Payments, Credit & Asset Prices

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Dollar payments; quarterly at annual rates

Enduser

Interbank w/ reserves

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Payments, Credit & Asset Prices
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Measures of money

Zero Maturity Money

Reserves

$ Trillions

$ Trillions

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Simple model of asset pricing & payments

- **Endusers** = households & institutional investors
  - use deposits to pay for goods & securities
  - ”deposits” = funds precommitted for payments
    (incl. MMMF shares, assets in sweep arrangements, credit lines,...)

- **Banking sector handles payment instructions**
  - manages liquidity via reserves & interbank credit
  - deposit creation requires costly leverage
  - cost of leverage declines with value & safety of bank assets

- **Government trades in securities & issues interest bearing reserves**

⇒ Determine inside money supply, nominal price level & real asset prices
Key mechanisms

- Determination of price level: \( PT = \bar{v}D \)
  - endog. supply of deposits from banks’ leverage choice
  - \( T \) includes institutional investor trades

- Intermediary asset pricing
  - banks value assets as collateral (e.g. low overnight rate)
  - inst. investors’ valuation depends on cost of deposits

- Increase in uncertainty about assets payoffs
  - lowers supply of deposits → lower price level
  - lowers demand for deposits → higher price level

- Effects of policy on price level & real asset prices
  - work through changes in liquidity & collateral benefits
  - depend on financial structure & policy regime
    - scarce reserves vs abundant liquidity
    - higher interest on reserves: lower price level if less bank assets nominal
    - lower interest rate increases or decreases asset prices
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

- **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, Lucas-Nicolini 15

- **interest on reserves**
  Sargent-Wallace 85, Hornstein 10, Kashyap-Stein 12, Woodford 12, Ireland
  13, Cochrane 14, Ennis 14
Model: enduser layer

- Constant aggregate output
  - mass one of trees, each yields $x$ units of fruit

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

- Payments
  - consumption s.t. deposit-in-advance constraint $PC \leq \bar{v}D$
  - equilibrium deposit rate $i_D$ low enough so constraint binds
  - constant velocity: $PT = \bar{v}D$, here $T = C = x$

- Will add later
  - other intermediaries
  - payment for securities transactions
Valuation of trees

- Trees = all productive assets
  - including human capital, housing etc
  - cannot be sold short

- Bank ownership of trees
  - only subset of $\beta$ trees can be held by bank
  - "bank trees" trade at nominal price $Q^b$

- Capture uncertainty about tree payoff by high discount rate
  - households act as if they believe payoffs decline at rate $s$
  - if household is marginal investor in tree:

$$\text{steady state price} = \frac{\text{payoff}}{\delta + s}$$

- can be derived as ambiguity premium (Ilut-Krivenko-Schneider 2015)
Model structure

Households → deposits → Banks → equity → Banks

Trees
Bank trees

Reserves

 overnight credit
Bank layer

- Banks owned by households
  - maximize shareholder value $E \sum_t \exp(-\delta t) y_t^b$

- Subperiod 1: liquidity management

- Subperiod 2: portfolio & capital structure choice

- Constant returns & costless adjustment of equity
  - no endogenous state variables
Bank layer: liquidity management

- **Subperiod 1**
  - bank enters with deposits $D$, reserves $M$; enduser transactions $\tilde{\nu} D$
  - $\phi \tilde{\nu} D = \text{net funds sent to other banks (or received if } \phi < 0)$
  - $\phi$ iid across banks, cdf $G$, $E[\phi] = 0$

- **Bank layer liquidity constraint**
  \[ \phi \tilde{\nu} D \leq M + F' \]
  
  - threshold rule: borrow overnight iff $\phi > M / \tilde{\nu} D$
  - more interbank payments if more transactions, overnight credit

- **Liquidity benefit of holding reserves**
  - high if multiplier $D / M$, cost of interbank credit high
  - zero if reserves large relative to deposits (*abundant liquidity*)
Banking sector: portfolio choice

- Shareholder payout

\[
P y^b = M(1 + i_R) - M' + (Q^b + P_x)\theta - Q^b\theta' - D(1 + i_D) + D' - F(1 + i) + F' - c(\ell)L
\]

- Leverage cost per dollar of debt

\[
\ell = \frac{L}{K} = \frac{\text{debt}}{\text{collateral}} = \frac{D' + \max\{F', 0\}}{\rho(s)Q^b\theta' + M' + \min\{F', 0\}}
\]

- \(c(\ell)\) strictly increasing \& convex; cost \(cL\) paid to household
- weight \(\rho(s) < 1\) on uncertain trees

