Strategic Money and Credit Ledgers

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Introduction

- Historically, credit and payment systems were not only bank-centric.
  (E.g. grain trade in early modern England used uncollateralized "bills-of-exchange".)

- But the system that has emerged is based on collateralized bank lending
  $\Rightarrow$ problems with financial exclusion
  - Credit requires a well functioning legal system to seize and value collateral.
  - Sales revenue for small firms is not collateralizable.

- Digital ledgers & BigTech reopened interest in uncollateralized non-bank finance.
  (E.g. Alibaba's My Bank in China; Payment FinTechs in India.)

Q. Can non-banks expand uncollateralized credit?

This Talk

- **FinTech vision:** put payments & loans on digital record keeping system (*"ledger"*)
  - Producers pay for inputs with uncollateralized IOUs on the ledger.
  - When producers sell outputs, the ledger automatically allocates revenue to repay IOUs.

- **Practical difficulty:** need to *incentivize ledger use* (and disincentivize cash use).
  - Otherwise, agents can sell goods on the side for "cash" and avoid ledger monitoring.

- **BigTech platform:** can *force ledger use* and set up an IOU system. Why?
  - Platform can block cash payments on its marketplace, making cash less "liquid".
  - $\Rightarrow$ agents stop storing cash and side trades become impossible ("tokenizes" economy).
  - Platform more likely to set up an IOU system in high inflation environments.
  - Other arrangements (e.g. banks, crypto, supply chains) cannot work as successfully.

- **Policy makers:** should worry about *platform rents* and GE effects of public ledgers.

Literature Review

- Ledgers, contracting, and settlement assets.
  Aiyagari & Wallace (1991), Freeman (1996a, 1996b), Kocherlakota (1998).
  - This paper: large, private, profit-maximizing institution controls ledger.

- BigTech uncollateralized finance
  Garber et al. (2021), Liu et al. (2024), Rishabh and Schäublin (2021), Bigio (2024), Kahn & van Oordt (2022).
  - This paper: macrofinance model of a platform finance ecosystem.

- Digital currencies and currency competition
  Chiu & Wong (2020), Chiu & Koeppel (2025), Fernadez-Villaverde (2018), Cong, Li & Wang (2019); Rogoff & You (2019); Chiu et al. (2019); Keister & Sanches (2020); Schilling & Uhlig (2019), Kahn et al. (2019), Gosh, Vallee & Zeng (2024)
  - This paper: centralized, private digital currencies provided by trading platforms.

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Environment

- 2 agent types: savers, producers
- 2 good types: storable endowments ("commodity money"), perishable output

- Savers born with endowment goods
- Each producer can use 1 endowment good to start a project (but *has no* endowment).
- Producer's project $z \in (1, 2)$ output goods
- Agents get linear utility form consuming *others'* endowment or output goods.

Producers must issue uncollateralized IOUs to buy endowment goods.

Agents need to trade to consume goods.

Information and Enforcement Frictions

First best: Planner reallocates:

- Endowments from savers to producers so that they can start projects.
- Output goods across agents so that they can consume.

Frictions:

- *F1.* Agents have public identities but their actions are private.
- *F2.* Agents cannot commit.
- *F3.* No public legal system for contract enforcement.
- $\Rightarrow$ Producers cannot issue IOUs *privately* to savers because they will not be repaid.

Q: Can we introduce a privately controlled recording keeping system (i.e. "ledger") to get IOUs issuance and first best production?

Different Market Economies

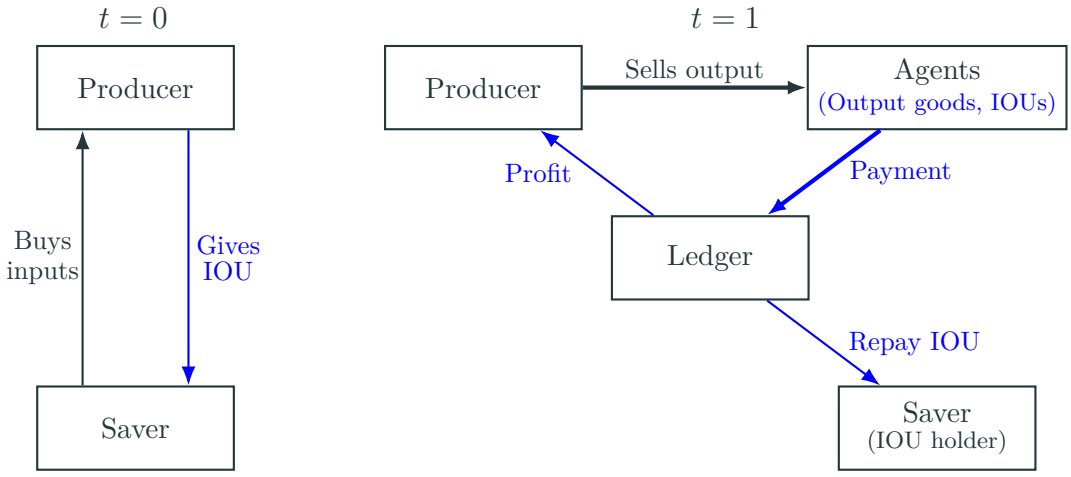
- *A ledger is simply a digital record keeping system with ([Kocherlakota, 1998]):*
  - *Token or asset balances: wealth held by different agents using ledger.*
  - *Contracts: instructions for executing transactions conditional on information.*
  - *Information: that has been provided to the ledger.*
- Economy 1: with a **independent** privately operated **ledger**.
- Economy 2: with a **tech platform** controlling the **ledger**.
- Economy 3: with a **public ledger** ("CBDC" or "broad FedNow").

