Systemic risk diagnostics: coincident indicators and early warning signals

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Contributions. What is done?

We construct (i) **coincident risk indicators** and (ii) **early warning signals** for financial distress.

(i) = '**thermometers**' to read off the 'heat' in financial system. Common stress based on shared risk factors, and likelihood of simultaneous failure of financial intermediaries.

(ii) = '**barometer**', forward looking indicator, based on deviations of credit risk conditions from macro-financial fundamentals.

How? Model **latent macro-financial and credit risk components** for the U.S., EU-27, and rest of the world.

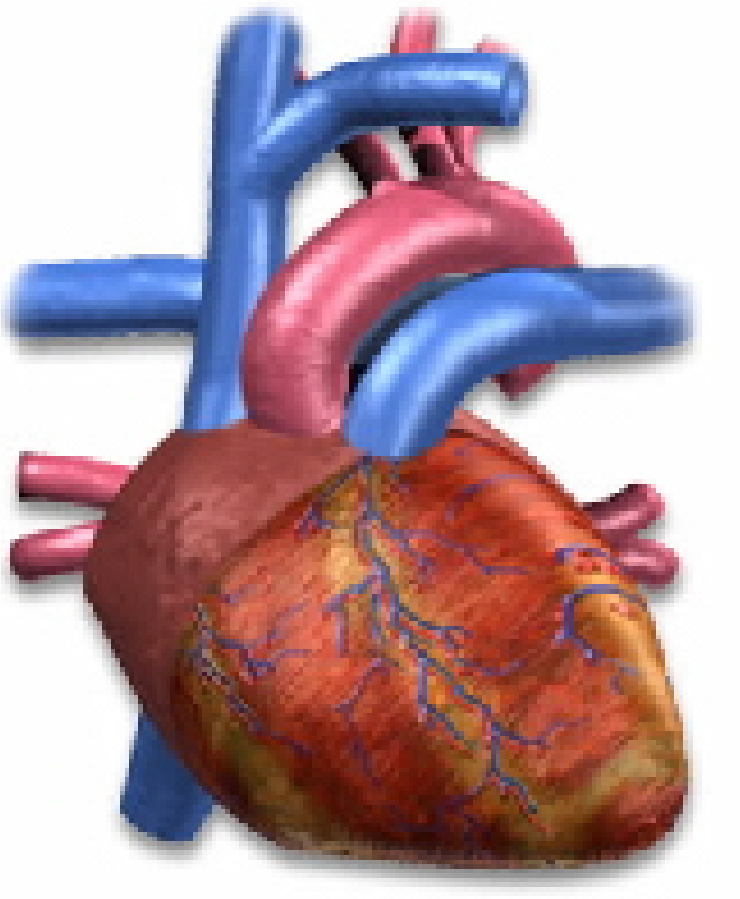
Motivation: cost of crisis and regulatory response

Reinhart and Rogoff (Ch. 10, 2009): A systemic banking crisis is followed by 56% $\downarrow$ in equity prices, 36% $\downarrow$ in real estate prices, 9% $\downarrow$ in RGDP, 7% $\uparrow$ unemployment, 86% $\uparrow$ gov't debt, and 16% $\downarrow$ in sovereign rating score.

Financial Stability departments need to extend their toolkits.

Model-based 'thermometers' and 'warning signals' in addition to market intelligence and stress tests. Dirt cheap!

System failure analogy



Financial systems have crises, people have heart attacks.

What are the risk factors? (un)conditional probabilities?

An early warning system

Economics of systemic risk

1. **Time series of SR**:
   - SR buildup may occur when measured risk is low;
   - SR buildup may be linked to financial sector growth, underwriting standards, degree of monitoring, risk management of market participants.
   - Challenge to build forward looking measures.
2. **Cross section of SR**:
   - **Fire sale externality:** deleveraging spills across institutions due to market illiquidity.
   - **Hoarding externality**: institutions hoard lending capacity.
   - **Runs:** e.g. on the shadow banking system.
   - **Network externality:** building up of counterparty credit risk due to interlocking of claims.

Empirical systemic risk literature

(very incomplete listing)

Systemic risk contribution: Adrian and Brunnermeier (2009), Huang, Zhou, Zhu (2009, 2010), Acharya, Pedersen, Philippon, Richardson (2010), Brownlees and Engle (2010), White, Kim, and Manganelli (2010),..

