Macroeconomic Framework for Quantifying Systemic Risk by Zhiguo He and Arvind Krishnamurthy

Discussion by Tobias Adrian

Federal Reserve Bank of New York

The New Normal for Monetary Policy, FRBSF, March 27, 2015

The views expressed here are those of the author and do not necessarily reflect those of the Federal Reserve Bank of New York or the Federal Reserve System
Overview

- Contribution of the paper
  1. He-Krishnamurthy have been pioneering macro-finance models with intermediaries, building a coherent framework over the years
  2. The current paper is applying this framework to study systemic risk

- Review
  1. The model
  2. The quantitative results

- My comments
  1. Funds and banks
  2. Stress testing
Households and Production

- **Households**

\[
\mathbb{E} \left[ \int_0^{+\infty} e^{-(\rho t)} \frac{(c_t^y)^{1-\phi}(c_t^h)^{\phi}}{1-\gamma} \right] dt
\]

- **Production**

\[
Y_t = AK_t
\]

\[
dK_t/K_t = i_t - \delta dt + \sigma dZ_t
\]

\[
\Phi (i_t, K_t) = i_t K_t + \frac{\kappa}{2} (i_t - \delta)^2 K_t
\]

- **Price of capital** \( q_t \), **price of housing** \( P_t \)
Intermediaries

- Mean-variance preferences, equity capacity constraint \( E_t \leq \varepsilon_t \)

\[
\mathbb{E} [dR_t - r_t dt] + \frac{m}{2} \nabla [dR_t] \quad \text{s.t.} \quad \frac{d\varepsilon_t}{\varepsilon_t} = mdR_t
\]
Intermediaries

- Mean-variance preferences, equity capacity constraint $E_t \leq \varepsilon_t$

$$
\mathbb{E} [dR_t - r_t dt] + \frac{m}{2} \nabla [dR_t] \quad \text{s.t.} \quad \frac{d\varepsilon_t}{\varepsilon_t} = m dR_t
$$

$\varepsilon_t$ \equiv \text{Aggregate bank capital capacity}

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**Figure 1: Model Schematic**

- Loans to Capital Producers $i_t$
- Intermediary Sector
- Capital $q_t K_t$
- Housing $P_t H$
- Equity $E_t$
- Debt $W_t - E_t$
- Constraint: $E_t \leq \varepsilon_t$
- No constraint

**Household Sector**
- Financial Wealth $W_t = q_t K_t + p_t H$
- $(1 - \lambda) W_t$
- $\lambda W_t$
Amplification: Model and Data

- Strong amplification effects when the capital constraint binds
- Captures joint dynamics of intermediary equity, land prices, spreads
Intermediary Wealth Share $e = E/K$ as Key State Variable

- Leverage inversely related $e$
- Systemic risk when capital constraint binds and leverage shoots up
Key Assumption: Capital Constraint is Mutual Fund Flow-Performance Chevalier-Ellison 1997

- Skin in the game constraint is key amplification mechanism
- Generates strongly countercyclical leverage
Comments

1. Funds and banks

2. Stress testing
Countercyclical Net Equity Issuance of Banks

- Huge issuance in the depth of the crisis
- Same is true for dealers
Countercyclical $e = \frac{E}{K}$ for Banks

- Ratio of commercial bank equity to nonfinancial equity declines during expansions and rises sharply during downturns
Procyclical Book Leverage of Banks

▶ Countercyclical equity results in procyclical leverage
Procyclical Book Leverage of Banks

Procyclical Book Leverage of Banks

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Comment 1: Funds and Banks

Procyclical Book Leverage of Broker-Dealers

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Procyclical Equity of He-Krishnamurthy

- Countercyclical leverage is due to procyclical equity flows
- Data strongly supports this for mutual funds
Reconciling Cyclicality of Leverage
Adrian-Boyarchenko 2013

Households
Invest in risk-free debt, non-bank financial sector and bank financial sector

Banks
Create new capital; financed by debt issuance to the households

Funds
Hold existing capital; financed by profit sharing contracts with households

Producers
A-K production technology; financed by financial sector
Leverage Growth and Financial Sector Asset Growth

(c) Model

(d) Data

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Funds and Banks

- He-Krishnamurthy matches the fund sector well
- Modeling the bank sector requires different constraints
- This explains procyclicality of financial sector assets
Stress Testing in He-Krishnamurthy

- Stress test scenario is mapped into underlying shock to capital
- Stress test assumptions similar to CCAR
  - 6 quarters of adverse shocks to equity
  - Cumulatively -30% return on equity
- Probability of crisis calculated via simulation
- Model captures feedback effects
Comment 2: Stress Testing

Probability of Crisis in He-Krishnamurthy

- What if capital regulation would be based to stress tests?

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Stress Test based Capital Regulation

Consider a forward-looking capital constraint

\[
\max_{\{i, \beta, k\}} \mathbb{E}_t \left[ \int_t^{\tau^D} e^{-\rho(s-t)} w_t(i, \beta, k) \, ds \right]
\]

s.t.

\[
\theta_t^{-1} \geq \sqrt{\mathbb{E}_t \left[ \int_t^T (\sigma_{k,s}^2) \, ds \right]}
\]

“Choose optimal capital plan”

While VaR constraint is proportional to contemporaneous risk, CCAR makes capital proportional to forward looking risk

Equilibrium dynamics change

Adrian-Boyarchenko 2012 conjecture that this mitigates procyclicality
Conclusion

He and Krishnamurthy have pioneered models of financial intermediation within a macro context

Contribution of this paper is to consider systemic risk

My comments

1. The theory models fund sector, not banking
   - Banks exhibit procyclical leverage (Adrian-Shin)
   - Risk based capital constraints can explain procyclicality (Adrian-Boyarchenko)

2. How do stress tests influence equilibrium outcomes?
   - Impact of stress tests on equilibrium outcomes is not modeled
   - Conjecture that CCAR mitigates procyclicality
Countercyclical Dealer Equity

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Book Leverage is Procyclical
Market Leverage is Countercyclical

JPM, BoA, C

Quarterly Asset Growth (%) vs. Quarterly Book Leverage Growth (%)

β = 0.448
t-stat = 105.703
R² = 0.301

Quarterly Market Leverage Growth (%) vs. Quarterly Enterprise Value Growth (%)

β = -0.064
t-stat = -134.906
R² = 0.073
Market Leverage moves with Book-to-Market

- The book-to-market ratio is outside of the control of banks
- Banks manage accounting based ROE and book leverage