Private Money Creation and Equilibrium Liquidity

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Outline

Introduction

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Conclusions

Introduction and motivation

- Monetary system: coexistence of
  - publicly-issued money
  - privately-issued money (liabilities of financial intermediaries)
- Money / liquidity: typically low-risk assets. Gorton (2016):
  - “An asset that is (*almost always*) valued at face value without expensive and prolonged analysis”
  - “Can easily be used to exchange for goods or services or to exchange for another asset."
  - Starting from the eighteen century

Results

- Our paper:
  - Take as given role of of some assets as providers of liquidity
  - Public money not sufficient to satiate demand of liquidity
  - Can financial intermediaries achieve the efficient level of liquidity by issuing private money?
    - Hayek (1976): Yes
      (competition in money issuance eliminates rents)
    - Our model: Not necessarily
- Low-risk public and private money:
  - *Safe money*: never defaulted
  - *Pseudo-safe money*: defaulted during crisis
    (when defaulted, cannot be used for transactions)
- Efficiency is achieved only if intermediaries issue *safe* money

Preview

- Cash-credit model (Lucas and Stokey, 1987)

  Cash := government bonds and deposits, that are not in default

- Multiplicity: continuum of equilibria, two classes
  - Good: intermediaries have high equity, issue safe money
  - Bad: intermediaries have low equity, issue pseudo-safe money

- Nature of the multiplicity:
  - Across equilibria, within financial sector: Modigliani-Miller
  - But: debt-equity ratio affects economy-wide welfare

Policy: capital requirements, liquidity requirements

Comparison with literature

- Modeling assumptions:
  - Cash-credit (Lucas and Stokey, 1987)
  - Quasi-linear utility (Lagos and Wright, 2005)
  - Price level determined by present-value of real taxes
    (Woodford, 1994; Sims, 1994)
- Public and private money in OLG models
  - Sargent and Wallace (1982): real bill vs. quantity theory
  - Bullard and Smith (2003):
    results affected by dynamic inefficiencies of OLG models
- Liquidity services provided by money-like instruments (deposits, etc)

  (Gorton, 2016; Gorton and Pennacchi, 1990; Moreira and Savov, 2016)

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Timing and agents

- Model:
  - Capital in fixed supply
  - Infinite horizon, discrete time (two subperiods)
  - Cash-credit model
    - First subperiod: CIA market (CIA = cash-in-advance)
      "Cash" := debt (deposit, gvt debt) whose issuer is not in default
    - Second subperiod: centralized market
- Agents:
  - Continuum of household
  - Continuum of competitive banks
    - start activity at time t, second subperiod
    - liquidated at time $t+1$, second subperiod
  - Consolidated fiscal-monetary authority

Households: utility

- Utility:

$$E_0 \sum_{t=0}^{\infty} \beta^t \left[\log C_t + X_t\right]$$

  - C_t = cash good (first subperiod)
  - X_t = credit good (second subperiod)

Technology

- Capital in fixed supply $\overline{K}$
- Price of capital: Q_t^K
- Output $Y_t = A_t \overline{K}$

  Aggregate shock A_t:

$$A_t = \begin{cases} A_h & \text{with prob. } 1-\pi \\ A_l & \text{with prob. } \pi \end{cases}$$

- A_t realized at time t, first subperiod; i.i.d. over time
- Output can be sold as cash good or credit good

Financial intermediaries

- Start activity at time t, second subperiod

  Invest in capital K_t^I by issuing deposits D_t and equity N_t:

$$\underbrace{Q_t^K K_t^I}_{\text{value capital}} = \underbrace{Q_t^D D_t}_{\text{deposits}} + \underbrace{N_t}_{\text{net worth}}$$

  Deposits: face value D_t, price Q_t^D (zero-coupon bonds)

- Liquidation at time $t+1$, second subperiod. Profits:

$$\Pi_{t+1} = \underbrace{Q_t^K K_t^I \left(1 + i_{t+1}^K\right)}_{\text{capital + return}} - \underbrace{\left(1 - \chi_{t+1}\right) D_t}_{\text{deposits (possibly defaulted)}}$$

  - Limited liability: $\Pi_{t+1} \geq 0$
  - If limited liability constraint is binding