Common exposure to macro risk factors/stress testing: Aikman et al (RAMSI, 2009), Segoviano and Goodhart(2009), Giesecke and Kim (2010), De Nicolo and Lucchetta (2010), Castren, Dees, Zaher (2010), Koopman, Lucas, and Schwaab (2010, 2011),..

Early warning signals/financial imbalances: Borio and Lowe (2002), Reinhart and Rogoff (2008, 2009), Borio and Drehmann (2009), Alessi and Detken(2009), Barell, Davis, Karim, Liadze (2010),..

The model setup

$$\text{Mixed obs } Y_t = (y_{1,1t}, \ldots, y_{R,Jt}, x_{1t}, \ldots, x_{Nt}, \bar{z}_{1t}, \ldots, \bar{z}_{St})'.$$

$$y_{r,jt} | f_t^m, f_t^d, f_t^i \sim \text{Binomial}(k_{r,jt}, \pi_{r,jt}) \quad \text{Act default experience}$$

$$x_{it} | f_t^m, 0, 0 \sim \text{Normal}(\mu_{it}, \sigma_i^2) \quad \text{Macro-fin. covariates}$$

$$\bar{z}_{st} | f_t^m, f_t^d, f_t^i \sim \text{Normal}(\bar{\mu}_{st}, \bar{\sigma}_s^2) \quad \text{Transformed EDFs}$$

$$\pi_{r,jt} = [1 + e^{-\theta_{r,jt}}]^{-1} \quad \text{Default probability firm j}$$

$$\text{Signals } \theta_{r,jt} = \lambda_{0,rj} + \beta_{rj}' f_t^m + \gamma_{rj}' f_t^d + \delta_{rj}' f_t^i$$

$$\text{Factors } f_t = (f_t^{m\prime}, f_t^{d\prime}, f_t^{i\prime})'$$

$$= \Phi f_{t-1} + \eta_t, \quad \eta_t \sim \text{NID}(0, I - \Phi\Phi')$$

Monte Carlo Maximum Likelihood

The observation density of $y = (y_1', ..., y_T')'$ can be expressed as

$$p(y;\psi) = \int p(y|f;\psi)p(f;\psi)df.$$

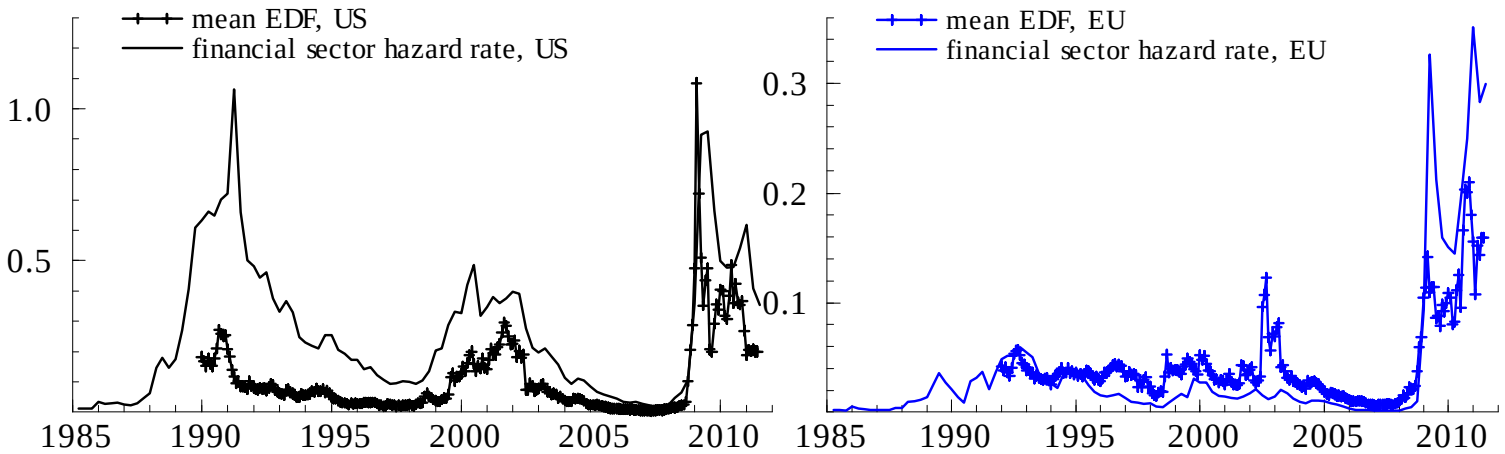
A MC estimator of $p(y;\psi)$ based on importance sampling is given by

$$\hat{p}(y;\psi) = \hat{g}(\tilde{y};\psi)M^{-1}\sum_{k=1}^{M}\frac{p(y|f^{(k)};\psi)}{g(\tilde{y}|f^{(k)};\psi)}, \quad f^{(k)} \sim g(f|\tilde{y};\psi).$$

