Motivation

- **Main features**
  - Model that combines money and intermediation – inside money
  - Value of money is endogenously determined
    - (Samuelson, Bewley, KM, ...)
  - Fisher (1933) deflationary spiral
    - Negative shock hits assets side of intermediaries’ balance sheets and is amplified through leverage and volatility dynamics
    - Decline in inside money, leads to deflationary pressure hits intermediaries’ balance sheet on the liability side
  - Inside money and outside money
    - "Endogenous" money multiplier $= f(health of intermediary sector)$
  - **Monetary policy**
    - Redistribution from/towards intermediary sector
      - Difference to New Keynesian framework
    - "Greenspan put" - time-inconsistency
      - Difference to example in Kydland-Precott
  - Unified framework to study financial and monetary stability
Motivation – some stylized facts/empirics

- **Stylized facts from current crisis**
  - Deflationary pressure
  - Money multiplier collapsed (see e.g. Goodhart 2010)
    - Monetary base increased
    - M3 stayed roughly constant
  - Banking sector profits were helped by monetary economics
  - Aggressive risk-taking before crisis

- **Empirical findings**
  - King- Ploser (1984) inside money has significantly more power for output than monetary base
  - Mervin King (1994) more indebted countries suffered sharper downturn in 1990s recession
  - Eisfeld-Rampini (2008) less capital reallocation in downturns
Roadmap

- Passive monetary policy - “Gold standard”
  - No money, no lending
  - Outside money (Polar case 1)
  - Perfect lending (Polar case 2)
  - Lending through intermediated lending (inside money)
    - Lending and money multiplier depends on net worth of i-sector
    - Deflation spiral

- Active Monetary Policy
  - Introduce long-term bond and OMO
  - Redistributional effects
  - “Greenspan put” - Time-inconsistency

- Differences to New Keynesian framework
No money

productive $\theta = 2\%$

less productive $98\%$

Assets | Liabilities
--- | ---
capital | net worth

No direct lending due to frictions

$y_t \rightarrow a(k_t)k_t$

$y_t \rightarrow a(1-k_t)k_t$

$2\%$ $k_t$

$98\%$ $(1-k_t)$
\[ d k_t = (\Phi(i_t) - \delta) k_t \, dt + \sigma k_t \, dZ_t \]

\[ dZ_t = 0 \]
More capital is in “productive hands”

Notice difference to Bewley economy
  - Productivity shocks vs. endowment shocks
Price of capital: $q = 7.84$
Price of money: $p = 7.04$
Fraction of capital held by productive HH: $\pi = 4.2\%$

Outside money

- **productive 2%**
  - Assets: capital, net worth
  - Liabilities:

- **less productive 98%**
  - Assets: capital, outside money, net worth
  - Liabilities:

Random switches

No direct lending due to frictions

Switch outside money for capital

Net worth
Other polar case: Unconstrained borrowing

- Price of capital $q = 8.38$
- Price of money $p = 2.09$
- Capital 50:50, i.e. $\kappa = 0.5$ (if no risk)
Compare

- With borrowing: \( q = 8.38, \ p = 2.09 \)
- Without borrowing: \( q = 7.84, \ p = 7.04 \)
  - capital allocated inefficiently – productive agents hold only 4.2%
  - underinvestment, as the price of capital \( q \) is depressed
  - total net worth of living agents (measured in current output) is actually greater, but investments generate lower return
Intermediaries

productive 2%

assets

loans from banks

net worth

equity held by banks

liabilities

productive HH

intermediaries

less productive 98%

assets

loans to productive households

deposits

net worth

equity of productive HH

net worth

bank deposits

money

capital

held by banks

held by banks

capital

held by banks

held by banks
Intermediaries

Assume that the bank is exposed to a fraction \( \geq \alpha \) of the risk of capital it finances, "skin in the game".

\textbf{productive 2%}

\begin{itemize}
  \item Assets
    \begin{itemize}
      \item loans from banks
      \item capital
    \end{itemize}
  \item Liabilities
    \begin{itemize}
      \item equity held by banks
      \item net worth
    \end{itemize}
\end{itemize}

\textbf{less productive 98%}

\begin{itemize}
  \item Assets
    \begin{itemize}
      \item deposits
    \end{itemize}
  \item Liabilities
    \begin{itemize}
      \item capital
      \item net worth
    \end{itemize}
\end{itemize}

\textbf{intermediaries}

\begin{itemize}
  \item Assets
    \begin{itemize}
      \item loans to productive households
      \item equity of productive HH
    \end{itemize}
  \item Liabilities
    \begin{itemize}
      \item deposits
      \item net worth
    \end{itemize}
\end{itemize}
The big picture