    $\Rightarrow \Pi_{t+1} = 0$; (partial) default on deposits, $\chi_{t+1} > 0$

CIA market

- Cash-in-advance constraint:

$$\underbrace{P_t C_t}_{\substack{\text{consumption} \\ \text{expenditure}}} \leq \underbrace{B_{t-1}}_{\substack{\text{public} \\ \text{money}}} + (1 - I_t) \underbrace{D_{t-1}}_{\substack{\text{private} \\ \text{money}}}$$

  - B_{t-1}: government bonds
  - D_{t-1}: deposits at private banks

- I_t: default indicator function:

$$I_t = \begin{cases} 1 & \text{if } \chi_t > 0 \text{ (banks default on deposits, even partially)} \\ 0 & \text{otherwise} \end{cases}$$

  - (Ad-hoc) assumption: if default (even partial) security D_{t-1} cannot be used to buy C_t
  - In principle, same restriction applies to B_{t-1}
    But: no government default in equilibrium

Household problem

$$V\left(B_{t-1},\, D_{t-1},\, \underbrace{W_t}_{\text{other wealth}}\right) = \max_{C_t, X_t, B_t, D_t, K_t^H,} \left\{ \log C_t + X_t + \beta E_t\, V\left(B_t,\, D_t,\, W_{t+1}\right) \right\}$$

subject to CIA constraint:

$$P_t\, C_t \leq \underbrace{B_{t-1}}_{\text{public money}} + (1 - I_t) \underbrace{D_{t-1}}_{\text{private money}}$$

and budget constraint:

$$\underbrace{P_t X_t}_{\substack{\text{credit good} \\ \text{expenditure}}} + \underbrace{Q_t^B B_t}_{\text{public money}} + \underbrace{Q_t^D D_t}_{\text{private money}} + \underbrace{Q_t^K K_t^H}_{\text{capital}} + \underbrace{N_t}_{\substack{\text{net worth} \\ \text{banks}}} \leq W_t + I_t\,(1 - \chi_t)\, D_{t-1}$$

If $I_t = 1$ (banks default)
$\Rightarrow (1 - \chi_t)\, D_{t-1}$ not used to buy C_t, can be used in centralized market

$$W_{t+1} = \underbrace{Q_t^K K_t^H \left(1 + i_{t+1}^K\right)}_{\text{capital + return}} + \underbrace{\Pi_{t+1}\left(N_t\right)}_{\text{profits banks}} - \underbrace{P_{t+1}\, T_{t+1}}_{\text{lump-sum tax}}$$

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Household problem

- Quasi-linear utility $\rightarrow$ marginal utility of wealth = 1

  Expected return required on illiquid assets = $1/\beta$

- First-best requires that *in all states* (h *and* l):

$$\frac{1}{C_t} = 1$$

$$\text{marginal utility cash good} = \text{marginal utility credit good}$$

If CIA not binding in all states $\rightarrow$ first best

Government

- Flow budget constraint:

$$B_{t-1} = Q_t^B B_t + P_t T_t$$

- Present-value:

$$\frac{B_{t-1}}{P_t} = E_t \left\{ \sum_{j=0}^{\infty} \beta^j \left[T_{t+j} + \underbrace{\left(Q_{t+j}^B - Q_{t+j}^f \right)}_{\text{liquidity premium}} \frac{B_{t+j}}{P_{t+j}} \right] \right\}$$

Q_t^f = price of zero-coupon bond that cannot be used for transactions

- Assumption: $T_t = (1-\beta)\, T - \left(Q_t^B - Q_t^f \right) \frac{B_t}{P_t}$

$$\Rightarrow \quad \frac{B_{t-1}}{P_t} = T$$

- Government does not default in equilibrium

(price level P_t adjusts to equate real value of public debt to taxes)

Government: limit on taxes

- Assumption: $T < 1$ (bound on real taxes)

  Government cannot raise "too much" real taxes

- If $D_{t-1} = 0$ (no private money) $\rightarrow$ real public money B_{t-1}/P_t too low to finance first-best consumption of cash good C_t,

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Equilibrium

Given $B_{t-1} = B$ (public money) and T:

- Prices (Q_t^K, Q_t^D, Q_t^B) and quantities (K_t^H, K_t^I, D_t, N_t, C_t, X_t, χ_t, I_t)
- Such that:
  - households maximize utility
  - intermediaries maximize profits
  - government present-value equation holds
  - markets clear
- Restriction: **only one type of deposits**

