The complexity of financial crisis in a long-period perspective: facts, theory and models
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FINANCIAL FRAGILITY IN A MACRO MODEL À LA MINSKY WITH REGIME SWITCHING

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Outline of the Presentation

- Background and Motivations
- Objectives and Methodology
- The Model
- Results
- Conclusions and Perspectives

Background and Motivation

Objectives and Methodology

- **Targets**:
  - Evaluation of present evolution of the economy
  - insert the Minskian “triad” (hedge, speculative and Ponzi units) into a macroeconomic context where there is a sharp distinction between a solvent regime and a crisis regime

- **Novelty of the approach with respect to Minsky** :
  - Dynamic setting with regime-switching (ideally similar to Minsky’s ceilings and floors); the dynamic properties of the model depend on what happens:
    - Within each state;
    - Between the two states;
    - Time spent in each regime.
  - Financial instability introduced by means of a particular aggregate investment function

Objectives and Methodology

- Technical features of the model:
  - Dynamic model where AD is integrated with AS
    - AD where Investment is affected by debt
  - Boundedly rational agents
    - Learning in order to make forecasts
  - Stochastic component introduced thorough thresold
    - Complex dynamics hence need to deal with simulations

- These phenomena are compatible with:
  - Endogenous cycles (due to expectations and financial variables)
  - Run-away dynamics (run-away inflation, debt deflation…)
  - Extreme events and fundamental uncertainty

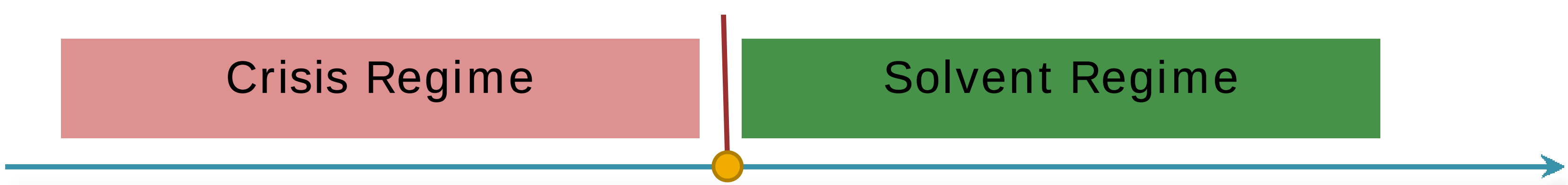
The Minskian Triad

The Macro Thresold

Solvency condition (stocks): $PR_{t-1} > R_{t-1}D_{t-1}$

Debt ratio: $d_t = \dfrac{D_t}{P_{t-1}Y_{t-1}}$

Solvency condition (flows): $(1+g_{t-1})(1+\pi_{t-1}) > \dfrac{R_{t-1}d_{t-1}}{(1-\omega_{t-1})}$



$$(1+\overline{E}_t g_{t+1})(1+\overline{E}_t \pi_{t+1}) > \frac{R_{t-1}d_{t-1}}{(1-\omega_{t-1})} + \varepsilon_t$$

The Model

$$R_t = R_j^* + \psi_1\left(\overline{E}_t\pi_{t+1} - \pi_{0j}\right) - \psi_2\left(\overline{E}_t g_{t+1} - g_{0j}\right)$$

$$d_t = \frac{d_{t-1}\left(1+R_{t-1}\right)}{\left(1+g_{t-1}\right)\left(1+\pi_{t-1}\right)} + \frac{i_{t-1}}{\left(1+g_{t-1}\right)} - \left(1-\omega_{0j}^*\right)$$

$$r_t = \frac{\left(1+R_t\right)}{\left(1+\overline{E}_t\pi_{t+1}\right)} - 1$$

$$i_t = \eta_1 + \eta_{2j}(1-\omega_{0j}^*)(1+\overline{E}_t g_{t+1}) - \eta_{2j}\frac{Rtdt}{(1+\overline{E}_t\pi_{t+1})} - \eta_{3j} r_t + \eta_{4j}\overline{E}_t g_{t+1}$$

$$g_t = i_t + c_1\left(1+\overline{E}_t g_{t+1}\right) + c_2 - 1$$

$$\tau_t = \tau_{1j} + \tau_2 i_t$$

$$l_t = l_{t-1}\frac{\left(1+g_t\right)}{\left(1+\tau_t\right)}$$

$$u_t = 1 - l_t$$

$$\pi_t = \varphi_1\overline{E}_t\pi_{t+1} - \sigma_1\left(u_t - u_{0j}^*\right) + (1-\varphi_1)\pi_{t-1}$$