1. Independent Ledger Economy: Trading and Record Keeping

- At $t = 0$:
  - Producers can issue IOUs recorded on the ledger.
    (An IOU promises $R \geq 1$ goods at $t = 1$ for each endowment good given at $t = 0$.)
  - Savers choose whether to lend by purchasing IOUs or store endowment goods.

- At $t = 1$: competitive market for trading endowment goods, output goods, IOUs.
  - Ledger settlement at end of $t = 1$ (centralized): can be made with **any** good or IOU
  - Spot settlement instantaneously (decentralized) if at least one agent has endowment goods - i.e. endowment goods are "universally liquid" (usable for all settlements).
  - Ledger trades automatically settle IOUs; Spot trades allow agents to default.
  - Terms-of-Trade – 1 endowment good : p output goods and 1 IOU : q output goods
    (endowment goods trade at high price (high p) because spot trades allow default)

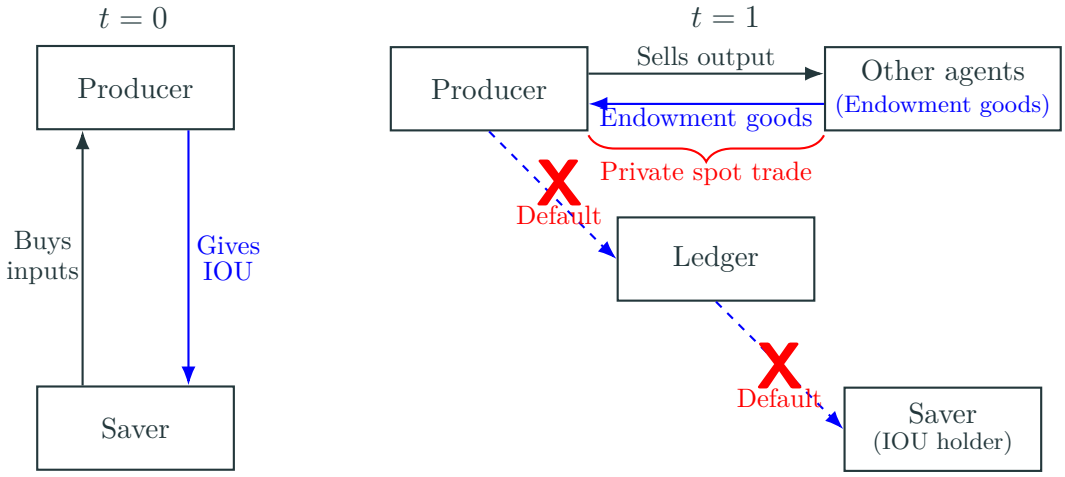
1. FinTech Vision: Payments and Contracting Through a Ledger



Idea: moving all payments & contracts into one "ecosystem" ensures IOU repayment.

What can go wrong with the FinTech vision?

1. Endowment Good ("Commodity Money") Payments Lead to Default



Problem: Presence of a universally liquid "commodity money" prevents contracting.

1. Independent Ledger Economy: Equilibrium

Result: *In equilibrium, no agents accept IOUs and no production takes place.* Why?

- If other agents are producing, then it is optimal for a saver to:
  - Store endowment goods at $t = 0$ instead of saving using IOUs,
  - Use endowment goods at $t = 1$ to purchase output goods from producers in spot trades,
  - Because the spot trades allow producers to default, the saver obtains a more favorable terms-of-trade than if they saved with IOUs.

