Payments, Credit & Asset Prices

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Dollar payments; quarterly at annual rates
Simple model of payments & asset pricing

- **Endusers** = households & institutional investors
  - pay for goods & assets with payment instruments = **inside money**
  - payment instruments = deposits, MMF shares, credit lines

- **Banks handle enduser payment instructions**
  - make interbank payments with reserves = **outside money**
  - liquidity management: hold reserves or rely on interbank credit?
  - capital structure: liquidity benefit vs leverage cost of pmt instruments

- **Government issues debt & reserves, trades in assets**

⇒ **Questions**
  - Interaction asset markets vs payment system
  - How does policy affect asset prices & nominal price level
  - What does an efficient payment system look like?
Determination of prices

- Nominal price level: \( PT = \bar{v}(D + L) \)
  - bank supply of inside money \( D + L \)
  - \( T \) includes institutional investor trades
  - inflation follows from growth rate of nominal govmt liabilities

- Opportunity cost of payment instruments
  - inside money in enduser layer: depends on bank leverage, liquidity cost
  - reserves in bank layer: depends on real return set by government

- Intermediary asset pricing
  - banks’ valuation high if collateral scarce
    - endogenous market segmentation
    - e.g. short interest rate priced only by banks
  - active traders’ valuation high if inside money cheap
Related Literature

- asset pricing with constrained investors
  Lucas 90, Kiyotaki-Moore 97, Geanakoplos 00, He-Krishnamurthy 12, Buera-Nicolini 14, Lagos-Zhang 14, Bocola 14, Moreira-Savov 14

- monetary policy & financial frictions
  Bernanke-Gertler-Gilchrist 99, Curdia-Woodford 10, Gertler-Karadi 11, Gertler-Kiyotaki-Queralto 11, Christiano-Motto-Rostagno 12, Brunnermeier-Sannikov 14, Jakab-Kumhof 15

- banks & liquidity shocks
  Diamond-Dybvig 83, Bhattacharya-Gale 87, Allen-Gale 94, Holmstrom-Tirole 98, Bianchi-Bigio 14, Drechsler-Savov-Schnabl 14

- multiple media of exchange
  Freeman 96, Williamson 12, 14, Rocheteau-Wright-Xiao 14, Andolfatto-Williamson 14, Chari-Phelan 14, Lucas-Nicolini 15

- interest on reserves
  Sargent-Wallace 85, Hornstein 10, Kashyap-Stein 12, Woodford 12, Ireland 13, Cochrane 14, Ennis 14
Baseline: only goods transactions require inside money
Extension: asset trades also require inside money
Inside money: deposits & credit lines

Households → Banks → Active traders

- Equity
- Credit lines
- Deposits

Banks → Reserves

- Overnight credit
- Nominal govmt debt
- Bank trees
- Trees
Model: enduser layer

- Constant aggregate output
  - mass one of trees, each yields $x$ units of fruit as dividend
  - labor income

- Households
  - risk neutral with discount rate $\delta$
  - can invest in trees, deposits, short credit, bank equity
  - cannot borrow or hold reserves (= numeraire)

- Payments
  - consumption s.t. deposit-in-advance constraint $PC \leq D$
  - equilibrium deposit rate $i_D$ low enough so constraint binds
  - for now: only goods payments

- Capture uncertainty about tree by low payoff expectations
  - households act as if they believe payoffs $x$ decline by $s$ percent
  - can be derived as ambiguity premium (Ilut-Krivenko-Schneider 2015)
## Bank layer

<table>
<thead>
<tr>
<th>Assets</th>
<th>Liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>$M$</td>
<td>Deposits</td>
</tr>
<tr>
<td>$F^+$</td>
<td>Fed funds borrowing</td>
</tr>
<tr>
<td>$B$</td>
<td>Equity</td>
</tr>
<tr>
<td>$Q^b \theta$</td>
<td></td>
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</tbody>
</table>

**Banks owned by households, maximize shareholder value**

**nominal shareholder payout**

$$M(1 + i_R) - M' + F (1 + i) - F' + (Q^b + Px) \theta - Q^b \theta' - D (1 + i_D) + D' + \text{leverage costs}$$

**short lending** $F = F^+ + B - F^-$

**constant returns & costless adjustment of equity**
Bank liquidity management

- **Liquidity shocks**
  - bank enters with deposits $D$, reserves $M$
  - $\tilde{\phi}D =$ net funds sent to other banks (or received if $\tilde{\phi} < 0$)
  - $\tilde{\phi}$ iid across banks, cdf $G$, $E[\tilde{\phi}] = 0$

- **Bank liquidity constraint**

$$\tilde{\phi}D \leq M + F^-$$

  - threshold rule: borrow overnight iff $\tilde{\phi} > M/D =: \phi$
  - if reserves large relative to deposits, $F^- = 0$ (*abundant liquidity*)

- **Optimal liquidity ratio**
  - higher opportunity cost of reserves $i - i_R \geq 0 \Rightarrow$ lower $\phi$
  - if $i = i_R$, indifferent between short bonds & reserves
Bank capital structure

