (collateralized) and CB purchases/loans yields the policy-adjusted $\bar{M}_t^{\mathrm{policy}}$.

4.4 Bank credit, collateral, and policy menus

Banks extend loans/repo against eligible collateral with haircuts h_a by asset class a. The central bank provides (i) collateralized lending to banks and (ii) outright purchases with configurable eligibility sets and policy weights across asset classes. Operations create deposits/reserves and may *defer* dues when the CB buys claims *on* imminent debtors.

4.5 Experiments and measurement

We run panels over (i) distributional structure (creditor concentration, topology), (ii) timing (amortization/coupon frequency, maturity walls), (iii) microstructure (RTGS vs. LSM; with/without bank intraday credit), and (iv) policy (size/composition ΔM, eligibility/haircuts, targeting rules). Outcomes: $\bar{M}_t$, $\bar{M}_t^{\mathrm{policy}}$, missed-payment share, velocity of settlement balances, interest-flow incidence, and bank liquidity/leverage metrics.

5 Analytical framework (insert next)

6 Setup and Notation

Let agents be indexed by $i, j = 1, \ldots, N$ and discrete time by $t = 0, 1, 2, \ldots$.

- A *due payment* (interest or principal) in period t from i to j is $D_{i\to j,t} \geq 0$.
- Period outflows and inflows:

$$F_{i,t} \equiv \sum_j D_{i\to j,t}, \qquad I_{i,t} \equiv \sum_j D_{j\to i,t}.$$

- Net position for period t: $n_{i,t} \equiv I_{i,t} - F_{i,t}$ (net creditor if $n_{i,t} > 0$, net debtor if $n_{i,t} < 0$).
- Start-of-period money (means of payment) of agent i: $m_{i,t}$; system money $M_t \equiv \sum_i m_{i,t}$.
- Each contract belongs to a class $k \in \mathcal{K}$ (issuer/quality/type). Commercial-bank haircuts $h_k \in [0, 1)$; CB-purchase eligibility $\mathcal{K}_{CB} \subseteq \mathcal{K}$.

The *sequence of dues* in each period is generated from term/maturity and coupon schedules (weekly/quarterly/annual).[2]

7 Minimum Liquidity from the Three Factors

[Raw minimum liquidity] Given the set $\{D_{i\to j,t}\}$ due in period t, the minimum system money required to settle *all* period-t dues without new bank/CB intervention is

$$\boxed{\bar{M}_t \;=\; \sum_i \max\{0,\, F_{i,t} - I_{i,t}\} \;=\; \sum_{i:n_{i,t}<0} (-n_{i,t})}$$

and the contemporaneous liquidity gap is $G_t \equiv \max\{0,\, \bar{M}_t - M_t\}$.
Intuition. Aggregate transfers must flow from period-t net debtors to period-t net creditors. Circulation allows reuse of the same unit of money, but it cannot create the net transfer. Hence at least the sum of debtor shortfalls must be present somewhere in the system. This formalizes the chapter's three factors: *size* (dues), *distribution* (net debtor/creditor split), and *timing* (the current-period due set).[3]

8 The Fourth Factor: Eligibility, Targeting, and Sequence

Policy channels modify $\bar{M}_t$ before settlement by either *creating deposits at the right agents* or *rescheduling the dues that bind.* Let $L_{i,k,t} \leq (1 - h_k)Q_{i,k,t}$ be deposits created at debtor i via bank loans against eligible collateral of class k (with encumbrance $Q_{i,k,t}$), and let $P^{\text{in}}_{i,t}$ be deposits received by i from asset sales or targeted CB purchases. Let $P^{\text{def}}_{i,t} \geq 0$ denote dues *deferred in* t because the CB *buys the claim on* i and rolls the schedule.

