A Model of Capital and Crises

Zhiguo He
Booth School of Business, University of Chicago

Arvind Krishnamurthy
Northwestern University and NBER

Stockholm School of Economics, December 2010
Introduction

- Intermediary capital can affect asset prices.
- We study the role of distressed intermediary capital in the crises of market with complex asset classes (e.g. MBS).
Introduction

- Intermediary capital can affect asset prices.
- We study the role of distressed intermediary capital in the crises of market with complex asset classes (e.g. MBS).
- A General Equilibrium (GE) model where intermediaries, rather than households, are marginal.
  - Frictions are endogenously derived based on optimal contracting considerations. This affects prices.
  - Contracting takes future price dynamics into consideration.
Introduction

- Intermediary capital can affect asset prices.
- We study the role of distressed intermediary capital in the crises of market with complex asset classes (e.g. MBS).
- A General Equilibrium (GE) model where intermediaries, rather than households, are marginal.
  - Frictions are endogenously derived based on optimal contracting considerations. This affects prices.
  - Contracting takes future price dynamics into consideration.
- Mechanism: Intermediation capital affects participation/risk-sharing.
- In normal times households participate through intermediation;
- When intermediaries suffer losses,
  - Distressed intermediary sector averse to hold risky positions, risk premium goes up.
  - Households “fly to quality,” drive down interest rate.
Unit supply of **risky asset** with dividend $\frac{dD_t}{D_t} = gdt + \sigma dZ_t$, and **riskless asset** in zero-net supply.

- Risky asset price $P_t$ and interest rate $r_t$ are determined in GE.

**Households** $\mathbb{E} \left[ \int_0^\infty e^{-\rho^h t} \ln c^h_t dt \right]$.

- Limited participation in risky asset market. They invest in intermediaries.

**Specialists** $\mathbb{E} \left[ \int_0^\infty e^{-\rho t} \ln c_t dt \right]$, $\rho < \rho^h$. They run **intermediaries**.

- Only intermediaries/specialists can invest in the risky asset. They are marginal investors.
- Derive **Intermediation Constraint** from moral hazard primitives.
Intermediation: 1) Short-term contracting between agents; 2) Equilibrium in competitive intermediation market;
   ▶ No friction in short-term-borrowing/repo market.
Asset pricing: 3) Optimal consumption/portfolio decisions; 4) GE.
The Heart of the Model: Capital Constraint

- Say household with wealth $W^h_t$, and specialist with wealth $W_t$.
  - Given specialist’s contribution $W_t$ in the intermediary, household contributes $T^h_t$ as equity investment.
  - Capital Constraint: $T^h_t$ is capped at $mW_t$.

- Intermediation capacity $mW_t$ is increasing in the specialist's contribution $W_t$, as reflection of agency friction.

1. Intermediary capital requirement: outside/inside contribution ratio; (Holmstrom-Tirole, QJE)
   - Officers/Directors inside holdings in financial industry around 18%.
2. Incentive contract— the performance share of hedge fund managers. Think of "2 and 20."
3. Mutual funds' flow-performance sensitivity. Specialist’s $W_t$ tracks his past gains and losses (Shleifer-Vishny, JF)
The Heart of the Model: Capital Constraint

- Say household with wealth $W_t^h$, and specialist with wealth $W_t$.
  - Given specialist’s contribution $W_t$ in the intermediary, household contributes $T_t^h$ as equity investment.
  - Capital Constraint: $T_t^h$ is capped at $mW_t$.

- Intermediation capacity $mW_t$ is increasing in the specialist’s contribution $W_t$, as reflection of agency friction.

- How to interpret $m$?
  1. Intermediary capital requirement: outside/inside contribution ratio; (Holmstrom-Tirole, QJE)
     - Officers/Directors inside holdings in financial industry around 18%.
  2. Incentive contract—the performance share of hedge fund managers. Think of “2 and 20.”
  3. Mutual funds’ flow-performance sensitivity. Specialist’s $W_t$ tracks his past gains and losses (Shleifer-Vishny, JF)
Intermediation Constraint: An Example

- Say $m = 1$, $W^h_t = 80$. Comparing $W^h_t$ to $mW_t$.

- **Unconstrained Region**: $W_t = 100$. Then $T^h_t = W^h_t = 80$;
  - Zero net debt. Risky asset price $P_t = W_t + W^h_t = 180$.
  - Fund's total equity 180. Intermediary holds risky asset without leverage, first-best risk sharing.

