Melting Down: Systemic Financial Instability and the Macroeconomy

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Macro-Prudential Research (MaRs) Network
ECB
23-24 June 2014

Motivation

- 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

What we do

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

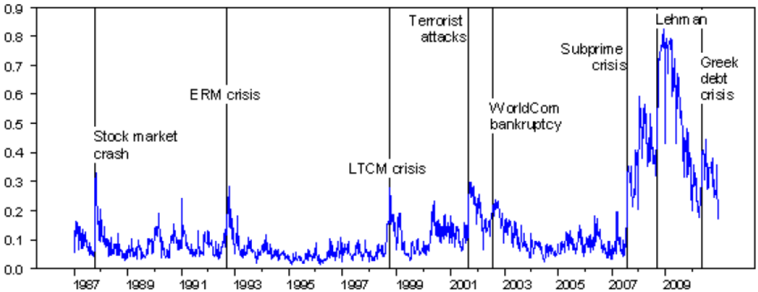
Main features

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

Economic Questions

- **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:

$$y_t' A_0(s_t^c) = \sum_{l=1}^{p} y_{t-l}' A_l(s_t^c) + z_t' C(s_t^c) + \varepsilon_t' \Xi^{-1}(s_t^v), \qquad (1)$$

y: Endogenous variables

z: Exogenous variables and intercept terms

A_0, A_l, C: Coefficient matrices

ε_t: Random shocks

s_t^c, s_t^v: Unobserved state variables evolve according to two independent first-order Markov processes:

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

$\Rightarrow$ 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; π: 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)

model parameters	constant	variance change		variance and coeff. change	
	1v1c	2v1c	3v1c	2v2c	3v2c
log(mdd)	-6.05	92.36	131.95	126.08	147.36
- diff. constant	*0*	*98.41*	*138.00*	*132.13*	*153.41*

- Constant parameter model clearly outperformed by all others

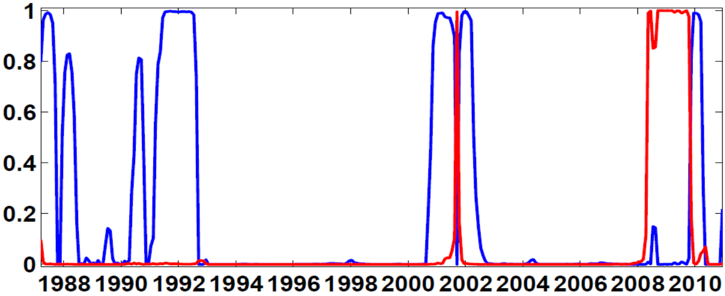
Systemic stress: Just the shocks or change in transmission?

MS-VAR results: Marginal Data Density (MDD)

model parameters	constant	variance change		variance and coeff. change	
	$1v1c$	$2v1c$	$3v1c$	$2v2c$	$3v2c$
log(mdd)	-6.05	92.36	131.95	126.08	147.36
- *diff. constant*	*0*	*98.41*	*138.00*	*132.13*	*153.41*

- 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

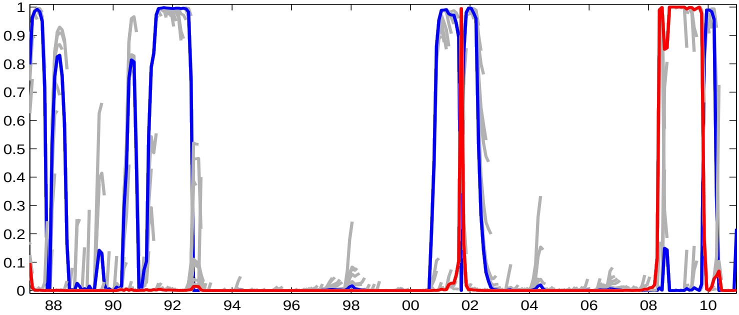


- *Red:* Systemic Fragility regime (HV,HC), *Blue:* Medium stress regime (MV,HC)

Smoothed state probability:

High stress coefficient episodes with different stress shock volatilities match historic events

A tool for macro-prudential surveillance?



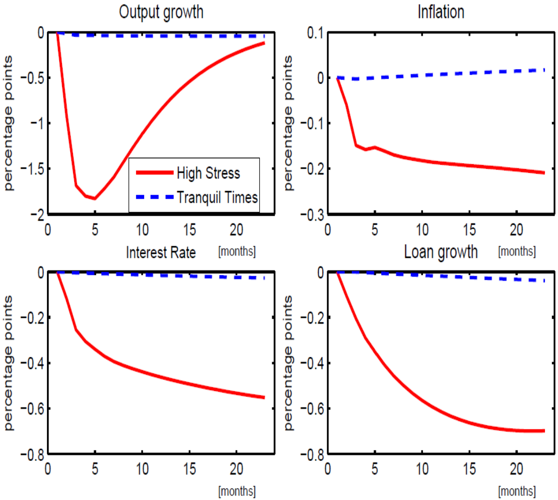
- *Red:* Systemic Fragility regime (HV,HC), *Blue:* Medium stress regime (MV,HC), *Grey:* Real-time state probabilities

