A Macro-Finance model with Realistic Crisis Dynamics

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Abstract

What causes deep recessions and slow recovery? I revisit this question and develop a macro-finance model that quantitatively matches the salient empirical features of financial crises such as a large drop in the output, a high risk premium, reduced financial intermediation, and a long duration of economic distress. The model has leveraged intermedia tors featuring stochastic productivity and regime-dependent exit that govern the transition in and out of crises. A model without these two features suffers from a trade-off between the amplification and persistence of crises. I show that my model resolves this tension and generates realistic crisis dynamics.

Introduction

A Macro-finance model with financial amplification to explain deep and persistent financial crises

1. Two sector model with households, and experts facing a) stochastic productivity and b) regime-dependent exit rate
2. Trade-off between unconditional risk premium and probability of crisis
3. My model resolves these tensions and provides a better match to data

Economic Mechanisms

Setup:

• Two classes of agents: Households, and Experts (financially constrained, leveraged).
• Normal times: More productive experts sufficiently capitalized, hold all capital

Crisis dynamics:

• Capital and Productivity shock: negative shock to j leveraged expert net worth → amplification
  (large risk premium, GDP falls, investment failures, and return volatility increases)
• Regime-dependent exit
  1. Larger exit in crisis pushes economy deeper into recession
  2. only way to come out of crisis is by increased expert productivity. Slow mean reversion in productivity → delayed recovery (persistence)

Model

AK technology: \( y_{j} = a_{j} b_{j} \), \( j \in \{e, h\} \)

1. Productivity of experts is time-varying and follows the process

\[
\frac{dy_{j}}{dy_{j}} = \left( \Phi(y_{j}) - \delta \right) dt + \sigma dW_{j}\]

with \( dW_{j} \neq dW_{h} \) and \( \delta < y_{e} < y_{h} < \tau \) Reflects bank economies of scale

2. Experts exit at rate \( \gamma_{j} \in \{\text{normal, crisis}\} \), with \( \text{normal} = 9 \times \text{crisis} \)

⇒ Reflects bank runs during crisis

Experts solve

\[
U_{j} = \max_{C_{j},K_{j},\lambda_{j}} E_{t} \left[ \int_{t}^{\infty} f(C_{j}, K_{j}, \lambda_{j}) dt + U_{j} \right]
\]

s.t.

\[
\frac{dK_{j}}{dt} = \left( s_{j} \frac{C_{j}}{K_{j}} - r_{j} \right) K_{j} + \sigma_{j} \left( \sigma_{j} + \rho_{j} \right) (K_{j}^{2} - \lambda_{j}^{2})
\]

• Transition time \( \nu \) is exponentially distributed with rate \( \nu_{j} \in \{\text{normal, crisis}\} \)

\[
\frac{\nu_{j}}{\nu_{h}} \frac{\sigma_{j}}{\sigma_{h}} = \frac{\lambda_{j}}{\lambda_{h}}
\]

• Fraction of capital invested

• \( \chi_{j,e} \) fraction of equity retained in balance sheet

• Preferences follow Duffie-Epstein utility

\[
f\left( y_{j}, j \right) = (1 - \gamma_{j} b_{j} \left( \log(y_{j}) - \frac{1}{2}\sigma_{j}^{2} \log(1 - \gamma_{j} b_{j}) \right)
\]

Solution Method

• Two state variables: wealth share of experts \( z_{1} \) (endogenous), productivity of experts \( \rho_{j} \in \{e, h\} \)
• Solution boils down to solving coupled system of PDEs in \( j_{e} \) and \( j_{h} \)

Equilibrium quantities:

\[
J_{e}, J_{h}
\]

Value functions (PDEs):

\[
\text{Newton-Raphson Method}
\]

Quantitative Analysis

• Neural network approach (ALIENs) developed in Gopalakrishna (2022)

Table 1: Empirical vs Model moments

Table 2: Comparison of moments

Conclusions

• Wealth share of intermediaries alone cannot jointly match asset pricing, output, and crisis moments
  1. Trade-off between unconditional risk premium (amplification) and duration of crisis (persistence)
  2. Model of stochastic productivity and regime-dependent exit generates realistic crisis dynamics, and a better match to data

• Active machine learning opens new avenues for future research
  1. Brainnermeier-Sannikov meets Bansal-Yaron economy (Gopalakrishna (2021))
  2. Heterogeneous intermediaries
  3. Main street vs Wall street disconnect, good booms vs bad booms

Figure 1: Balance sheet

Figure 2: Figure caption

Figure 3: Trade-offs in benchmark model