- **Constrained Region**: $W_t = 50$. Then $T^h_t = mW_t = 50$;
  - Intermediary's total equity is $50 + 50 = 100$. But $P_t = 130$.
  - In equilibrium, the intermediary borrows 30 from the debt market; it is supplied by households $W^h_t = 30$.
  - Specialist and household have equal shares in the intermediary; Specialist's leveraged position in risky asset: $\alpha = \frac{50 + 15}{50} = 130\%$.
  - Risk premium has to adjust to make this high leverage optimal.
Intermediation Constraint: An Example

- Say $m = 1$, $W^h_t = 80$. Comparing $W^h_t$ to $mW_t$.
- **Unconstrained Region:** $W_t = 100$. Then $T^h_t = W^h_t = 80$;
  - Zero net debt. Risky asset price $P_t = W_t + W^h_t = 180$.
  - Fund’s total equity 180. Intermediary holds risky asset without leverage, first-best risk sharing.
- **Constrained Region:** $W_t = 50$. Then $T^h_t = mW_t = 50$;
  - Intermediary’s total equity is $50 + 50 = 100$. But $P_t = 130$.
  - In equilibrium, the intermediary borrows 30 from the debt market;
    - It is supplied by households $W^h_t - T^h_t = 30$.
  - Specialist and household have equal shares in the intermediary;
  - Specialist’s leveraged position in risky asset: $\alpha = \frac{50 + 15}{50} = 130\%$.
  - Risk premium has to adjust to make this high leverage optimal.
Risk Premium and Interest Rate

Scaled Specialist's Wealth $w$

Risk Premium

- $w_c^c(m = 4) = 13.02$
- $w_c^c(m = 6) = 9.07$

Interest Rate

- $w_c^c(m = 6) = 9.07$
- $w_c^c(m = 4) = 13.02$
Road Map

- Intermediation contracts;
  - IC constraints, maximum exposure supply, etc.
- Agents’ consumption/portfolio decisions;
- Competitive equilibrium in intermediation markets;
- Equilibrium asset prices.
- Conclusion.
**Intermediation Stage Game**

- **Short-term** contracts only. At time $t$, contract from $t$ to $t + dt$.
- Household with wealth $W_t^h$, and specialist with wealth $W_t$.
  - Household contributes $T_t^h$, specialist $T_t$. $T_t = T_t^h + T_t$. 

Moral Hazard:

1. Unobserved due diligence action $s_t = f(0, 1)$.
2. Unobserved portfolio choice $E_{It}$ (dollar exposure to risky asset); Undoing activity. Not crucial.

Fund's return $E_{It}(dR_t + r_t dt - \mu_t dt)$, private benefits $B_t dt$. Focus on implementing working.

Risky asset return $dR_t = dP_t + D_t dt$. $P_t$ and interest rate $r_t$ are endogenous.
Intermediation Stage Game

- **Short-term** contracts only. At time $t$, contract from $t$ to $t + dt$.
- Household with wealth $W^h_t$, and specialist with wealth $W_t$.
  - Household contributes $T^h_t$, specialist $T_t$. $T^l_t = T^h_t + T_t$.
- Specialist in charge of intermediary. **Moral Hazard:**
  1. Unobserved **due diligence action** $s_t = \{0, 1\}$.
     - Shirking ($s_t = 1$) reduce return by $X_t$ but brings private benefit $B_t$.
  2. Unobserved **portfolio choice** $E^l_t$ (dollar exposure to risky asset);
     - Undoing activity. Not crucial.
- Fund’s return $E^l_t (dR_t - r_t dt) + T^l_t r_t dt - s_t X_t dt$, private benefit $s_t B_t dt$. Focus on implementing working.
  - Risky asset return $dR_t = \frac{dP_t + D_t dt}{P_t}$ and interest rate $r_t$ are endogenous.
Intermediation Contract

- **Affine contracts** for sharing returns.
  - \( \beta_t \): specialist’s share; \( K_t \, dt \): transfer to specialist.

- \( \Pi_t \equiv \left( T_t, T_t^h, \beta_t, \hat{K}_t \right) \in [0, W_t] \times [0, W_t^h] \times [0, 1] \times \mathbb{R} \).

- Set \( K_t \equiv \left( \beta_t T_t^l - T_t \right) r_t + \hat{K}_t \).