- Intermediaries net worth
  - Zero: like economy with only outside money (p high)
  - Very large: perfect lending (no frictions) (p low)
  - Intermediate: amplification – (non-linear effects)
    money multiplier changes
    outside money stays constant, inside money fluctuates

- Contracting friction:
  - Intermediaries have to hold $\alpha$ fraction of risk
    (in order to have incentive to monitor)
  - No contracting on productivity switch – relation to Bewley
  - (no distinction between cash flow news, $k_t$, and SDF news)
Endogenous risk - amplification

- Exogenous risk: cash flow news/shock on $k$
  \[ dk_t = (\phi(i_t) - \delta) k_t \, dt + \sigma k_t \, dZ_t \]

- Endogenous risk: SDF news
  - Price of capital (in terms of output)
    \[ dq_t = \mu^q_t q_t \, dt + \sigma^q_t q_t \, dZ_t \]
  - Asset side of HH: $d(k^q_t q_t) = \ldots + (\sigma^q_t + \sigma) (k_t q_t) \, dZ_t$

- Endogenous, fluctuating between 7.04 and 8.38, depending on the amount of lending/bank net worth
**Endogenous risk - amplification**

- **Exogenous risk:** cash flow news/shock on $k$
  \[ dk_t = (\phi(i_t) - \delta) k_t \, dt + \sigma k_t \, dZ_t \]

- **Endogenous risk:** SDF news
  - Price of capital (in terms of output)
    \[ dq_t = \mu_t^q q_t \, dt + \sigma_t^q q_t \, dZ_t \]
  - Asset side of HH: $d(k_tq_t) = \ldots + (\sigma_t^q + \sigma) (k_tq_t) \, dZ_t$
  - Price of money (aggregate value of money is $p_t K_t$)
    \[ dp_t = \mu_t^p p_t \, dt + \sigma_t^p p_t \, dZ_t \]
  - Money risk: $d(p_tK_t) = \ldots (p_tK_t) \, dt + (\sigma_t^p + \pi_t \sigma) (p_tK_t) \, dZ_t$
  - Bank risk:
    \[ n_t (\sigma_t^p + \pi_t \sigma) + x_t (\sigma_t^q + \sigma - \sigma_t^p - \pi_t \sigma) \]

Endogenous, fluctuating between 7.04 and 8.38, depending on the amount of lending/bank net worth

endogenous, fluctuating between 2.09 and 7.84

intermediaries will charge a fee $x_t f_t$ for taking on this risk
Amplification through “deflation spiral”

- As intermediaries’ net worth declines
- Intermediation + *inside money* shrinks
  - Economic activity declines
- Value of *outside money* rises - deflation
- Intermediaries are doubly hit
  - Asset side: asset values decrease
  - Liability side: real debt value increases
- Deflationary spiral
An equilibrium consists of functions that for each history of macro shocks \( \{Z_s, s \in [0, t]\} \) specify

- the price of capital \( q_t \), the value of money \( p_t \) and bank fees \( f_t \)
- capital holdings \( \pi_t \) and \( 1 - \pi_t \) and rates of investment of productive and unproductive households
- rates of consumption of productive and unproductive households
- such that
  - given prices and bank fees, productive households choose asset holdings, consumption and investment to maximize utility
  - given fees, banks lend and consume to maximize utility
  - unproductive households - portfolio of capital and money/deposits
  - markets for capital, output and loans clear
Scale invariance

- Our model is scale invariant in
  - $N_t$ (total intermediary net worth) an
  - $K_t$ (aggregate capital)
- $\eta_t = \frac{N_t}{K_t}$
- Solve for
  - $\pi_t = \text{fraction of capital managed by productive HH}$
  - $q_t = \text{price of physical capital}$
  - $p_t = \text{price of money}$
  - $f_t = \text{fee for intermediation (spread)}$
    as a functions of the state variable $\eta_t = \frac{N_t}{K_t}$
- Mechanic application of Ito’s lemma – equilibrium conditions get transformed into ordinary differential equations for $\pi(\eta)$, $q(\eta)$, $p(\eta)$ and $f(\eta)$
Equilibrium: $p$ and $q$
Observations

As $\eta$ goes up:

- Intermediaries take on more risk, competition increases and fees for intermediation services go down
- Capital is allocated more efficiently, more productively
- The price of capital increases due to higher demand $\Rightarrow$ greater productive efficiency
- Unproductive agents hold more inside money (deposits in financial institutions) and less outside fiat money
- The price of fiat money goes down (so it would go up in the event that $\eta$ falls, leading to deflation)
- There is an additional source of amplification relative to an economy without money: as $\eta$ goes down, the value of assets fall, while the value of liabilities increase (due to deflation)
Roadmap

- Big picture overview
- Passive monetary policy: “Gold standard”
  - Model setup
  - 2 polar cases
    - Impaired i-sector: “lending” via outside money only
    - Perfect i-sector: perfect lending
  - General model with aggregate risk
    - Lending and money multiplier depends on net worth of i-sector
    - Deflation spiral