- Optimal portfolio \& capital structure choice

- equate returns on all assets \& liabilities to return on equity \(\delta\)
- tradeoff theory: liquidity benefit vs leverage cost of debt
Model structure

Households → deposits → Banks

Banks → equity → Banks

Banks → overnight credit → Reserves

Trees

Bank trees

Reserves
Equilibrium

- **Government**
  - consolidate Fed and Treasury
  - fix reserves $M$ & reserve rate $i_R$
  - lump sum transfers adjust to satisfy budget constraint

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

- **Steady state equilibria**
  - constant growth rate of $M = \text{inflation}$
  - neutrality: price level $\propto$ reserves
  - reduce to 2 equations in $(D/M, \ell)$ or 2 prices $(i, 1/P)$
  - comparative statics
Liquidity management curve

- Prices s.t. banks choose optimal money multiplier $D/M$
- Slopes down in $(i - \pi, 1/P)$ plane:
  - high price level (low $1/P$)
    - $= \text{hi } D/T$
    - $= \text{hi multiplier } D/M$
    - $= \text{lots of overnight credit}$
    - $= \text{hi } i - i_R$
  - flat if abundant liquidity:
    - lo price level (high $1/P$)
      - $= \text{lo multiplier } D/M$
      - $= \text{no overnight credit}$
      - $= i = i_R$
Market participation & asset pricing

- Only banks lend overnight & hold all trees they have access to
  - banks’ collateral benefit lowers short rate, increases tree price
  - overnight credit & bank trees unattractive to households

- Bank Euler equations price assets
  - overnight credit: lower real interest rate if higher leverage
    \[ \delta = (i - \pi) + \kappa(\ell) \]
    collateral benefit
  - trees: higher price if higher leverage, lower uncertainty premium \( s \)
    \[ Q^b = \frac{P\chi}{\delta + s - \kappa(\ell)} \]
Capital structure curve

- Prices s.t. banks choose optimal leverage ratio $\ell$
- Slopes upward in $(i - \pi, 1/P)$ plane:

  - higher interest rate
    - $\equiv$ lo leverage
    - $\equiv$ lo deposits
    - $\equiv$ lo price level (hi $1/P$)

  - steeper if banks’ share of nominal assets higher
    (lower price level increases collateral value)
Equilibrium with scarce reserves

- Curves cut at $i > i_R$; high money multiplier $D/M$; high $P$
- Active interbank credit market
Equilibrium with abundant liquidity

- Curves cut at $i = i_R$; low money multiplier $D/M$; low $P$
- Interbank credit dries up, fewer payments
Increase in uncertainty

- Comparative statics: increase in spread $s$
  - new steady state: lower tree prices, higher premia on trees

- Less collateral
  - less deposits at any $i$
    (CS shifts right)

- Lower multiplier $D/M$
  - less overnight credit
  - lower interest rate
    (move along LM)
Central bank asset purchases

- Government buys bank trees at market price
- New steady state s.t. \( M^* - M = \frac{P_x}{(\delta + s - \kappa(\ell))} \)

- More reserves
  - for any \( P \), lower \( D/M \)
  - lower credit & \( i \)
  - (LM shifts left)

- More collateral
  - more deposits at any \( i \)
  - (CS shifts left)

- More nominal collateral
  - (CS steeper)

- Less exposure to \( s \)!

\[ \downarrow \text{real rate} \]
\[ \downarrow \text{bank leverage} \]
Policy with abundant liquidity: reserve rate

- Higher interest on reserves = higher $i_R$

- Same $i - i_R$ at any $D/M$
  $\Rightarrow$ less deposits at any $i$
  (LM shifts up)

- Less deposits
  $\Rightarrow$ lower leverage
  $\Rightarrow$ higher interest rate
  (move along CS)

- Less deflationary if more nominal collateral
  (CS steeper)
Nominal long term assets

- Debt issued against trees
  - consols with nominal payoff $\nu$
  - leveraged trees: nominal payoff $P - \nu$
  - both payoff streams discounted at $\delta + s$
  - banks may hold consols, but not leveraged trees
  - interpretation: mortgages, long term govmt debt

- Equilibrium with nominal long term assets
  - banks hold all nominal assets
  - steeper CS curve

- Helicopter drop of reserves no longer neutral
  - higher price level lowers value of other nominal collateral
  - share of reserves / all nominal assets matters!

