Melting Down: Systemic Financial Instability and the Macroeconomy

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Financial crises are regular but infrequent events.

Recent financial crisis: Financial instability lead to severe disruption of real economy.

Recently growing literature on theoretical economic models that incorporate financial instability as well as nonlinearities, e.g., Brunnermeier and Sannikov (2012), He and Krishnamurthy (2012), Boissay, Collard and Smets (2013), but few empirical contributions.
Systemic financial instabilities and economic dynamics

- **Empirical approach:** Impose little economic structure
  1. Since no consensus on channels of crises: Empirical evidence is needed
  2. Complement structural economic models with nonlinearities

- **Model**
  1. Multivariate Markov-Switching Vectorautoregressive (MS VAR) model
  2. Recently developed Bayesian estimation methods [Sims-Waggoner-Zha (2008)]
What we do

Main features

1. Introduce systemic financial instability in empirical macro model
2. Allow for non-linearities in parameters and shock variances
3. Model empirically interdependencies between financial sector and euro area macro-economy, amplification and feedback effects
Q: Nonlinearities in relation between systemic financial stress and macroeconomy in the euro area?  
A: Yes.

1. Q: Only shock variances larger in high systemic stress episodes? Or even change in transmission?  
A: Fundamental change.

2. Q: Does macroeconomy react differently to shocks in high stress vs tranquil episodes, accounting for feedback effects?  
A: Yes, economically important differences.

3. Q: Is the composite indicator of systemic stress (CISS) useful?  
A: Yes, it has important features.

4. Q: Model useful in tracking systemic stress episodes in real time?  
A: Yes, quasi real-time performance is remarkably good.
Composite Indicator of Systemic Stress

- All major financial markets and financial intermediaries
- Components: Equity, bond, money and FX markets, banking
- Basic sub-components: mainly volatilities and risk spreads
- Key features: Weighted by time-varying cross-correlations (‘systemic’), real-time, financial intermediation included;

see Hollo, Kremer and Lo Duca (2012) for details
Model

Multivariate MS-VAR model:

\[ y_t' A_0(\mathbf{s}_t^c) = \sum_{l=1}^{p} y_{t-l}' A_l(\mathbf{s}_t^c) + z_t' C(\mathbf{s}_t^c) + \varepsilon_t' \Xi^{-1}(\mathbf{s}_t^v), \quad (1) \]

- \( y \): Endogenous variables
- \( z \): Exogenous variables and intercept terms
- \( A_0, A_l, C \): Coefficient matrices
- \( \varepsilon_t \): Random shocks
- \( s_t^c, s_t^v \): Unobserved state variables evolve according to two independent first-order Markov processes:

\[ \Pr(s_t^m = i|s_{t-1} = j) = p_{ij}, \quad i, j = 1, 2, \ldots, h^m, \quad m = c, v. \quad (2) \]

\( \Rightarrow \) Coefficient switching and switching in shock variances
Model Estimation and Evaluation

*Estimation of posterior mode (see SWZ08):*

- Blockwise BFGS optimization algorithm
- Algorithm: parameters divided into blocks; initial guesses for parameters used in hill-climbing quasi-Newton optimization routine

*Model evaluation (statistical):*

- Marginal Data Densities usually via Modified Harmonic Mean (Gelfand & Dey, 1994)
- MHM might be unreliable when posterior distributions far from Gaussian
- We use method by Sims, Waggoner and Zha (2008)
Euro Area: Data and Identification

- Endogenous variables: \( y_t = [\Delta ip, \pi, R, \Delta l, S] \)
  - \( ip \): industrial production; \( \pi \): HICP inflation; \( R \): 3-month Euribor; \( l \): loans; \( S \): systemic stress indicator
- Identification: Choleski decomposition, variables ordered as shown
  - \( \Rightarrow \) only stress is allowed to respond instantaneously to innovations in all other variables and nothing responds instantaneously to stress
- Euro area data: monthly frequency, annual rates, seasonally adjusted, January 1987 to December 2010
Evidence for Nonlinearities?

**MS-BVAR results:** Marginal Data Density (MDD)

<table>
<thead>
<tr>
<th>model parameters</th>
<th>constant</th>
<th>variance change</th>
<th>variance and coeff. change</th>
</tr>
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<tbody>
<tr>
<td>1v1c</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>log(mdd)</td>
<td>-6.05</td>
<td>92.36</td>
<td>126.08</td>
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<td>- diff. constant</td>
<td>0</td>
<td>98.41</td>
<td>132.13</td>
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Constant parameter model clearly outperformed by all others
### Systemic stress: Just the shocks or change in transmission?

**MS-VAR results:** Marginal Data Density (MDD)

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- Constant parameter model clearly outperformed by all others
- Models with 3 variance regimes outperform other models
- Evidence for fundamental change in economic dynamics in high stress episodes in addition to shock variances
The economic history of stress: State probabilities

Red: Systemic Fragility regime (HV,HC), Blue: Medium stress regime (MV,HC)

Smoothed state probability:
High stress coefficient episodes with different stress shock volatilities match historic events

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A tool for macro-prudential surveillance?

- **Red**: Systemic Fragility regime (HV,HC), **Blue**: Medium stress regime (MV,HC), **Grey**: Real-time state probabilities

State probabilities rather robust in real-time

Limited type one and type two errors
The transmission of systemic financial stress

Impulse Response Functions to Stress shock (cond. on regime)

High systemic fragility / high stress:
- Sharp, immediate growth decline, persists almost 2 years
- protracted decline in loans
- strong reaction of standard monet. policy
Systemic stress shock

Constant parameter model severely underestimates effects in high systemic fragility;
\( \Delta IP \): output growth,
\( \Delta P \): inflation,
\( R \): monet. policy,
\( \Delta Ln \): Loan growth
Regime switching counterfactual

Counterfactual: Regime change, Oct 2008 to Feb 2009, tranquil times instead systemic fragility

- Systemic financial stress ($S$) at substantially lower levels
- Reduction of output growth ($\Delta IP$) would have been substantially smaller in tranquil times
Regime switching counterfactual (contd)

Counterfactual: Oct 2008 to Feb 2009, tranquil regime instead of systemic fragility

- Syst. stress lower
- Output growth and inflation much higher
- Substantial pos. loan growth effects
- Monet. policy reacts much less

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Counterfactual: Loan growth reduction as in systemic fragility, Oct 2001 to March 2002 (dot-com bubble)

- Substantial negative effects on output growth, inflation, interest rates and loan growth
Conclusions

- **Q:** Nonlinearities in relation between systemic financial stress and macroeconomy in the euro area?
- **A:** Yes. Relevant for monetary and macroprudential policies.

Episodes of systemic financial instability and systemic fragility:

- Economic dynamics change fundamentally, not only larger shocks
- Macroeconomic effects larger and more persistent in response to financial stress shocks in high stress vs tranquil episodes, accounting for feedback effects

1. **Q:** Is the composite indicator of systemic stress (CISS) useful?
   - **A:** Yes, it has important features.

2. **Q:** Model useful tracking systemic stress episodes in real time?
   - **A:** Yes. Promising for macroprudential surveillance.
Alternative stress measure: Stock market volatility

Impulse Response Functions to Stress shock (cond. on regime)

- First row: CISS
- Second row: Stock market volatility
- Stock market volatility shock: Responses are smaller and much less persistent in high systemic stress