1. Case Study: FinTech in India

- [Rishabh and Schäublin, 2021] studies FinTechs and debt repayment in India.
- Finds that non-performing borrowers:
  - Drop their non-cash sales, right after loan disbursal, by 18%.
  - Divert about 11% of their transactions right after disbursal
- Argues that: *"By persuading their customers to not pay . . . using the lender's POS but with alternative means of payments (e.g. cash), a merchant can circumvent the automatic repayment to the payment company."*

Can a BigTech platform *"rescue"* the FinTech vision?

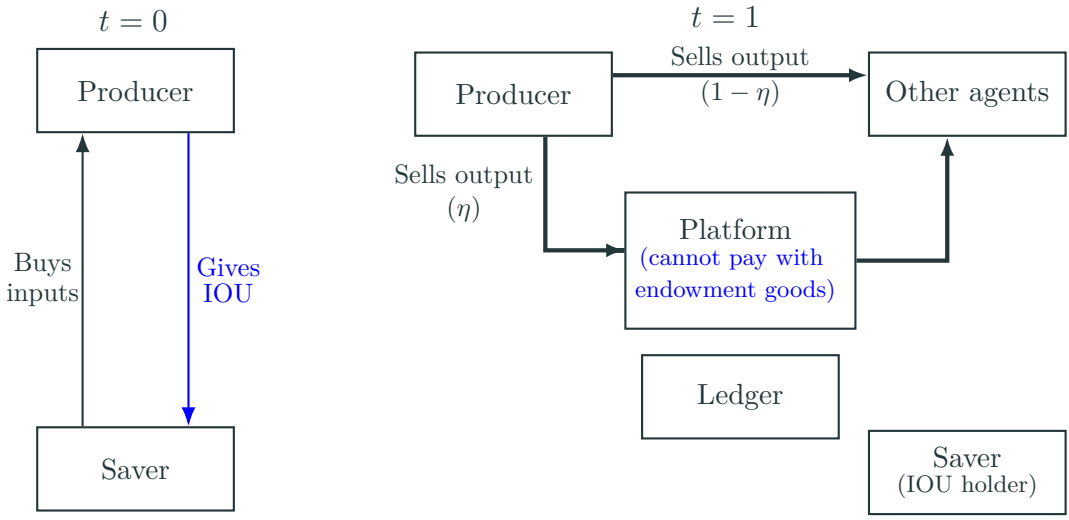
2. Platform-Ledger Economy: Platform Controlling Trading & Ledger

- At $t = 1$: there are now two trading technologies for connecting goods traders:
  - **P**rivate platform (p) that is controlled by profit maximizing operator
  - **O**ff the platform (o) - open public marketplace.
  - Agents find platform trades with probability η (and marketplace trades with $1 - \eta$).
    (Endogenized in the monetary dynamic model.)

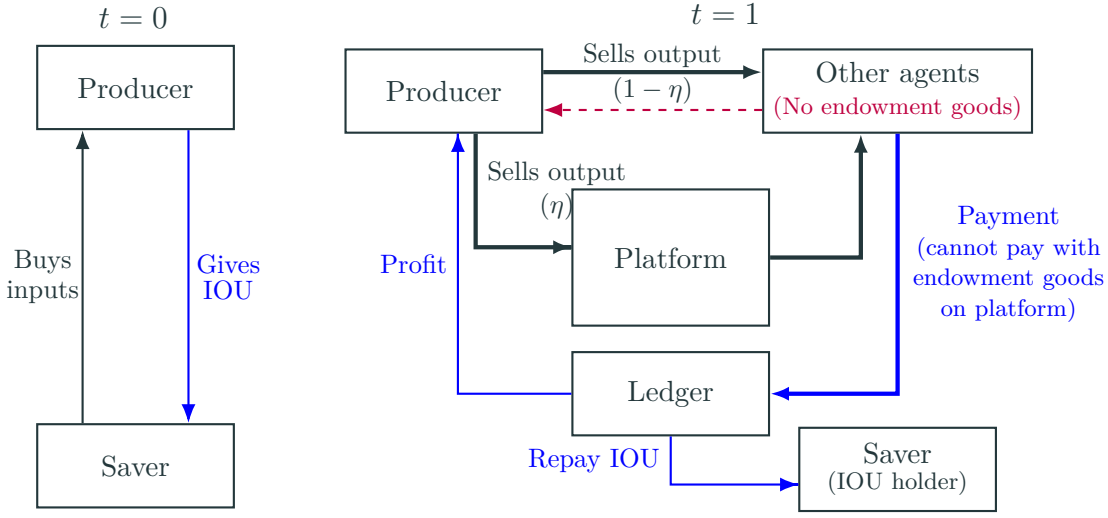
- Platform provides the trading technology *and* the settlement ledger:
  - Prevents agents from making payments using endowment goods
    $\Rightarrow$ stored endowment good is not "universally liquid" anymore (segmentation)
  - Charges markup μ (or subsidy for $\mu < 0$) when agents trade on the platform.