- Dynamic budget constraint

\[
\begin{align*}
    dW_t &= W_t r_t \, dt - c_t \, dt + \beta_t \mathcal{E}_t^l \left( dR_t - r_t \, dt \right) + K_t \, dt, \\
    dW_t^h &= W_t^h r_t \, dt - c_t^h \, dt + (1 - \beta_t) \mathcal{E}_t^l \left( dR_t - r_t \, dt \right) - K_t \, dt.
\end{align*}
\]

- Reduce contract to \((\beta_t, K_t)\). **Sharing rule** and **fee**.
  - Specialist chooses \( \mathcal{E}_t = \beta_t \mathcal{E}_t^l \). Household buys risk exposure \( \mathcal{E}_t^h = (1 - \beta_t) \mathcal{E}_t^l \) from intermediary.
  - In competitive intermediation market, the fee will take some simple linear form.
IC Constraint and Maximum Household’s Exposure

- $\mathcal{E}_t^l$ fund’s total risk exposure. S: $\mathcal{E}_t = \beta_t \mathcal{E}_t^l$, H: $\mathcal{E}_t^h = (1 - \beta_t) \mathcal{E}_t^l$.

- $dW_t = W_t r_t dt - c_t dt + \beta_t \mathcal{E}_t^l (dR_t - r_t dt) + K_t dt + s_t (B_t - \beta_t X_t) dt$.

- IC constraint: specialist bears at least certain fraction of risk.
  - Incentive provision. Skin in the game.
  - No shirking: $\beta_t X_t - B_t \geq 0 \Rightarrow \beta_t \geq \frac{B_t}{X_t} \equiv \frac{1}{1+m}$.
  - A lower bound on $\beta_t$. 
IC Constraint and Maximum Household’s Exposure

- $\mathcal{E}_t^l$ fund’s total risk exposure. S: $\mathcal{E}_t = \beta_t \mathcal{E}_t^l$, H: $\mathcal{E}_t^h = (1 - \beta_t) \mathcal{E}_t^l$.

- $dW_t = W_t r_t dt - c_t dt + \beta_t \mathcal{E}_t^l (dR_t - r_t dt) + K_t dt + s_t (B_t - \beta_t X_t) dt$.

- IC constraint: specialist bears at least certain fraction of risk.
  - Incentive provision. Skin in the game.
  - No shirking: $\beta_t X_t - B_t \geq 0 \Rightarrow \beta_t \geq \frac{B_t}{X_t} \equiv \frac{1}{1+m}$.
  - A lower bound on $\beta_t$.

- Specialist always chooses $\beta_t \mathcal{E}_t^l = \mathcal{E}_t^*\text{ independent of } \beta_t$.
  - In the paper we show $\mathcal{E}_t^*$ is independent of $K$.

- Household exposure from the contract

\[
\mathcal{E}_t^h = (1 - \beta_t)\mathcal{E}_t^l = \frac{1 - \beta_t}{\beta_t} \mathcal{E}_t^*.
\]

- Household maximum exposure $\mathcal{E}_t^h \leq m\mathcal{E}_t^*$. 
**Key Intuition and Equity Implementation**

- The households exposure is capped due to agency frictions 
  \[ \mathcal{E}_t^h \leq m\mathcal{E}_t^* \].

- It caps a risk-sharing rule between households and specialists.
  - Incentive provision implies that specialists have to bear sufficient risk.

- In bad times this friction kicks in.
  - Even if specialists wealth is low, they still have to bear disproportionally large risk.
Key Intuition and Equity Implementation

- The households exposure is capped due to agency frictions 
  \[ E_t^h \leq mE_t^*. \]
- It caps a risk-sharing rule between households and specialists.
  - Incentive provision implies that specialists have to bear sufficient risk.
- In bad times this friction kicks in.
  - Even if specialists wealth is low, they still have to bear disproportionately large risk.
- **Equity implementation**: Households (outsiders) cannot hold more than \[ \frac{m}{1+m} \] (equity) shares.
- **Equity capital constraint**: Given specialist’s equity \( W_t \), households can make at most \( mW_t \) equity contributions.
- Recall contract \((\beta_t, K_t)\). We have derived equilibrium \( \beta_t \). What determines fee \( K_t \)?
  - Households pay competitive fees in the intermediation market.
Competitive Intermediation Market

Definition. At time $t$, specialists make offers $(\beta_t, K_t)$ to specialists, and households can accept/reject the offers. The intermediation market reaches equilibrium if:

1. $\beta_t$ is incentive compatible for each specialist.
2. There is no coalition of households and specialists, such that some incentive-compatible contracts can make households strictly better off while specialists weakly better off.
**Competitive Intermediation Market**

**Definition.** At time $t$, specialists make offers $(\beta_t, K_t)$ to specialists, and households can accept/reject the offers. The intermediation market reaches equilibrium if:

1. $\beta_t$ is incentive compatible for each specialist.
2. There is no coalition of households and specialists, such that some incentive-compatible contracts can make households strictly better off while specialists weakly better off.