- Leverage costs
  - resource cost per unit of real debt
  - strictly increasing & convex in leverage $\ell = \text{debt} / \text{risk weighted assets}$
  - lower weight $\rho(s)$ on risker assets

- Optimal leverage
  - issue debt until
    - marginal cost of debt = marginal benefit of collateral $\kappa(\ell)$
  - bank Euler equation $\delta = i - \pi + \kappa(\ell)$
  - higher $i \Rightarrow$ collateral is cheap, hold more collateral
    $\Rightarrow$ lower leverage $\ell$
## Bank optimal choices

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<tr>
<td>$M$ Reserves</td>
<td>Deposits $D$</td>
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<tr>
<td>$F^+$ Fed funds lending</td>
<td>Fed funds borrowing $F^-$</td>
</tr>
<tr>
<td>$B$ Govmt bonds</td>
<td>Equity</td>
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<tr>
<td>$Q^{b\theta}$ Bank trees</td>
<td></td>
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</tbody>
</table>

Banks choose two key ratios

1. **Liquidity ratio**

\[
\phi = \frac{M}{D}
\]

2. **Collateral ratio**

\[
l^{-1} = \frac{M + F^+ + B + \rho(s)Q^{b\theta}}{D + F^-}
\]
Equilibrium

- Government
  - fix path of nominal liabilities $M_g, B_g$ and reserve rate $i_R$
  - lump sum transfers adjust to satisfy budget constraint
  - has leverage cost $c_g(\ell_g)$, where $\ell_g = (M_g + B_g)/$ tax base

- Market clearing
  - goods, reserves, overnight credit, deposits, trees

- Steady state equilibria
  - constant output and growth rate of $M, B$ = inflation
  - neutrality: price level $\propto$ reserves
  - reduce to 2 equations in $(\phi, \ell)$
  - comparative statics
  - after unanticipated shock, new steady state reached after one period
Steady state equilibria with goods trade only

- plot collateral and liquidity ratio

- scarce reserves
  - banks borrow reserves if large withdrawal
  - (US before 2008)

- abundant reserves
  - banks never borrow
  - (US since 2008)
Capital structure curve

- what collateral is needed to handle transactions $T$ given reserves?
- slopes up: more reserves, more collateral

- depends on gov policy because government changes collateral mix
- steeper with larger share of nominal assets in collateral
Liquidity management curve

- what collateral holdings maintain return on equity given reserves?
- slopes down: reserves are taxed intermediate input, less collateral
  - bank’s money demand
  - low reserves
  - high opp costs \( i - i^R \)
  - high interest rate \( i \)
  - collateral cheap
  \[ \Rightarrow \] hold more collateral
- gov chooses \( i^R, \pi \)
- abundant reserves:
  \( i = i^R \) is upper bound on collateral prices
Equilibrium

- intersection of the CS and LM curves
- determines equilibrium collateral and liquidity ratios

- also determines equilibrium interest rate and Fed funds credit

- read price level from $PT = D = M/\phi$

- could be in scarce or abundant reserves region
Shifts in capital structure curve

- shifts down: less collateral in banking system
  - open market purchase = fewer bonds
  - increase in uncertainty about bank trees
  - new steady state: lower real interest rate inflationary/deflationary
  - large shift makes reserves abundant
Shifts in liquidity management curve

- shifts up: higher real return on reserves
- lower tax on reserves: can afford to hold more collateral and still maintain return on equity
- higher interest on reserves or lower growth rate of nominal reserves
- new steady state real rate increases deflationary
- large shift makes reserves abundant, policy tools: unconventional monetary policy, real return on reserves
Optimal policy

- Minimize total cost of leverage = move towards origin
- Trade off bank vs government leverage

- abundant reserves optimal only if government borrowing cheap
- select optimal equilibrium by picking real return on reserves
Active traders

- Competitive firms owned by household
  - issue equity, invest in deposits & subset of trees
  - each firm optimistic about one tree, perceive lower uncertainty $s$ than households and other traders
  - identity of favorite tree within subset changes with probability $\hat{\nu} \leq 1$
  - all trades must be paid with deposits or intraday credit

- budget constraint ($z = 1$ if identity of favorite tree changes)
  \[ z\hat{Q}\theta' = I + \hat{D} \]

- limit on intraday credit
  \[ I \leq \hat{\gamma}\hat{D} \]

limit binds if $i_D - \pi < \delta$
Increase in uncertainty with active traders

- Shift down: bank collateral worth less
- Shift up: lower demand for inside money from active traders

forces on price level:
- less inside money supply
- less inside money demand

details of financial structure matter!
Summary of main results

- Interaction securities markets vs payment system
  - value of banks’ collateral $\rightarrow$ supply of inside money
  - value of institutional investor trades $\rightarrow$ demand for inside money

- Government policy tools
  1. set real return on reserves $=$ tax on intermediate input
  2. change mix of collateral by issuing or trading securities
    - both affect collateral & liquidity benefits on assets
      - permanent effects on real asset prices
      - policy stance cannot be summarized by interest rates alone

- Scarce vs abundant reserves?
  - select by setting interest on reserves, nominal liabilities
  - optimal policy depends on government vs bank leverage costs