Savers now face tradeoff: endowment goods still command a high price (because they help producers default) but they are no longer as liquid as IOUs.

2. Platform Disincentivizes Endowment Good Storage



2. Platform Disincentivizes Endowment Good Storage



Savers do not store endowement goods if their lower liquidity outweighs higher value.

2. Intuition: Platform Ledger Crowds Out Spot Trades

- Imagine you are producer looking to sell goods privately for "money" and default.
- You can only do this if there is a counterparty who has stored a "suitcase of money".
- I.e., your ability to default depends on ***other agents'*** choice of payment technology.
- Even though the platform only controls *some* trades,
  ... it can disincentive *all* agents from holding "cash" by blocking its use on platform,
  ... which effectively shuts down the possibility of default side trades,
  ... so the only option in all trades is to use the monitored ledger system.

2. Platform-Ledger Economy: Equilibrium

(i) *For sufficiently large η, the platform constructs the ledger and sets the maximum markup $\bar{\mu}$ that is incentive compatible with full production and no default:*

$$\underbrace{\eta(1-\mu)q + (1-\eta)q}_{\text{Purchase IOU}} \quad \geq \quad \underbrace{(1-\eta)p}_{\text{Store endowment}} \quad , \quad \Rightarrow \quad \mu \leq 1 - \left(\frac{4}{z} - 1\right)\frac{1-\eta}{\eta} =: \bar{\mu}$$

- Platform can disincentivize endowment good storage while still extracting rents.

(ii) For sufficiently low η, the platform does not set up a ledger to enforce contracts.

- Platform must subsidize platform trades to disincentivize endowment good storage.

Only a dominant trading platform will set up the ledger and expand contracting.

2. Case Study: Chinese BigTech

- E.g. China's My Bank of Alibaba ecosystem [Liu et al., 2022]
- 98% uncollateralized, small loans
- Easy to apply, short-term liquidity needs (repaid before maturity)
- Financial inclusion: young/first-time borrowers with short credit history, rural areas

What about a public ledger option?

3. Public Ledger Extension (e.g. "CBDC" or "broad FedNow")

- Now, the government offers a public ledger technology to settle trades. Options:
  (i) Private "payment" CBDC: only provides payment settlement & respects agent privacy,
  (ii) "Smart" CBDC: . . . also records and settles contracts.

- **Corollary 1:** If the government provides a privacy-respecting "payment" ledger and forces the platform to accept payments through the public ledger (i.e. makes it universal), then there is no equilibrium with full contract enforcement.

- **Corollary 2:** If the government provides a "smart" ledger and eliminates endowment good payments (i.e. blocks commodity money), then all contracts are enforced and first best production is achieved.

Trade-off: efficient private payment system vs efficient contracting system.

Remarks: Other Potential Ledger Providers

- **Q.** Can a **bank** or **credit bureau** provide a ledger with uncollateralized loans?
  - Not in our environment: no repeated borrowing & hence no exclusion from future credit
  - More generally, we consider loans for which exclusion from future is insufficient to ensure enforcement and so collateral would be needed.

- **Q.** Can setting be generalized to a **random** z (aggregate) productivity setting?
  - Yes, ex-ante onboarding to system is key. Allows risk sharing with ledger-platform.

- **Q.** Can an **industrial supply chain** (e.g. automotive industry) provide a ledger?
  - Platform trading for all goods, so excludes agents from broad consumption basket.
  - Industrial supply concerns only a subset of goods (e.g. everything related to cars) .

    $\Rightarrow$ IOUs are not denominated in overall consumption basket.

    $\Rightarrow$ "Exchange rate risk" when IOUs repay (e.g. in cars) .

Lessons

1. Ledgers are only useful if they are “backed”.
   (Then the ledger system works like in [Kocherlakota, 1998].)

2. Crowding out commodity money eliminates “side-trading”.
   (Addresses problems in [Jacklin, 1987], [Farhi et al., 2009].)

3. Choice of payment technology determines whether future sales revenue can pledged.
   (Addresses [Holmström and Tirole, 1998], [Kiyotaki and Moore, 1997])

4. Natural monopoly: only large platform w/ ledger, incentivizes IOU repayment.

5. Public ledger tradeoff between payment and contracting efficiency.

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Q. What are the macro implications of using platform-backed IOUs as “currency”?