Define effective inflows/outflows after pre-settlement operations:

$$\tilde{I}_{i,t} = I_{i,t} + L_{i,\cdot,t} + P^{\text{in}}_{i,t}, \qquad \tilde{F}_{i,t} = F_{i,t} - P^{\text{def}}_{i,t}.$$

[Policy-adjusted minimum] After eligibility- and targeting-constrained operations in t (the "fourth factor"), the period minimum is

$$\boxed{\bar{M}^{\text{policy}}_t \;=\; \sum_i \max\{0,\, \tilde{F}_{i,t} - \tilde{I}_{i,t}\}\,, \qquad G^{\text{policy}}_t = \max\{0,\, \bar{M}^{\text{policy}}_t - M_t\}}$$

[2]"Strictly speaking" the minimum liquidity depends on the sum of debts; their *distribution* across agents; and the *sequence over time* of contracted payments. :contentReference[oaicite:4]index=4

[3]Three-factor dependence and the role of timing are emphasized in the chapter's debt-payment processes. :contentReference[oaicite:5]index=5

where $L_{i,\cdot,t}$ is limited by haircuts h_k and available eligible $Q_{i,k,t}$, and $P^{\text{in}}_{i,t}$, $P^{\text{def}}_{i,t}$ are induced by market/CB purchases restricted to $\mathcal{K}$ and $\mathcal{K}_{CB}$ as configured.

Targeting rule-of-thumb. If one unit of reserves must be spent, the highest payoff (for lowering $\bar{M}_t$ *now*) is to (i) buy from holders of claims *on net debtors due in t* (rescheduling reduces $\tilde{F}$), or (ii) lend to those debtors against eligible collateral (raising $\tilde{I}$ at the bottleneck). Buying broadly from distant net creditors helps only after deposits percolate through the network.[4]

9 Period Algorithm (Simulation-Ready)

1. **Assemble dues.** Build $\{D_{i\to j,t}\}$ from maturities and coupon schedules.
2. **Compute raw requirement.** Use Prop. 7 to get $\bar{M}_t$ and gap G_t.
3. **Rank bottlenecks.** Order agents by $F_{i,t} - I_{i,t}$ desc.
4. **Liquidity-relief stage (fourth factor).** For each binding debtor i:
   - 4.a. *Bank credit:* choose $L_{i,k,t} \leq (1-h_k)Q_{i,k,t}$ across eligible classes.
   - 4.b. *CB purchase:* buy claims *on i due in t* (defer $P^{\text{def}}_{i,t}$) or buy *from i* if i holds saleable assets (raise $P^{\text{in}}_{i,t}$).
   - 4.c. *Market sales:* if yields trigger investor demand, record $P^{\text{in}}_{i,t}$.
5. **Recompute** $\bar{M}^{\text{policy}}_t$ and G^{policy}_t via Prop. 8.
6. **Settle.** Execute payments in an order that minimizes peak cash draw (pay into debtor-chains first).
7. **Update state.** Roll schedules (for deferred claims), mark encumbrance, update bank/CB portfolios.

This sequence captures the chapter's *financial circulation* logic—first recycling money, then making claims liquid via sales, bank credit, and CB backstops.[5]

10 Worked Micro-Example

[Three MIAs, one period] Dues: $A\to B : 70,\ B\to C : 50,\ C\to A : 30.$ Then

$$n_A = -40, \quad n_B = +20, \quad n_C = +20 \ \Rightarrow\ \bar{M}_t = 40.$$

If $M_t = 10$, gap $G_t = 30$. Suppose A can pledge $Q_{A,k,t} = 40$ with $h_k = 0.25$. Then $L_{A,k,t} \leq 30$. Take $L = 30 \Rightarrow n^{\text{eff}}_A = -10$, so $\bar{M}^{\text{policy}}_t = 10$ and $G^{\text{policy}}_t = 0$. Alternatively, a CB purchase of the claim *on* A due in t (from current holders) can defer up to 70 of A's outflow, collapsing $\bar{M}^{\text{policy}}_t$ toward zero while transforming portfolios for $t+1$.