**Lemma 4:** Given symmetry at the beginning of time-$t$, the resulting intermediation equilibrium is symmetric.

**Lemma 5:** In equilibrium, households face a per-unit-exposure price of $k_t \geq 0$: to purchase $\mathcal{E}_t^h$, he has to pay $K_t = k_t \mathcal{E}_t^h$.

- Idea: equivalence between core and Walrasian equilibrium.
- Households and specialists form coalition to chop off the exposure linearly.

- Now we start studying agent’s consumption/portfolio problems
Households’ Consumption/Portfolio Rules

- Log investors. Simple consumption rule; myopic mean-variance portfolio choice.

- Risky asset return \( dR_t = (\pi_{R,t} + r_t) \, dt + \sigma_{R,t} \, dZ_t \).

- Household max \( \max_{\{c_t, \mathcal{E}_t\}} \mathbb{E} \left[ \int_0^\infty e^{-\rho t} \ln c_t^h \, dt \right] \) subject to

\[
dW_t^h = W_t^h r_t \, dt - c_t^h \, dt + \mathcal{E}_t^h (dR_t - r_t \, dt) - k_t \mathcal{E}_t^h \, dt.
\]

- Relative to standard problem, households achieve exposure \( \mathcal{E}_t^h \) by paying per-unit-cost of \( k_t \).

- Optimal consumption \( c_t^{h^*} = \rho^h W_t^h \), optimal exposure

\[
\mathcal{E}_t^{h^*} = \frac{\pi_{R,t} - k_t}{\sigma_{R,t}^2} W_t^h.
\]

  - Optimal risk exposure is decreasing in exposure price \( k_t \).
Specialists’ Consumption/Portfolio Rules

- Specialist supplies exposure $\frac{1-\beta_t}{\beta_t} \mathcal{E}^*_t$. Given exposure price $k_t$, he gets intermediation fees $K_t dt = k_t \left( \frac{1-\beta_t}{\beta_t} \mathcal{E}^*_t \right) dt$.

- The specialist is solving: $\max_{\{c_t, \mathcal{E}_t, \beta_t\}} \mathbb{E} \left[ \int_0^\infty e^{-\rho t} \ln c_t dt \right]$ subject to

$$dW_t = \mathcal{E}_t (dR_t - r_t dt) + \max_{\beta_t \in [\frac{1}{1+m}, 1]} \left( \frac{1-\beta_t}{\beta_t} \right) k_t \mathcal{E}^*_t dt + W_t r_t dt - c_t dt.$$ 

- $\beta_t^* = \frac{1}{1+m}$ if $k_t > 0$, otherwise $\beta_t^* \in \left[ \frac{1}{1+m}, 1 \right]$ if $k_t = 0$. Exposure supply schedule.

- $\mathcal{E}^*_t$, as the exposure expected by households, is not under the specialist’s control.

  - In REE, this must coincide with the specialist’s optimal choice.

- Solution: $c_t^* = \rho W_t$ and $\mathcal{E}_t^* = \frac{\pi R_t}{\sigma^2 R_t} W_t$, and specialists receive fee of $q_t W_t dt$ where $q_t = \left( \frac{1-\beta_t^*}{\beta_t^*} \right) k_t \frac{\pi R_t}{\sigma^2 R_t}$.
Exposure demand $E_t^h(kt) = \frac{\pi_{R,t} - kt}{\sigma_{R,t}^2} W_t^h$; exposure supply is free with maximum cap $mE_t^* = m\frac{\pi_{R,t}}{\sigma_{R,t}^2} W_t$. 

Proposition 1: The economy is in one of two equilibria:

1. Unconstrained region $E_t^h(kt) = 0$, and $\beta_t < 1 + m$.
2. Constrained region $E_t^h(kt) = m$, and $\beta_t = 1 + m$.

Excess intermediation supply, zero rent. 
Scarce intermediation supply, positive rent.
Equilibrium in Competitive Intermediation Market

- Exposure demand \( E_t^h(kt) = \frac{\pi_{R,t} - kt}{\sigma_{R,t}^2} W_t^h \); exposure supply is free with maximum cap \( mE_t^* = m\frac{\pi_{R,t}}{\sigma_{R,t}^2} W_t \).