Environment Changes

- Introduce settlement using **currency** (govt cash in spot trades, IOUs on ledger).
  Why? Introduce secondary market for IOUs and endogenous terms-of-trade.
- Move to an infinite horizon **OLG** model.
  Why? So currency is valued and we can discuss dynamic feedback.
- Allow agents to choose where to trade (**endogenous** η).
  Why? Endogenize platform ability to "back" ledger through trading advantage.
- Introduce saving into **financial intermediaries** ("funds").
  Why? To get aggregation and explore exclusion from financial markets.
- Introduce **flexible project size**.
  Why? Mark-ups distort production level

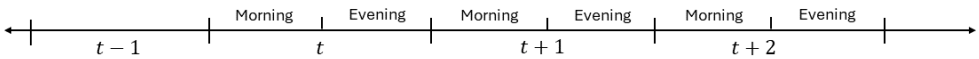
Environment Changes: Demographics

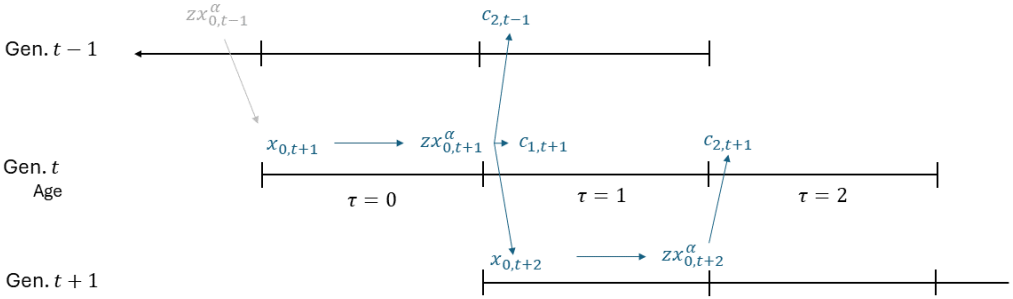
- Discrete time, infinite horizon, OLG model with one consumption good.
- Agents start as **producers** then become **log-utility consumers**:
  - Age 0: born without resources but with technology: x_t goods $\mapsto y_{t+1} = z x_t^{\alpha}$ goods .
  - Age 1: produce and sell their goods, consume, repay, or default on IOUs, and save.
  - Age 2: consume and exit.
- Each age, agents choose trading technology $n \in \{p \text{ (platform)}, o \text{ (open market)}\}$
  - Discrete choice: Get i.i.d. extreme value "search" amenity from trading on n:

$$\zeta_\tau^{ni} \sim \underbrace{Gu(1/\gamma_\tau, \cdot)}_{\text{Agent specific}} + \underbrace{\log(\zeta^n)}_{\text{Technology specific}} \quad , \quad i \in [0,1]$$

  - So γ_τ is the elasticity of substitution at age τ and ζ^n is technology trading advantage.

OLG: Production and Goods Flow

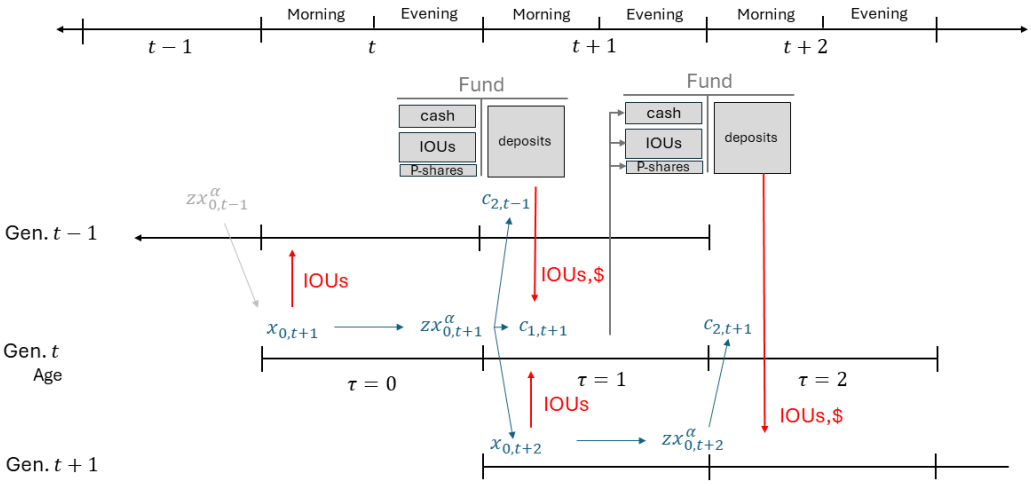




Environment Changes: Currencies

- The two payment technologies now **settle using financial assets**:
  - **S**pot transactions have a **resource-in-advance constraint**:
    - Payment must be made using public money.
  - **L**edger has **no** resource-in-advance **constraint**:
    - Agents pay on ledger using claims to non-risky future income on the ledger.
    - ("Ledger-IOUs", "credit-goods", digital "bills-of-exchange", "tokenized" income)
- Prices: ϵ_t is real exchange rate b/n IOUs and money ("platform-goods" numeraire)
- Returns: R_t^b is the return on IOUs, R_t^m is the return on money.
- Continuum of competitive mutual funds that pool resources across agents:
  - Issue deposits @R_t^d, make loans @R_t^l, hold money reserves, and hold platform equity.
  - Only **funds excluding defaulting agents** have **access to the ledger**.