Active Monetary Policy

- Introduce long-term bond
  - Short-term interest rate policy
  - Asset purchase and OMO
- Redistributional effects
- “Greenspan put” - Time-inconsistency
Monetary policy

So far, outside money fixed, pays no interest ("Gold standard") + no central bank

- Short-term interest rate policy
  - Central bank accepts deposits & pays interest (by printing money)
    - E.g. short-term interest rate is lowered when \( \eta \) becomes small
  - Introduce consul (perpetual) bond
    - pays interest rate in ST (outside) money
  - Budget neutral policies

- Asset purchases
  - Bond – open market operations (OMO)
  - Outside equity
  - Risky capital \( k_t \)

- Perfect commitment (Ramsey) vs. imperfect commitment
  - Markovian (in \( \eta \))
Instrument 1: short-term interest rate

- Productive
- Intermediary
- Less productive

- Monitoring
  - Diamond (1984)
  - Holmström-Tirole (1997)

- Incentive for intermediary to monitor (have to hold outside equity)
- Incentive for entrepreneur to exert effort

\[ \phi \geq \alpha(\lambda) \]

\[ (1-\phi) \]

\[ k_t p_t \]

[Diagram with nodes labeled as capital, debt, equity, inside money, outside money, short-term interest rate, and long-term government bonds. Diagram shows the flow and relationships between these elements.]
**Instrument 1: short-term interest rate**

- Without long maturity assets changes in short-term interest rate has no effect
  - Interest rate change equals instantaneous inflation change
- With long-term bond
  (monetary instruments: fraction $\chi$ is cash and $1 - \chi$ are bonds)
- with 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
Instrument 2: Asset purchase (OMO)

- Open market operation
  - changes “maturity structure of government obligations”
  - Redistributes wealth if monetary policy is accommodative

- Intuition:
  - As $\eta$ declines $i(\eta)$ is lowered. This increases the value of G-bonds which helps to stabilize $\eta$.
  - For low $\eta$ maturity structure of overall o-money rises
  - (Monetary policy should depend on maturity structure of government debt)

- Aside: short-term interest rate changes often also involve very small scale OMO
Optimality of monetary policy

- Lowers risk on liability side of intermediaries
  \[(\sigma_t^q + \sigma - \sigma_t^p - \kappa_t \sigma)\]

- Signal = fundamental risk + valuation risk + money risk
  - Signal precision increases
  - Improves “incentives”
Moral hazard – “Liquidity bubbles”

- Accommodating Monetary policy rule
  “Greenspan put”
  - Ex-post efficient – recapitalizes intermediary sector
  - Ex-ante inefficient – if excessive
    stimulates risk taking on behalf of intermediaries
    “Liquidity bubble”

- Time consistency problem with
  - Intermediaries/bankers instead of workers/labor unions

- Rationale for banking regulation
  - To reduce probability of low $\eta$ realizations
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- Differences to New Keynesian framework
<table>
<thead>
<tr>
<th>Key friction</th>
<th>Price stickiness</th>
<th>Financial friction</th>
</tr>
</thead>
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<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>First order effects</td>
<td>Affect HH’s intertemporal trade-off Nominal interest rate impact real interest rate due to price stickiness</td>
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<td>Second order effects</td>
<td>Redistributional between firms which could (not) adjust price</td>
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<td>Wage stickiness Price stickiness + monopolistic competition</td>
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<td>Risk build-up phase</td>
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<td>Endogenous due to accommodating monetary policy</td>
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<tr>
<td>Net worth dynamics</td>
<td>zero profit → no dynamics</td>
<td>dynamic</td>
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<tr>
<td>State variables</td>
<td>Many exogenous shocks Intermediation/friction shock</td>
<td>Endogenous intermediation shock</td>
</tr>
<tr>
<td>Monetary policy rule</td>
<td>Taylor rule (is approximately optimal only if difference in u’ is well proxied by output gap) • spreads • credit aggregates (?)</td>
<td>Depends on signal quality and timeliness of various observables</td>
</tr>
<tr>
<td>Policy instrument</td>
<td>Short-term interest rate + expectations</td>
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<td>Role of money</td>
<td>In utility function (no deflation spiral)</td>
<td>Storage Precautionary savings</td>
</tr>
</tbody>
</table>
Conclusions/further research

- Unified macromodel to analyze both
  - Financial stability 2\textsuperscript{nd} pillar of the ECB
  - Monetary stability 1\textsuperscript{st} pillar
    - 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
  - Redistributional feature
  - Time inconsistency problem – “Greenspan put”

- Future research
  - Persistent productivity shocks
  - Maturity mismatch in intermediary sector