Remarks:

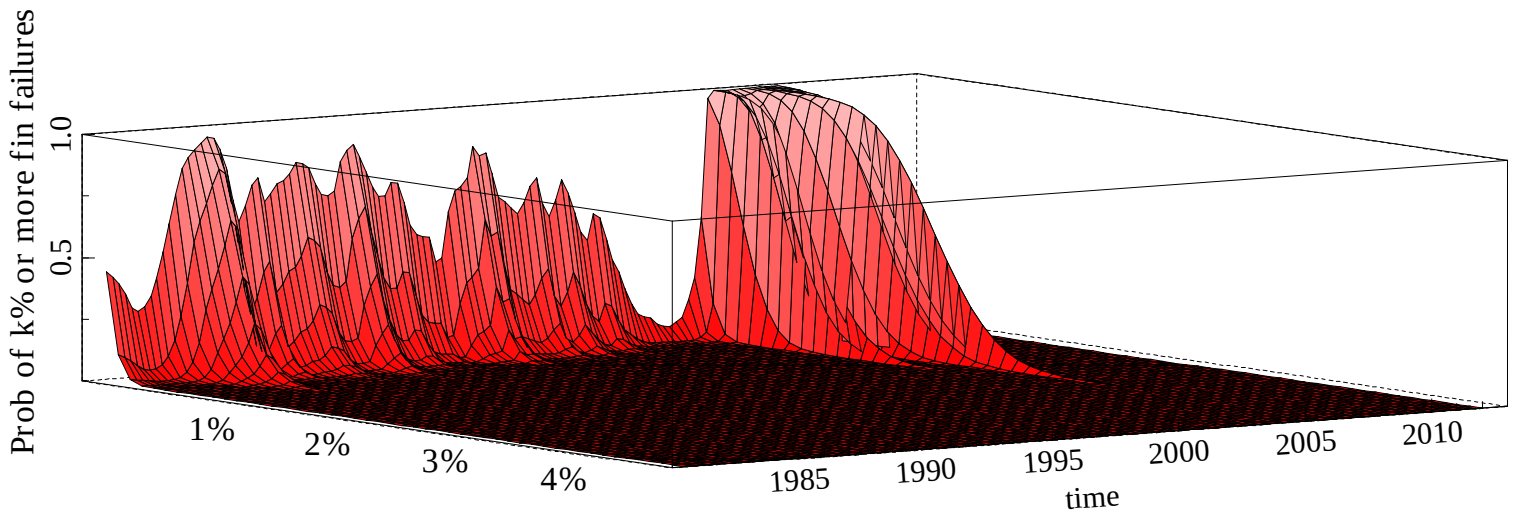
* Based on Durbin and Koopman (1997) and KLS (2010, 2011).
* Importance density $g(f|\tilde{y};\psi)$ is Laplace approximation to $p(f|y;\psi)$.
* Details in technical appendices A1 to A3.

Broad financial sector failure rate



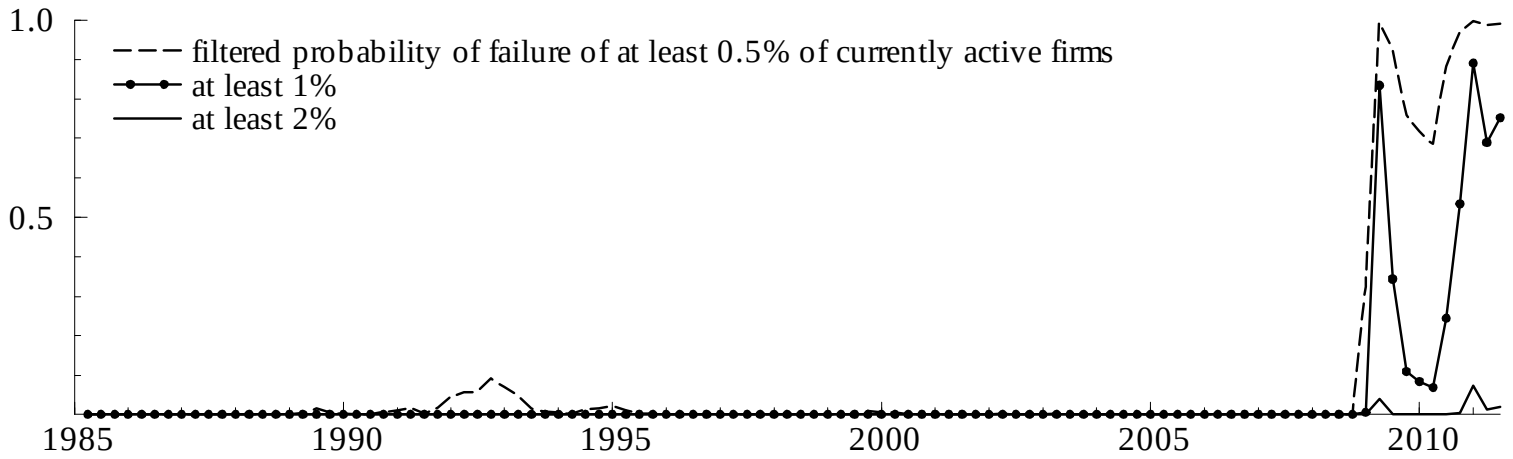
Implied financial sector failure rate vs mean EDF for largest 20 financials. Sector rate is aggregated across banks and other financials, see Giesecke and Kim (2010).