[4] The chapter highlights how the *class of debt*, *from whom* it is purchased (or accepted as collateral), and the *sequence by which* added liquidity meets due obligations determine immediate relief; and it stresses that $\bar{M} - M$ is *determinate* given the inherited debt structure at any time. :contentReference[oaicite:6]index=6

[5] Roles of bank lending, securitisation/marketization of claims, and central-bank purchases; and the notion of "credit deadlock" and QE as cure. :contentReference[oaicite:7]index=7

11 Implementation Hooks (Direct Mapping to Your Stack)

Data & state

- Contracts: $(i, j, \text{notional}, \text{rate}, \text{maturity}, \text{amort.}, k) \to$ due builder for $\{D_{i\to j,t}\}$.
- Eligibility maps: bank haircuts h_k and borrower encumbrance $Q_{i,k,t}$; CB eligibility $\mathcal{K}_{CB}$ and a targeting policy.

Analytics modules (V2)

- **Liquidity Mismatch** $\to$ report $F_{i,t} - I_{i,t}$, $\bar{M}_t$, G_t, and policy-adjusted $\bar{M}_t^{\text{policy}}$, G_t^{policy} per time step. *(Tasks V2)*[6]
- **Debt Structure & Defaults** $\to$ maturity ladders that generate $\{D_{i\to j,t}\}$; record deferrals and default cascades. *(Tasks V2)*[7]
- **Funding Chains** $\to$ trace where policy liquidity lands (who sells to whom; who receives deposits). *(Tasks V2)*[8]
- **Money Flux/Reflux** $\to$ log deposit creation ($L_{i,k,t}$) and reflux on settlement. *(Tasks V2)*[9]

Posting logic (code)

- Use your existing quadruple-entry settlement: debit debtor deposits, credit creditor deposits; update corresponding bank liabilities; on deferral, extinguish due asset/liability pair and replace with rolled claim. *(Code V1)*[10]
- Add a `liquidity_relief()` pre-settlement hook that executes steps 4(a)–(c) above and writes: (i) loan creation entries (bank asset, borrower deposit), (ii) CB/market purchase entries (seller deposit, portfolio changes), (iii) deferral rewrites for purchased dues.

12 Risk Metrics (Optional, Plug-and-Play)

For each agent, compute MLR/FLR and embed into triggers for step 4(b)–(c):

$$\text{MLR}_n = p_n^{\text{mlr}} \left(\frac{\text{LMV}_n - P_n^{\text{f.mkt}}}{\text{LMV}_n} \right), \qquad \text{FLR}_{t,n} = \Pr(r_f > r_e)\,(r_f - r_e),$$

and use a *default probability* proxy $\Pr(F_o < F_r)$ with loss scaling by liquidity-adjusted assets and liability structure.[11] These produce policy heuristics like “tighten eligibility or expand purchases when aggregate $G_t^{\text{policy}} > 0$ *and* median FLR is rising.”

[6]Module: “Liquidity Mismatch with Forward-Looking Projections”. :contentReference[oaicite:8]index=8

[7]Module: “Debt Structure, Defaults, and Money-Creating Issuance”. :contentReference[oaicite:9]index=9

[8]Module: “Funding Chains and Roles”. :contentReference[oaicite:10]index=10

[9]Module: “Money Supply and Flux/Reflux”. :contentReference[oaicite:11]index=11

[10]See deposit-transfer settlement and delivery-claim settlement paths in the current code base. :contentReference[oaicite:12]index=12

[11]Liquidity/credit risk decomposition to integrate with simulation diagnostics. :contentReference[oaicite:13]index=13

13 Remarks on Determinacy and Path Dependence

Given inherited portfolios and due schedules, $\bar{M}_t - M_t$ is determinate at each t; the process of *making claims liquid* (sales, bank credit, CB purchases) then modifies the structure for future periods—exactly the dynamic the chapter stresses.[12] Your simulation captures that evolution via explicit balance-sheet rewrites and the settlement constraint.[13]

Note: Replace this comment with your formal derivations, propositions, and the micro-example.

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[12] On determinacy of $\bar{M} - M$ and structural evolution under liquidity-making operations. :contentReference[oaicite:14]index=14

[13] Full balance-sheet simulation and settlement-first design. :contentReference[oaicite:15]index=15