OLG: Adding Intermediaries/Funds



Agent Problem (Under No-Default)

- Each generation t chooses input purchases x_0, consumption and deposits (c_1, c_2, d_1), and where to trade each age $\underline{\mathbf{n}} = (n_0, n_1, n_2)$ to solve (suppressing the t subscript):

$$\mathbb{E}_t\Big[\max_{x_0,c_1,c_2,d_1,\underline{\mathbf{n}}} \{\zeta_0^{n_0} + \zeta_1^{n_1} + (1-\beta)u(c_1) + \beta(\zeta_2^{n_2} + u(c_2))\}\Big]$$

$$s.t. \quad d_1 \leq \epsilon_{t+1}^{n_1}\left(z(x_0)^\alpha - (1+\mu^{n_1})c_1\right) - R_{t,t+1}^{ln_0}(1+\mu^{n_0})x_0$$

$$(1+\mu^{n_2})\epsilon_{t+2}^{n_2}c_2 \leq R_{t+1,t+2}^{dn_2}d_1$$

where

- ζ_τ^n is the extreme value shock at age τ on trading technology n,
- μ_t^n is the buyer markup when using trading technology n,
- ϵ_t^n is real exchange rate on trading technology n ($\epsilon_t^p = 1$; $\epsilon_t^o = \epsilon_t$ =price off platform)
- $R_{t,t+1}^{ln}$ is gross loan rate and $R_{t+1,t+2}^{dn}$ deposit rates offered by the fund when the depositor asks for the medium of exchange on trading technology n.

Agent Choice and Equilibrium (Under No-Default)

- Consumption-saving choice is standard given log-utility.
- The fraction of agents choosing trading technologies n_0, n_1, and n_2 are:

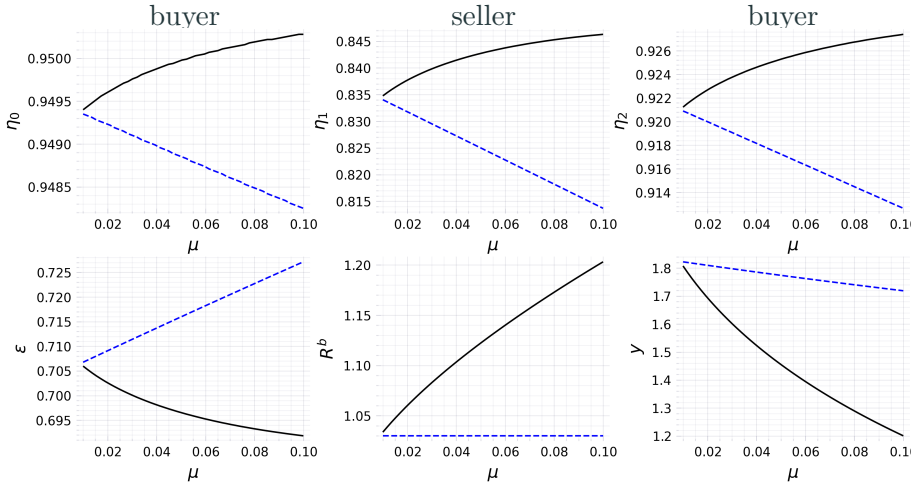
$$\eta_{0,t}^{n_0} = \frac{\left(\zeta_0^{n_0}((1+\mu_t^{n_0})R_{t,t+1}^{ln_0})^{-\frac{\alpha}{1-\alpha}}\right)^{\gamma_0}}{\sum_{n_0'}\left(\zeta_0^{n_0'}((1+\mu_t^{n_0'})R_{t,t+1}^{ln_0'})^{-\frac{\alpha}{1-\alpha}}\right)^{\gamma_0}}, \quad \eta_{2,t+2}^{n_2} = \frac{\left(\zeta_2^{n_2}R_{t+1,t+2}^{dn_2}/((1+\mu_{t+2}^{n_2})\epsilon_{t+2}^{n_2})\right)^{\gamma_2}}{\sum_{n_2'}\left(\zeta_2^{n_2'}R_{t+1,t+2}^{dn_2'}/((1+\mu_{t+2}^{n_2'})\epsilon_{t+2}^{n_2'})\right)^{\gamma_2}}$$