The Model: crisis regime (1)

$$
\begin{cases}
R_t = R_1^* + \psi_1\left(\overline{E}_t \pi_{t+1} - \pi_{01}\right) - \psi_2\left(\overline{E}_t g_{t+1} - g_{01}\right) \\
d_t = \dfrac{d_{t-1}\left(1 + R_{t-1}\right)}{\left(1 + g_{t-1}\right)\left(1 + \pi_{t-1}\right)} + \dfrac{i_{t-1}}{\left(1 + g_{t-1}\right)} - \left(1 - \omega_{01}^*\right) \\
r_t = \dfrac{\left(1 + R_t\right)}{\left(1 + \overline{E}_t \pi_{t+1}\right)} - 1 \\
\boxed{i_t = \eta_1 - \eta_3 r_t} \\
g_t = i_t + c_1\left(1 + \overline{E}_t g_{t+1}\right) + c_2 - 1 \\
\tau_t = \tau_{11} + \tau_2 i_t \\
l_t = l_{t-1} \dfrac{\left(1 + g_t\right)}{\left(1 + \tau_t\right)} \\
u_t = 1 - l_t \\
\pi_t = \varphi_1 \overline{E}_t \pi_{t+1} - \sigma_1\left(u_t - u_{01}^*\right) + (1 - \varphi_1)\pi_{t-1}
\end{cases}
$$

The Model: solvent regime (2)

$$\left\{\begin{aligned}
R_t &= R_2^* + \psi_1\left(\overline{E}_t\pi_{t+1} - \pi_{02}\right) - \psi_2\left(\overline{E}_t g_{t+1} - g_{02}\right) \\
d_t &= \frac{d_{t-1}\left(1+R_{t-1}\right)}{\left(1+g_{t-1}\right)\left(1+\pi_{t-1}\right)} + \frac{i_{t-1}}{\left(1+g_{t-1}\right)} - \left(1-\omega_{02}^*\right) \\
r_t &= \frac{\left(1+R_t\right)}{\left(1+\overline{E}_t\pi_{t+1}\right)} - 1 \\
i_t &= \eta_1 + \eta_2(1-\omega_{0j}^*)(1+\overline{E}_t g_{t+1}) - \eta_2 \frac{Rtdt}{(1+\overline{E}_t\pi_{t+1})} + \eta_4 \overline{E}_t g_{t+1} \\
g_t &= i_t + c_1\left(1+\overline{E}_t g_{t+1}\right) + c_2 - 1 \\
\tau_t &= \tau_{12} + \tau_2 i_t \\
l_t &= l_{t-1}\frac{\left(1+g_t\right)}{\left(1+\tau_t\right)} \\
u_t &= 1 - l_t \\
\pi_t &= \varphi_1\overline{E}_t\pi_{t+1} - \sigma_1\left(u_t - u_{02}^*\right) + (1-\varphi_1)\pi_{t-1}
\end{aligned}\right.$$

