Motivation

- Unified framework to study financial and monetary stability
- **I**: Intermediation (credit) - Inside money
- Value of money endogenous - store of value, liquidity
- In downturns, intermediaries create less inside money
  - Value of outside (base) money goes up
  - Fisher (1933) disinflationary spiral hits borrowers on liability side
  - **Endogenous** money multiplier = f(health of intermediary sector)
- Monetary policy (interest rates, open market operations)
  - Fills in demand for money when money multiplier contracts
  - “Stealth redistribution” from/towards intermediary sector
Some Literature

- Role of money
  - Unit of account affects price setting if prices are sticky
  - Medium of exchange cash in advance constraint, money in utility function
  - Store of value Samuelson, Bewley, Scheinkman-Weiss, Kiyotaki-Moore

- Without intermediaries
  - Inflation in downturns: less money needed since fewer transactions

- With intermediaries — have special role
  - Money view: (Friedman & Schwartz 1963)
    - “Moneyness” of bank liabilities decrease in downturns of intermediation
  - Credit view (demand/supply): (Tobin 1969)
    - BGG, KM, He & Krishnamurthy, BruSan10, Goodfriend 05, Curdia & Woodford 10, ...

- Financial stability + monetary policy
  - Diamond & Rajan (2006), Stein (2012)
Main results

- Passive monetary policy
  - Liquidity Spirals
  - Disinflationary spiral
  - Endogenous risk
  - Redistributional effects

- Active monetary policy
  - Interest rate
    - Current rate
    - Forward guidance
  - Asset purchase programs – open market operation
  - “Stealth” recapitalization
Baseline model without intermediaries

- Macro shock
  \( \lambda = \) arrival rate
- Idiosyncratic shock
  \( \phi = \) expropriation probability

Diagram:
- Government
  - Tax
  - Out-money
- Productive entrepreneurs
- Households
- Risky claims
Baseline model without intermediaries

- **Output:** \[ y_t = (a - \iota)k_t \]
- **Capital:** \[ dk_t = (\Phi(\iota_t) - \delta)k_t\, dt, \quad \Phi(0) = 0, \Phi' > 0, \Phi'' < 0 \]
- **Shocks**
  - \( \lambda \) arrival rate of macro shock
  - \( \phi \) probability of expropriation
- **Productive entrepreneurs**
  - No net worth – no risk bearing capacity
- **Households**
  \[ E\left[ \int_0^{\infty} e^{-rt} \log c_t \, dt \right] \]
  - Risky claims towards one entrepreneur
    - Cannot diversify across entrepreneurs
  - Outside money
Baseline model without intermediaries

- Wealth in the economy: \( q_t K_t + p_t K_t \)
- Assume degenerate \( \Phi(i) \) & denote \( g \equiv \Phi(0) - \delta \)

<table>
<thead>
<tr>
<th>Return</th>
<th>Absent shock</th>
<th>shock</th>
</tr>
</thead>
<tbody>
<tr>
<td>On capital ( r^K_t )</td>
<td>( \frac{(1 - \tau)a}{q} + g )</td>
<td>Loss with prob ( \lambda \Phi )</td>
</tr>
<tr>
<td>On money ( r^M_t )</td>
<td>( \frac{\tau a}{p} + g )</td>
<td></td>
</tr>
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</table>

- Optimal portfolio choice for households
  - ...
Baseline model without intermediaries

- Optimal portfolio choice for HH
  \[
  \max_x x r_t^K + (1 - x) r_t^M + \lambda \phi \ln(1 - x)
  \]

- FOC:
  \[
  \left( \frac{(1-\tau)a}{q} + g \right) - \left( \frac{\tau a}{p} + g \right) - \lambda \phi \frac{1}{1-x} = 0
  \]

- Market clearing:
  - Capital market: \( x = \frac{q}{q + p} \)
  - Goods market: \( r \left( q + p \right) K = aK \)

- Hence, \( q = \frac{(1-\tau)a}{r + \lambda \phi} \) and \( p = \frac{a \tau r + \lambda \phi}{r \left( r + \lambda \phi \right)} \)

- Value of money even if \( \tau = 0 \) (tax can be even slightly negative)
Frictionless model with \( \lambda = 0 \)

- No risk, hence \( r^M = r^K \)

- \( q = \frac{(1-\tau)\alpha}{r} \) and \( p = \frac{\alpha\tau}{r} \)

- Value of capital is higher
- Value of money is lower
  - Tax backing essential
## Two Polar Regimes

<table>
<thead>
<tr>
<th>Regime</th>
<th>Frictions</th>
<th>Value of fiat money</th>
<th>Price of capital</th>
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<tr>
<td>“Money”</td>
<td>severe</td>
<td>high</td>
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Two Polar Regimes with Intermediaries

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<tr>
<th>Regime</th>
<th>Frictions</th>
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<th>Intermediaries’ capitalization</th>
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<td>high</td>
<td>well</td>
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- **Role of intermediaries**
  - Monitoring and thereby reduce friction from $\phi$ to $\phi$
    - Have to take on productive agent’s equity risk to have incentive to monitor
    - Depends on their ability to absorb risk
  - Diversify
  - Maturity/liquidity transformation
Introducing intermediaries