$$\eta_{1,t+1}^{n_1} = \frac{\left(\zeta_1^{n_1}\left(\epsilon_{t+1}^{n_1}\right)^{\frac{1}{1-\alpha}+\beta-1}(1+\mu_{t+1}^{n_1})^{\beta-1}\right)^{\gamma_1}}{\sum_{n_0'n_1'}\left(\zeta_1^{n_1'}\left(\epsilon_{t+1}^{n_1'}\right)^{\frac{1}{1-\alpha}+\beta-1}(1+\mu_{t+1}^{n_1'})^{\beta-1}\right)^{\gamma_1}}$$

- Competitive equilibrium prices $(\epsilon, R^b, R^m, R^d, R^l, q^s)$ s.t. agents optimize and markets clear:

$$\epsilon_t = \left[\frac{\zeta_1^{\gamma_1}}{\zeta_2^{\gamma_2}}\frac{(1+\mu_t)^{\gamma_1(1-\beta)}}{(R_{t,t+1}^b/R_{t,t+1}^m)^{1+\gamma_2}}\left(1-\frac{(1-\beta)(1-\alpha)}{1+\mu_t}\right)^{\frac{\alpha}{1-\alpha}}\right]^{\frac{1}{\frac{\gamma_1+\alpha}{1-\alpha}+1+\gamma_2-\gamma_1(1-\beta)}},$$

Equilibrium for Different Markup Policies (No Default)



Black is general equilibrium. Blue is partial equilibrium with fixed interest rate.

Other variables are $z = 1$, $\alpha = 0.45$, $\beta = 0.95$, $\gamma_1 = 1.9$, $\gamma_2 = 1.5$, $\zeta = 1.0$.

GE Insight: GE Interest Rate Movements "Lock-in" Agents

- $\uparrow$ markups encourage agents to trade off the platform
- $\Rightarrow$ credit becomes scarce
- $\Rightarrow$ interest rate $R^b\uparrow$
  - demand for cash, $\Rightarrow$ loan supply $\downarrow$
  - opportunity cost of holding cash
    partially offsets the markup disincentive to trade on platform
- $\Rightarrow$ exchange rate (price off platform) $\varepsilon \downarrow \Rightarrow$ want to sell on platform $\eta_1 \uparrow$

Incentive Constraint

- Agents who default are excluded from the funds (and so the platform)
- No agents default if following incentive compatibility constraint is satisfied $\forall t \geq 0$:

$$\begin{aligned}&[\text{Agent's profit at age 1, if default}] \times \mathbb{E}[V'(\text{wealth}) \text{ at age 2, if excluded from platform}] \\ &\leq [\text{Agent's profit at age 1, if repay }] \times \mathbb{E}[V'(\text{wealth}) \text{ at age 2, with access to platform}]\end{aligned}$$

- There is **double exclusion** in full model:
  - from future on-platform trading
  - from saving in accepting ledger-IOUs
- In equilibrium, an increase in markup μ
  - decreases the threat of exclusion from future on-platform trading but
  - increases the threat of exclusion in IOU-savings because interest rate increases

Platform Problem

Taking the household SDF as given, the platform chooses a sequence of markups $\boldsymbol{\mu}$ to maximize their equity price by solving:

$$q_0^s = \max_{\boldsymbol{\mu}} \left\{ \sum_{t=0}^{\infty} \xi_{0,t} \pi_t^s \right\} \quad s.t.$$

Agent choices (including IC),

Equilibrium prices,

where $\xi_{0,t} = \prod_{j=0}^{t} (R_{j,j+1}^b)^{-1}$ is the household SDF.