The Steady States

Crisis Regime

$$g_{01} = \frac{(c_1 + c_2 - 1)\tau_2 - \tau_{11}}{(1 - c_1)\tau_2 - 1} = 0.0218$$

$$i_{01} = \frac{g_{01} - \tau_{11}}{\tau_2} = 0.208$$

$$\tau_{01} = \tau_{11} + \tau_2 i_{01} = 0.0218$$

$$d_{01} = \frac{i_{01} - (1 + g_{01})(1 - \omega_{01}^*)}{g_{01} - r_{01}} = 0.65$$

$$\pi_{01} = [(1 + R_{01})/(1 + r_{01})] - 1 = 0.0392$$

Solvent Regime

$$g_{02} = \frac{(c_1 + c_2 - 1)\tau_2 - \tau_{12}}{(1 - c_1)\tau_2 - 1} = 0.042$$

$$i_{02} = \frac{g_{02} - \tau_{12}}{\tau_2} = 0.22$$

$$\tau_{02} = \tau_{12} + \tau_2 i_{02} = 0.042$$

$$d_{02} = \frac{i_{02} - (1 + g_{02})(1 - \omega_{02}^*)}{g_{02} - r_{02}} = 0.53$$

$$\pi_{02} = [(1 + R_{02})/(1 + r_{02})] - 1 = 0.0751$$

Expectations

Individual forecast:

$$\begin{cases} \overline{E}_t^{opt} g_{t+1} = g_{02} \\ \overline{E}_t^{pess} g_{t+1} = g_{01} \end{cases}$$

$$\begin{cases} \overline{E}_t \pi_{t+1} = \pi_{01} & \text{If regime 1} \\ \overline{E}_t \pi_{t+1} = \pi_{02} & \text{If regime 2} \end{cases}$$

Market forecast:

$$\overline{E}_t g_{t+1} = \alpha_{opt,t} \overline{E}_t^{opt} g_{t+1} + \alpha_{pess,t} \overline{E}_t^{pess} g_{t+1}$$

$$\alpha_{opt,t} + \alpha_{pess,t} = 1$$

Selection mechanism:

$$U_{opt,t} = -\sum_{k=1}^{\infty} \chi_k \left[g_{t-k} - \overline{E}_{t-k-1}^{opt} g_{t-k} \right]^2$$

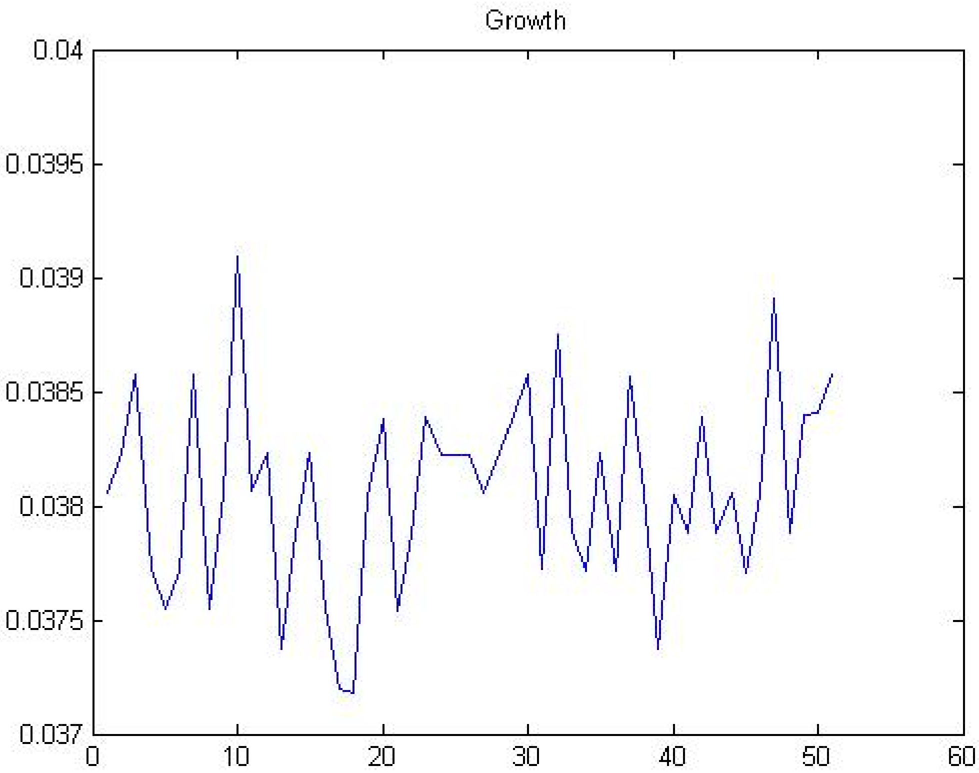
$$U_{pess,t} = -\sum_{k=1}^{\infty} \chi_k \left[g_{t-k} - \overline{E}_{t-k-1}^{pess} g_{t-k} \right]^2$$