- Monitor
- Diversify
- Maturity/liquidity transformation

Productive entrepreneurs

Government

- Tax
- Out-money

Intermediaries

- Risky claims
- Inside money
- Net worth

Risk claims

households
Adverse shock

- Split in 3 steps
  1. Shock impair assets
  2. Balance sheet shrink
  3. Real value of deposit

Diagram:
- Productive entrepreneurs
- Risky claims
- Intermediaries
- Tax
- Out-money
- Inside money
- Government
- Households
Shrink balance sheet – sell off of assets

Productive entrepreneurs

Government

Tax
Out-money

Intermediaries

Risky claims
money

households
Disinflation effect – value of liabilities expand

Productive entrepreneurs

Government

Tax

Out-money

Intermediaries

Risky claims

money

households

Risky claims
## Model with intermediation

### Optimal investment

\[
\max_i \Phi(i) - \frac{(1 - \tau)i}{q_t} \quad \Rightarrow \quad \Phi'(i_t) = \frac{(1 - \tau)}{q_t}
\]

### Optimal portfolio choice

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<th>Shock</th>
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</table>
| On capital \( r^K_t \) | \[
\frac{(1 - \tau)(a - \ell_t)}{q_t} + \mu^q_t + \Phi(\ell_t) - \delta \]
| | \( (1 - \phi) \frac{q'}{q_t} \) Loss with prob. \( \phi \) \( \frac{q'}{q_t} \) with prob. \((1 - \phi)\) |
| On money \( r^M_t \) | \[
\frac{\tau(a - \ell_t)}{p} + \mu^p_t + \Phi(\ell_t) - \delta \]
| | \( \frac{p'}{p_t} \) |

\( q_t \) and \( p_t \) denote the loan and deposit rates, respectively.
Model with intermediation

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<tr>
<td></td>
<td>intermediaries</td>
<td>household</td>
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<tr>
<td>On capital $r_t^K$</td>
<td>$(1 - \tau)(a - \iota_t) + \frac{\mu_q}{q_t} + \Phi(\iota_t) - \delta$</td>
<td>$(1 - \phi) \frac{q'_t}{q_t}$</td>
</tr>
<tr>
<td>On money $r_t^M$</td>
<td>$\tau(a - \iota_t) + \frac{\mu_p}{p} + \Phi(\iota_t) - \delta$</td>
<td>$\frac{p'_t}{p_t}$</td>
</tr>
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</table>

- Optimal investment

$$\max_i \Phi(i) - \frac{i}{q_t} \quad \Rightarrow \quad \Phi'(i_t) = 1/q_t$$

- Optimal portfolio choice
Model with intermediation

- Portfolio choice of ... similar to before
  - Households
  - Intermediaries discount rate of $\rho > r$

- Law of motion of net worth

- State variable

$$\eta_t = \frac{N_t}{(q_t + p_t)K_t}$$

- Law of motion (Ito’s lemma)

- Let’s denote $\theta_t \equiv \frac{q_t}{q_t + p_t}$ (fraction of “physical wealth”)
Yuliy can you email me the simulation?
After adverse shock

- Intermediary net worth ↓

- Capital:
  - fire sales, price q ↓
  - Allocation efficiency ↓

- Money:
  - Lending + deposits ↓
  - value of money p ↑
  - Multiplier ↓

- Banking
  - Hit on both sides of balance sheet
  - Externality among banks
  - Competition ↓
Monetary Policy

- So far, “Gold Standard”
  - outside money supply is fixed
  - pays no interest
  - no central bank

- Introduce consul (perpetual) bond
  - pays interest rate in short-term (outside) money

- Monetary Policies
  - Short-term interest rate policy
    - Central bank accepts deposits & pays interest rate (by printing money)
      - E.g. short-term interest rate is lowered when $\eta$ becomes small
    - Budget neutral policies (at any point in time)
  - Asset purchase program
    - Bond – open market operations (OMO/QE)
Monetary policy

- Government issues long-term (perpetual) bonds
- Controls short-term interest rate $\rho_t$, value $b_t K_t$ of bonds outstanding (through open-market operations)
- Now there are three assets in the economy

Value $b_t K_t$

Perpetual bonds:
- pay in money (at unit rate)
- endogenous price $B_t$ (in money)

Value $p_t K_t$

Capital

Value $q_t K_t$
• Buy bond, short money:
  – get current yield $1/B_t$
  – get appreciation in the price of the bond $\mu^B_t$ (relative to money)
  – pay short-term interest $\rho_t$
  – but perfectly hedged to fluctuations in money value (as $B_t$ is price in money)

• Thus, $dr^B_t - dr^M_t = 1/B_t + \mu^B_t - \rho_t$ (in the absence of shocks)

• A world portfolio of money and bonds earns return

$$(1 - b_t/p_t) \, dr^M_t + b_t/p_t \, dr^B_t = \tau (a - \iota)/p_t + \mu^p_t + \Phi(\iota_t) - \delta$$