**Proposition 1:** The economy is in one of two equilibria:

1. **Unconstrained region** \( E_t^h(kt = 0) < mE_t^* \), and \( \beta_t < \frac{1}{1+m} \).
   - Excess intermediation supply, zero rent.

2. **Constrained region** \( E_t^h(kt > 0) = mE_t^* \), and \( \beta_t = \frac{1}{1+m} \).
   - Scarce intermediation supply, positive rent.
Unconstrained vs. Constrained Regions (1)

Unconstrained Region

price $k_t$

Exposure demand

$\left( \frac{\pi_{R,t} - k_t}{\sigma^2_{R,t}} \right) W_t^k$

Exposure supply

$\begin{cases} 
0, m \left( \frac{\pi_{R,t}}{\sigma^2_{R,t}} \right) W_t & \text{if } k_t = 0, \\
\frac{m}{k_t} \left( \frac{\pi_{R,t}}{\sigma^2_{R,t}} \right) W_t & \text{if } k_t > 0.
\end{cases}$
Unconstrained vs. Constrained Regions (1)

Constrained Region

Exposure supply
\[
\begin{cases}
0, m \left( \frac{\pi_K}{\sigma_K^2} \right) W_t & \text{if } k_t = 0, \\
m \left( \frac{\pi_K}{\sigma_K^2} \right) W_t & \text{if } k_t > 0.
\end{cases}
\]

Exposure demand
\[
\left( \frac{\pi_{K_t} - k_t}{\sigma^2_{K_t}} \right) W_t^k
\]
Equilibrium Asset Prices: Solution

- We derive everything in closed form.
- State variables \((D_t, W_t)\). Scales with \(D_t\).
- Uni-dimensional state variable \(w_t = W_t / D_t\) captures wealth distribution.

\[
\begin{align*}
\text{Consumption rules } & \quad c_t = \rho W_h, \quad c_h = \rho h \quad W_h \\text{captures wealth} \\
\text{Zero net debt } & \quad W_t + W_h = P_t, \quad \text{goods clearing} \quad c_t + c_h = D_t. \quad \text{So } \quad P_t D_t = 1 - \rho h + \rho h w_t.
\end{align*}
\]

- Specialist's risky position \(\alpha_t = P_t (1 + m) W_t \geq 1\) in constrained region.
Equilibrium Asset Prices: Solution

- We derive everything in closed form.
- State variables \((D_t, W_t)\). Scales with \(D_t\).
- Uni-dimensional state variable \(w_t \equiv W_t / D_t\) captures wealth distribution.
- Consumption rules \(c^*_t = \rho W_t^h, c^h_t = \rho^h W_t^h\).
- Zero net debt \(W_t + W_t^h = P_t\), goods clearing \(c^*_t + c^h_t = D_t\). So

\[
\frac{P_t}{D_t} = \frac{1}{\rho^h} + \left(1 - \frac{\rho}{\rho^h}\right) w_t.
\]

- Specialist’s risky position \(\alpha_t = \frac{P_t}{(1+m)W_t} > 1\) in constrained region.
The economy is in constrained region whenever

\[ w_t = \frac{W_t}{D_t} < w^c \equiv \frac{1}{m\rho^h + \rho}. \]

- Unconstrained region, \( w_t \) moves deterministically. Constrained region, specialists take a higher leverage than households, so \( w_t \) drops when fundamental falls.

- When intermediary capital \( W_t \) falls,
  - Risk premium rises;
  - Interest rate falls;
  - Volatility rises;
  - Correlation endogenously rises.
  - Spreads on loans requiring capital (can be interpreted as fee \( q_t \)) rise.
### Asset Pricing (2)