Proportions:

$$\alpha_{opt,t} = \frac{\exp(\gamma U_{opt,t})}{\exp(\gamma U_{opt,t}) + \exp(\gamma U_{pess,t})}$$

$$\alpha_{pess,t} = \frac{\exp(\gamma U_{pess,t})}{\exp(\gamma U_{opt,t}) + \exp(\gamma U_{pess,t})}$$

The Dynamics of the Model



$u_{01}^* = 0.05$ $u_{02}^* = 0.03$	$\varphi_1 = 0.70$	$\sigma_1 = 0.02$
$\tau_{11} = 0.001$ $\tau_{12} = 0.02$	$\tau_2 = 0.10$	$\eta_1 = 0.201$
$\eta_{21} = 0$ $\eta_{22} = 0.1$	$\eta_{31} = 0.3$ $\eta_{32} = 0$ $\eta_{41} = 0$ $\eta_{42} = 0.3$	$c_1 = 0.40$
$c_2 = 0.405$	$\psi_1 = 2.50$	$\psi_2 = 0.8$
$\omega_{01} = 0.825$ $\omega_{02} = 0.8$	$R_1^* = 0.015$ $R_2^* = 0.08$	N=500

Conclusions and Perspectives

- The model shows persistent fluctuations that do not explode but remain bounded. The switching of the economy is therefore persistent.
- Sources of the result:
  - Presence and nature of the two regimes
  - Interdependence (organic/complex) nature of the model
  - Role of financial factors
  - Value of the thresold
  - Type of expectations
  - Not necessarily policy driven (robustness to changes in Taylor rule)

Conclusions and Perspectives

Ways towards further developments:

- Improve theoretical justification of equations
  - Especially find a way to deal with “fundamental” uncertainty
- Integrate liquidity constraints and deeper foundation of financial sector
- Improve formal aspects of the model
  - More attention to the role of heterogeneity

Main open question:

- Model fit to data

The Steady States

Crisis Regime

$$g_{01} = \frac{(c_1 + c_2 - 1)\tau_2 - \tau_{11}}{(1 - c_1)\tau_2 - 1} = 0.0218$$

$$i_{01} = \frac{g_{01} - \tau_{11}}{\tau_2} = 0.208$$

$$\tau_{01} = \tau_{11} + \tau_2 i_{01} = 0.0218$$

$$r_{01} = \frac{\eta_1 - i_{01}}{\eta_3} = -0.023$$

$$d_{01} = \frac{i_{01} - (1 + g_{01})(1 - \omega_{01}^*)}{g_{01} - r_{01}} = 0.65$$

$$u_{01} = u_{01}^* = 0.05$$

$$R_{01} = R_1^* = 0.015$$

$$\pi_{01} = [(1 + R_{01})/(1 + r_{01})] - 1 = 0.0392$$

Solvent Regime

$$g_{02} = \frac{(c_1 + c_2 - 1)\tau_2 - \tau_{12}}{(1 - c_1)\tau_2 - 1} = 0.042$$

$$i_{02} = \frac{g_{02} - \tau_{12}}{\tau_2} = 0.22$$

$$\tau_{02} = \tau_{12} + \tau_2 i_{02} = 0.042$$

$$r_{02} = \frac{Dg_{02} - B}{B + D} = ?????$$

$$d_{02} = \frac{i_{02} - (1 + g_{02})(1 - \omega_{02}^*)}{g_{02} - r_{02}} = 0.53$$

$$u_{02} = u_{02}^* = 0.03$$

$$R_{02} = R_2^* = 0.08$$

$$\pi_{02} = [(1 + R_{02})/(1 + r_{02})] - 1 = 0.0751$$