State probabilities rather robust in real-time

Limited type one and type two errors

The transmission of systemic financial stress

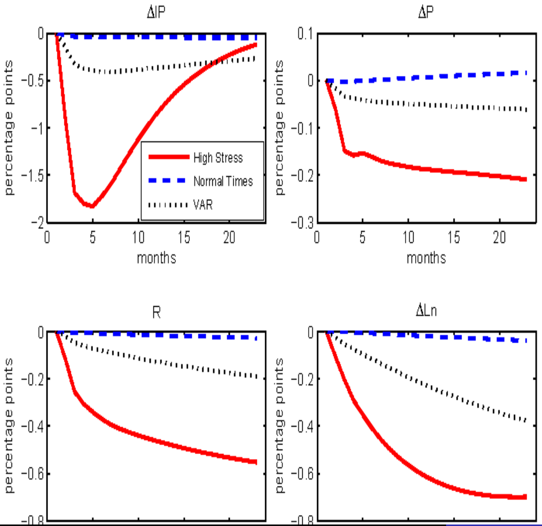
Impulse Response Functions to Stress shock (cond. on regime)



High systemic fragility / high stress:

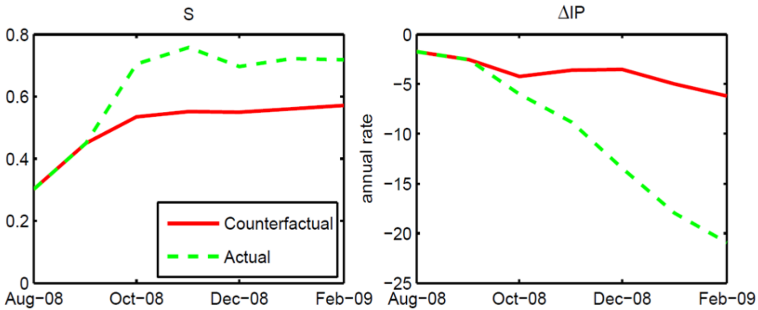
- Sharp, immediate growth decline, persists almost 2 years
- protracted decline in loans
- strong reaction of standard monet. policy

Regime switching vs constant parameter model



- Systemic stress shock
- Constant parameter model severely underestimates effects in high systemic fragility; ΔIP: output growth, ΔP: inflation, R: monet. policy, ΔLn: Loan growth

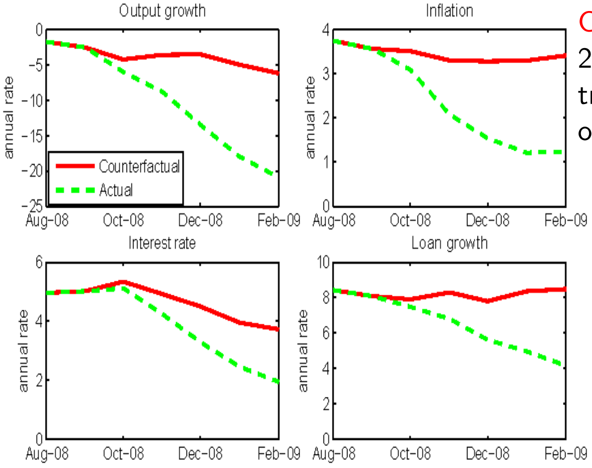
Regime switching counterfactual



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 (ΔIP) would have been substantially smaller in tranquil times

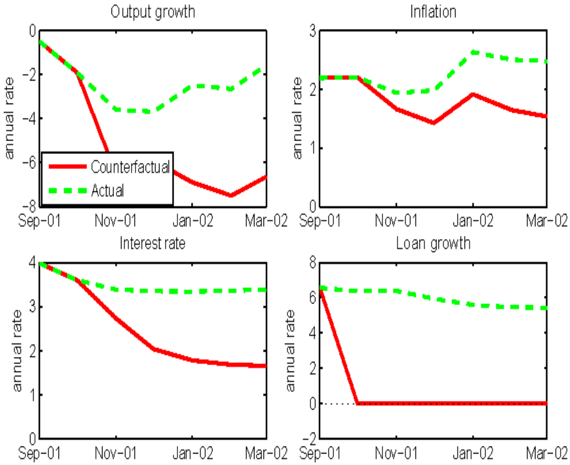
Regime switching counterfactual (contd)



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

Loan growth counterfactual



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:

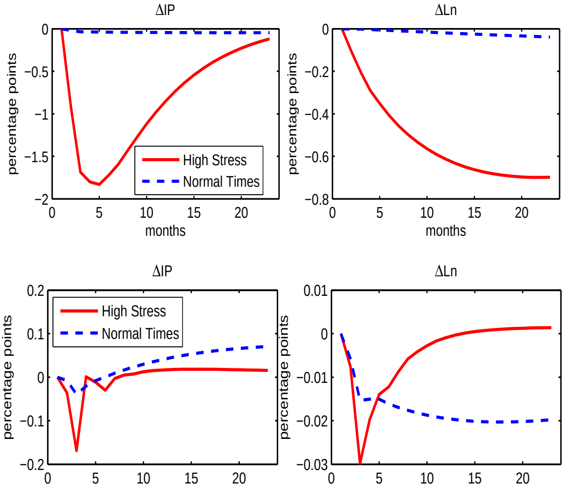
- Economic dynamics change fundamentally, not only larger shocks
- Macroeconomic effects larger and more persistent in response to financial stress shocks in high stress vs tranquil episodes, accounting for feedback effects

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.

Appendix

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