  (all deposits must have the same default rate)

Good equilibria

- First best: $C_t = 1$ in all states (h and l)
- $I_t = 0$: intermediaries are solvent in all states (h and l)

  Net worth "large enough"

$$N_t \geq \overline{N} = (1 - T) \left[\frac{1}{1 + r_l^K} - \beta \right]$$

- No liquidity premium on gvt bonds and deposits: $Q_t^B = Q_t^D = 1/\beta$
- Deposits $D_t = 1 - B/P = 1 - T$

  (amount required to complement public money and achieve $C_t = 1$)

Bad equilibria

- Intermediaries: net worth $N_t < \overline{N}$
  - h state: $I_t = 0$ (no default)
  - l state: $I_t = 1$ (default)
- Deposits $D_t = 1 - B/P = 1 - T$

  (same as in the good equilibrium equilibrium)
- First best is not achieved
  - h state: $C_t = 1$ (CIA not binding)
  - l state: $C_t = B/P < 1$ (CIA binding, "financial crisis")

    (default on deposits, cannot be used for transactions)
- Liquidity premium:
  - positive on gvt bonds: return on gvt bonds $< 1/\beta$
  - zero on deposits: E_t (return on deposits) $= 1/\beta$

    (default on deposits in state l; CIA not binding in h)

Modigliani-Miller (MM)

- Within the financial sector:
  - MM does not hold in general (deposits may have liquidity premium)
  - MM holds in equilibrium (no liquidity premium on deposits)
- Economy-wide welfare:
  - Equity-debt composition of intermediaries matters for welfare

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Capital requirements

- Capital requirements eliminate bad equilibrium
- Minimum requirements on net worth:

$$N_t \geq \overline{N} \equiv (1 - T) \left(\frac{1}{1 + r_l^K} - \beta \right)$$

- Capital requirements in terms of leverage:
  - max leverage (if leverage is too high $\Rightarrow$ default)
  - min leverage
    (if leverage is zero, i.e., 100% equity $\Rightarrow$ no private money creation)

Capital requirements

- Capital requirements eliminate bad equilibrium
- Minimum requirements on net worth:

$$N_t \geq \overline{N} \equiv (1 - T) \left(\frac{1}{1 + r_l^K} - \beta \right)$$

- Capital requirements in terms of leverage:
  - max leverage (if leverage is too high $\Rightarrow$ default)
  - min leverage
    (if leverage is zero, i.e., 100% equity $\Rightarrow$ no private money creation)
- More generally, if many states $s \in S$:

$$N_t \geq Deposits \times \left(\underbrace{\min_{s \in S} \frac{1}{1 + r_s^K}}_{\substack{\text{worst-case} \\ \text{return on assets} \\ \text{held by banks}}} - \underbrace{\frac{1}{1 + r}}_{\substack{\text{risk-free} \\ \text{rate}}} \right)$$

Liquidity regulation

- Basel III:
  - Liquidity coverage ratio (LCR)
  - Net stable funding ratio (NSFR)
- Requirements: hold high quality liquid assets
- In the model:
  - Requirement: hold \$1 of gvt bonds, for each \$ of deposit
  - Results:
    - Intermediaries transform public money into private money, they do not create any new liquidity
    - Efficiency is not achieved, even with capital requirements

(In our model: no benefits of liquidity regulation)

Welfare cost of liquidity regulation

- Similar to the welfare cost of inflation
- Welfare cost of inflation:
  - Nominal interest rate > 0
    (Friedman rule: interest rate $= 0$)
  - Welfare cost often measured as area under the money demand curve (Lucas, 2000)
- Welfare cost of liquidity requirement
  - Liquidity premium on gvt bonds > 0
    (Friedman rule: liquidity premium $= 0$)
- Different from the literature that uses models a la Diamond-Dybvig

  (cost of liquidity = productivity of long-term technology)

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- Cash-credit model with public and private money
- Multiple equilibria:
  - Leverage does not matter in the financial sector (Modigliani-Miller)
  - Leverage matters for efficiency
- Regulation:
  - Capital requirements eliminate bad equilibria
  - Liquidity requirements: welfare cost, similar to inflation
- Work in progress:
  - Each bank can issue bank-specific deposit $\rightarrow$ good equilibria only
  - Cost of issuing equity $\rightarrow$ good equilibria might not exist

  Richer interaction with regulation

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Appendix