<table>
<thead>
<tr>
<th></th>
<th>Uncon. Region</th>
<th>Con. Region</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha_t$</td>
<td>1</td>
<td>$\frac{1+(\rho^h-\rho)w_t}{(1+m)\rho^h w_t} &gt; 1$</td>
</tr>
<tr>
<td>$\sigma_{R,t}$</td>
<td>$\sigma$</td>
<td>$\frac{\sigma}{1+(\rho^h-\rho)w_t} \left( \frac{(1+m)\rho^h}{m\rho^h+\rho} \right) &gt; \sigma$</td>
</tr>
<tr>
<td>$\pi_{R,t}$</td>
<td>$\sigma^2$</td>
<td>$\frac{\sigma^2}{w_t(m\rho^h+\rho)} \left( \frac{(1+m)\rho^h}{m\rho^h+\rho} \right) \left( \frac{1}{1+(\rho^h-\rho)w_t} \right) &gt; \sigma^2$</td>
</tr>
<tr>
<td>$f_t$</td>
<td>0</td>
<td>$\frac{\sigma^2}{(\rho+m\rho^h)^2 w_t^2} \frac{1-(\rho+m\rho^h)w_t}{1-\rho w_t} &gt; 0$</td>
</tr>
<tr>
<td>$r_t$</td>
<td>$\rho^h + g - \sigma^2 + \rho (\rho - \rho^h) w_t$</td>
<td>$-\sigma^2 \left[ \rho \left( \frac{(1+m)(1-w_t)}{1-w_t} - m^2 \rho^h \right) + (m\rho^h)^2 \right] / (1-\rho w_t)(\rho+m\rho^h)^2$</td>
</tr>
</tbody>
</table>
Risk Premium and Interest Rate

- Asymmetry. Crisis like.
- When constraint binds $w_t < w^c$, specialist bears disproportionally large risk, causing more volatile pricing kernel.
- Flight to quality. 1) Specialists precautionary savings. 2) Household fly to debt market.
Consider an infinitesimal asset with
\[
\frac{d\hat{D}_t}{\hat{D}_t} = \frac{dD_t}{D_t} + \hat{\sigma} d\hat{Z}_t.
\]

The correlation between \(dR_t\) and \(\hat{dR}_t\) is:
\[
\text{corr}(dR_t, \hat{dR}_t) = \frac{1}{\sqrt{1 + (\hat{\sigma} / \sigma_{R,t})^2}}.
\]

Unconstrained region, since \(\sigma_R\) is constant, the correlation is constant.

Constrained region, rising correlation.

Market return volatility \(\sigma_{R,t}\) rises, magnifying the common component of returns.
Comovement (2)

- An MBS asset with payoff $X_T = 1$ if $W_T > W$, 0 otherwise.
- Price $Q_0$. Calculate $\text{Cov}(dR, dQ_0)$.

- For high $W$, negative *interest rate effect*: essentially it is bond;
- For low $W$, positive *liquidation effect*: essentially it is stock.
Observable Portfolio Case

- The key: $E_t^h \leq mE_t^*$ due to moral-hazard friction.
- Why do we set the specialist’s portfolio choice to be unobservable?
  - Consistent with limited participation;
  - Specialist’s exposure supply $E_t^*$ is independent of fees.
Observable Portfolio Case

- The key: \( E_t^h \leq mE_t^* \) due to moral-hazard friction.

- Why do we set the specialist’s portfolio choice to be unobservable?
  - Consistent with limited participation;
  - Specialist’s exposure supply \( E_t^* \) is independent of fees.

- Observable portfolio choice. Households can pay the fee per-unit-of delivered exposure, rather than the “guessed” exposure which is linear in \( W_t \) in equilibrium.

- The maximum supply \( mE_t^* \) is increasing in the exposure price \( k_t \):

  \[
  mE_t^* = m \frac{\pi_{R,t} + mk_t}{\sigma_{R,t}^2} W_t.
  \]

- Closed-form solution for everything. Qualitatively similar to unobservable case.

- Non-affine contract, to the extent of dealing with unobservability of \( E_t^* \), will not change our qualitative results.
Concluding Remarks (1)

- Canonical intermediation friction meets canonical GE asset pricing models.
- Calibratable, easy to quantify effects.
- We have another paper where specialists have general CRRA power utility, with capital constraint as given.
  - Add in labor income, debt households (create leverage in unconstrained region), and other necessary twists...
  - Study the crisis dynamics (especially recovery), government liquidity injection policies, etc.
Concluding Remarks (2): Calibration result

Crisis Recovery

<table>
<thead>
<tr>
<th>Transit to</th>
<th>Transit from 20%</th>
<th>Incremental Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>15%</td>
<td>0.23</td>
<td>0.23</td>
</tr>
<tr>
<td>12.5%</td>
<td>0.46</td>
<td>0.23</td>
</tr>
<tr>
<td>7.5%</td>
<td>2.62</td>
<td>1.60</td>
</tr>
<tr>
<td>5%</td>
<td>12.88</td>
<td>7.10</td>
</tr>
</tbody>
</table>