Loose Monetary Policy Increases The Profitability of The IOU System

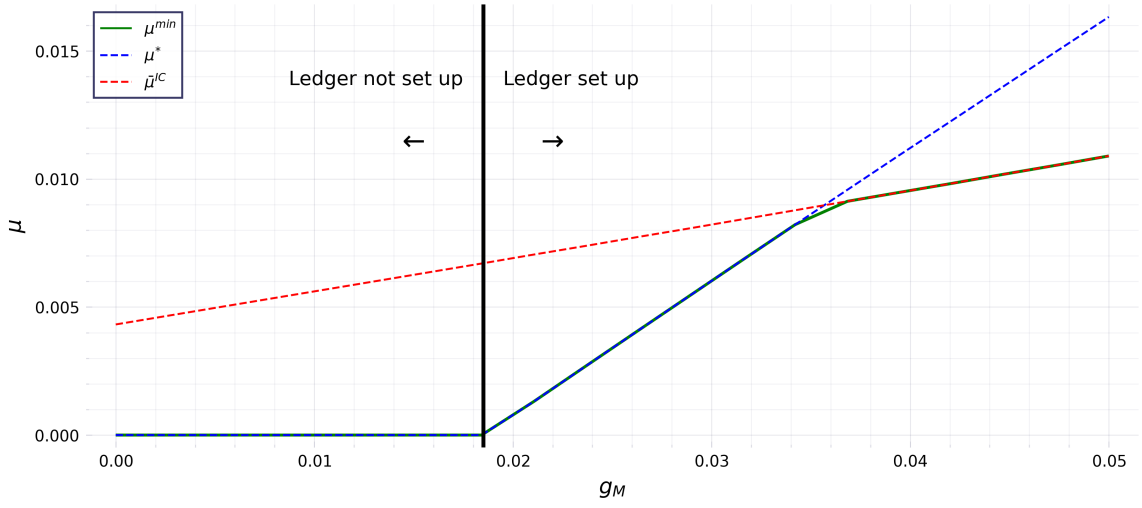


Figure 2: Platform optimization for money growth $g_M \in [0.0, 0.05]$.

Additional Lessons From The Macroeconomic Version

1. General equilibrium interest rate movements "lock-in" agents to the platform
   - High markups encourage agents to trade on the public marketplace.
   - This increases demand for cash, which limits loan supply and increases the interest rate.
   - This partially offsets the markup disincentive to trade on platform.
2. Without cash storage option, producers are "locked-into" the ledger IOU system
   - Without cash, producers only ever receive IOUs as payment,
   - And so they can never escape the ledger and default.
3. Loose monetary policy increases the profitability of the platform's IOU system
   - $\uparrow$ money growth $\Rightarrow \downarrow$ return on money $\Rightarrow$ money is less competitive with ledger IOUs.
   - $\uparrow$ Platform/ledger currency market power $\Rightarrow$ they can charger higher markups.

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"Tokenization" Extension: Platform Can Crowd Out Cash Trades

- So far, in the OLG model the platform/ledger operator:
  - Only allows IOU payment on the platform and
  - Excludes agents from the platform once they default.
- **Alternative setup:** Platform/ledger operator has more control:
  - Allows IOUs to compete with cash on the public marketplace,
  - Prevents cash payments on the platform,
  - Prevents IOU to cash exchange. (Analogue to two-period model)
- In this case, cash is not valued or traded.
- So producers only receive IOUs payments and can never escape the ledger to default.

Competing Ledger Extension: Regulation

- **Two platforms** $n \in \{1, 2\}$, no open public marketplace
  - Each platform manages ledger charging markup μ^n, and has trading quality ζ_τ^n.
  - Platforms choose their markups simultaneously
- All transactions are observed by one of the two platforms:
  - Default: write contract on ledger n, then default/trade on other platform $\neg n$.
- The regulator:
  - Allows platforms to Nash bargain at $t = 0$ over committing to exclude banks/funds.
  - Does not allow the platforms to collude on setting markups at times $t > 0$.
- **Proposition:** The outcome of the bargaining at $t = 0$ is that:
  - if $\zeta_\tau^1 = \zeta_\tau^2$ Contracts are enforced on both ledgers; No transfers between ledgers.
  - if $\zeta_\tau^1/\zeta_\tau^2$ sufficiently large, platform 1 provide monopoly ledger, platform 2 pays fee to 1. (i.e. "BigTech" platforms more natural providers of currency ledgers and "FinTech".)

Competing Ledger Extension: Regulation

- **Two platforms** $n \in \{1, 2\}$, no open public marketplace
  - Each platform potentially manages ledger, and
  - Each platforms choose a markup μ^n
- All transactions are observed by one of the two platforms:
  - Default: write contract on ledger n, then default/trade on other platform $\neg n$.
- The regulator:
  - Allows platforms to cooperate on excluding defaulting agents.
  - Does not allow the platforms to collude on setting markups at times.

Outcomes: (i) the larger trading platform provides a monopoly ledger,
(ii) the other platform pays fees for using the ledger,
(iii) consumer surplus is higher but markups are not eliminated.

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Conclusion

- **FinTech vision:** put payments & loans on digital record keeping system (*"ledger"*)
- **Practical difficulty:** need to *incentivize ledger use* (and disincentivize cash use).
- **BigTech platform:** can *force ledger use* and set up an IOU system.
- **Policy makers:** worry about *platform rents*, walled gardens, and interoperability.

Thank you

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