- Effect on policy experiments
  - higher reserve share makes CS steeper
Summary: monetary & fiscal policy

- Two key effects of asset purchases
  - liquidity management with more reserves:
    for any $P$, lower $D/M$, less interbank credit, lower $i$ (LM left)
  - capital structure with more collateral
    issue more deposits at any $i$ (CS left)
  ⇒ real interest rate declines & price level increases

- With scarce reserves: permanent liquidity effect
  - even if central bank purchases overnight credit
  - more reserves → less interbank credit
    ∼ more collateral → more deposits at any $i$

- Even with abundant liquidity, price level depends on collateral
  - asset purchases may swap bad for good collateral
  - with nominal assets, helicopter drop affects collateral

- Change interest on reserves with abundant liquidity
  - effect on price level depend on slope of CS
Extensions

- “Carry traders”
  - firms that invest in subset of trees, borrow from banks (e.g. broker-dealer funding via triparty repo)
  - increase in uncertainty perceived by carry traders lowers interest rate & price level, also get lower outstanding credit

- Credit lines
  - work like deposits if leverage cost depends on commitments

- Banks’ internal rate of return $> \delta$
  - e.g. inefficiency within bank
  - banks need not hold all eligible assets; flatter CS

- Variable velocity
  - deposits in the utility function $\Rightarrow D/P = f(i_D, T)$
  - flattens CS curve

- Curvature in utility from consumption
  - discount rate $\delta$ can decline with uncertainty
Active traders

- Competitive firms owned by household
  - issue equity, invest in deposits & subset of $\hat{\beta}$ trees
  - each firm optimistic about one tree, perceived spread $\hat{s} < s$
  - identity of favorite tree within subset changes with probability $\hat{\nu} \leq 1$
  - all trades must be paid with deposits or intraday credit

- Subperiod 1
  - 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 $i_D - \pi < \delta$

- Subperiod 2: settle intraday position, adjust portfolio & equity
- Payments: $\bar{v}\hat{Q}\hat{\beta}$ cleared, $\bar{v}D = \hat{\nu}\hat{Q}\hat{\beta}/(1 + \hat{\gamma})$ paid
Equilibrium with active traders
Equilibrium with active traders

- Assume \( \hat{s} \) low enough so traders hold all eligible trees, valuation is
  \[
  \delta - (i_D - \pi) = (1 + \hat{\gamma})(\hat{r} - \pi - (\delta + \hat{s}))
  \]

  - return on tree \( \hat{r} \) must compensate for lo return on deposits

- Equilibrium deposit holdings
  \[
  \hat{D}(1 + \hat{\gamma}) = \frac{\hat{\beta}xP}{\delta + \hat{s} + \frac{\delta - (i_D - \pi)}{1 + \hat{\gamma}}}
  \]

  - deposits & transactions \( \bar{v}D \) now increase with deposits rate \( i_D \)
  - more efficient netting (higher \( \hat{\gamma} \)): less deposits needed

- Determination of price level
  \[
  PC + \hat{v}\hat{D} = \bar{v}D
  \]

  - increase in asset trading = ”drop in velocity” in quantity equation
  - money creation need not increase price level
Asset price booms & inflation

- Increase in spread $\hat{s}$ perceived by active traders

- Less asset transactions ($\sim$ higher goods velocity)
  $= \text{for any } P, \text{lower } D/M$
  $= \text{less credit & } i$
  (LM shifts left)

- Less deposit demand
  $= \text{less leverage for any } i$
  (CS shifts left)

- Inflationary!
Equilibrium with active traders

- Decrease in uncertainty *perceived by active traders*
  - higher demand for deposits, lower deposit rate
  - banks leverage more, lower overnight rate & higher bank tree prices
  - decrease in price level as less deposits in goods market
  - more payments in both layers & more deposits held by inst. investors

- Monetary policy that lowers real interest rate
  - lowers deposits rate & trading cost of active traders
  - active trader trees increase in value & become larger share of total
  - lower average uncertainty premia since active traders perceive $\hat{s} < s$
This paper

- Simple model of asset pricing & payments
  - deposits needed for payment (for goods, securities)
  - banking sector handles payments (reserves & interbank market)
  - bank leverage is costly, responds to collateral value of bank assets

- Links securities market – payments system
  1. banks own securities, lend short term to institutional investors
  2. institutional investors require deposits for trading

- Increased uncertainty about asset payoffs
  1. lowers supply of deposits → lower price level, real interest rate
  2. lowers demand for deposits → higher price level, real interest rate

- Monetary policy
  - works through changes in liquidity & collateral benefits
  - affects asset prices through cost of inst. investor leverage & trading