• Combining these two equations, we can derive $dr^M_t$ and $dr^B_t$ separately...
- Bond (relative to money) rises in value by $B_t'/B_t$
- If money rises in value by $X$, then a world portfolio of money & bonds rises by

$$X \left(1 - \frac{b_t}{p_t} + \frac{b_t}{p_t} \frac{B_t'}{B_t}\right) = \frac{p_t'}{p_t}$$
- Thus, we can get $X = \ldots$
Equilibrium conditions

- Intermediary portfolio choice (with bonds)

\[
\max_{x,y} x \, \text{dr}_t^K + y \, \text{dr}_t^B + (1 - x - y)\text{dr}_t^M + \lambda \log(x (1 - \phi)q_t'/q_t + y B_t'/B_t X + (1 - x - y) X)
\]

- Market clearing: same as before, except to clear bonds

\[
b_t/(p_t + q_t) = y \eta_t \quad \text{(assuming only intermediaries hold bonds)}
\]

Intermediary aggregate net worth evolves as

\[
dN_t/dt = N_t (x \, \text{dr}_t^K + y \, \text{dr}_t^B + (1 - x - y)\text{dr}_t^M - r) \quad \text{(if no shocks)}
\]

\[
N_t' = N_t (x (1 - \phi)q_t'/q_t + y B_t'/B_t X + (1 - x - y) X) \quad \text{(if shock)}
\]

... a bit more algebra to solve, but logic the same as before
Example

- Parameters
  - $r = 5\%$
  - $a = 10\%$
  - $\delta = 4\%$
  - $\phi = 1\%$
  - $\phi = 20\%$
  - $\iota = 0$ (degenerate)

- No policy (red)
- Policy (black)
  - $\rho(\eta) = 0.25\% + 5\% \times \eta$
Observations

- As interest rate are cut in downturns, bonds held by intermediaries appreciate, this
  - protects intermediaries against shocks
  - increases the supply of asset that can be used as storage (weakens deflation)

- Because downturns are softened, for all $\eta$
  - drop in $\eta$ conditional on a shock $\downarrow$
  - price of capital $\uparrow$
  - money multiplier $\uparrow$
  - price of money $\downarrow$
  - intermediary allocation to capital $\uparrow$
  - household allocation to capital $\downarrow$
  - risk premia (and thus the rate of recovery, conditional on no shocks) $\downarrow$
Short-term interest rate policy

- Without long-maturity assets changes in short-term interest rate have no effect
  - Interest rate change equals instantaneous inflation change
- With bonds: of all monetary instruments, fraction $\frac{p_t}{p_t + b_t}$ is cash and $\frac{b_t}{p_t + b_t}$ are bonds
  - Deflationary spiral is less pronounced because as $\eta$ goes down, growing demand for money is absorbed by increase in value of long-term bonds
  - Also, intermediaries hedge risks better by holding long-term bonds
  - However, intermediaries also have greater incentives to increase leverage/risk-taking ex-ante
- Effectiveness of monetary policy depend on maturity structure (duration) of government debt
<table>
<thead>
<tr>
<th></th>
<th><strong>New Keynesian</strong></th>
<th><strong>I-Theory</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Key friction</td>
<td>Price stickiness &amp; ZLB</td>
<td>Financial friction</td>
</tr>
<tr>
<td>Driver</td>
<td>Demand driven as firms are obliged to meet demand at sticky price</td>
<td>Misallocation of funds increases incentive problems and restrains firms/banks from exploiting their potential</td>
</tr>
<tr>
<td>Monetary policy</td>
<td>Affect HH’s intertemporal trade-off</td>
<td>Ex-post: redistributional effects between financial and non-financial sector</td>
</tr>
<tr>
<td></td>
<td>Nominal interest rate impact real interest rate due to price stickiness</td>
<td>Ex-ante: insurance effect leading to moral hazard in risk taking (bubbles) - Greenspan put -</td>
</tr>
<tr>
<td></td>
<td>Redistributional between firms which could (not) adjust price</td>
<td></td>
</tr>
<tr>
<td>Time consistency</td>
<td>Wage stickiness</td>
<td>Moral hazard</td>
</tr>
<tr>
<td></td>
<td>Price stickiness + monopolistic competition</td>
<td></td>
</tr>
</tbody>
</table>
Conclusion

- Unified macro model to analyze both
  - Financial stability
  - Monetary stability
    - Liquidity spirals
    - Fisher deflation spiral

- Capitalization of banking sector is key state variable
  - Price stickiness plays no role (unlike in New Keynesian models)

- Monetary policy rule
  - Affects money supply
  - Redistributional monetary transmission channel
    - “stealth recapitalization”
  - Time inconsistency problem
    - “Greenspan put”
After a negative shock

- Intermediary net worth ↓

- Capital:
  - fire sales, price q ↓
  - Allocation efficiency ↓

- Money:
  - Lending + deposits ↓
  - value of money p ↓
  - Multiplier ↓

- Banking
  - Hit on both sides of balance sheet
  - Externality among banks
  - Competition ↓

- Intermediaries
  - Capital: fire sales, price q, Allocation efficiency
  - Money: Lending + deposits, value of money, Multiplier
  - Banking: Hit on both sides of balance sheet, Externality among banks, Competition