The likelihood of simultaneous FI failures in EU-27



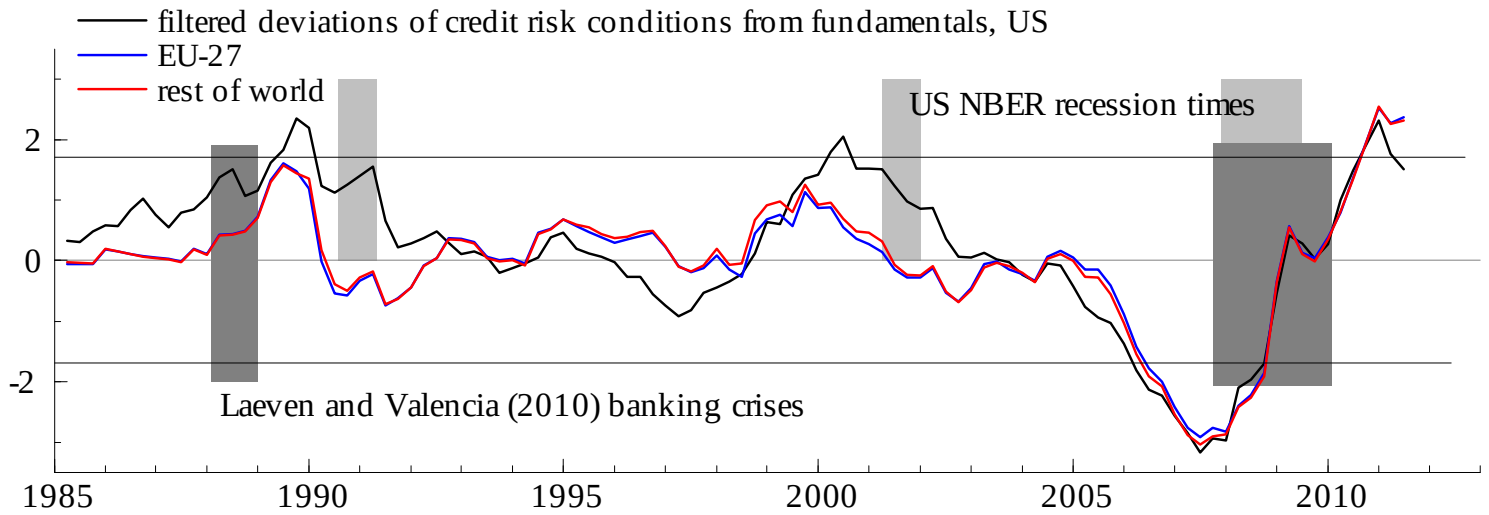
The probability of **k%** *or more* simultaneous failures as a (decreasing) function of **k**.

The likelihood of simultaneous FI failures in EU-27



The probability of **k%** *or more* simultaneous failures as a (decreasing) function of **k**.

Credit risk deviations indicator



"The indicator signals the extent to which local stress in a given industry (financials) and region is unexpectedly different from what would be expected based on macro-financial fundamentals".

$$\text{CRD}_{r,fin,t} = \gamma'_{rj} f^d_t + \delta'_{rj} f^i_t \; / \sqrt{\gamma'_{rj}\gamma_{rj} + \delta'_{rj}\delta_{rj}}$$

Ranking of credit based early warning indicators

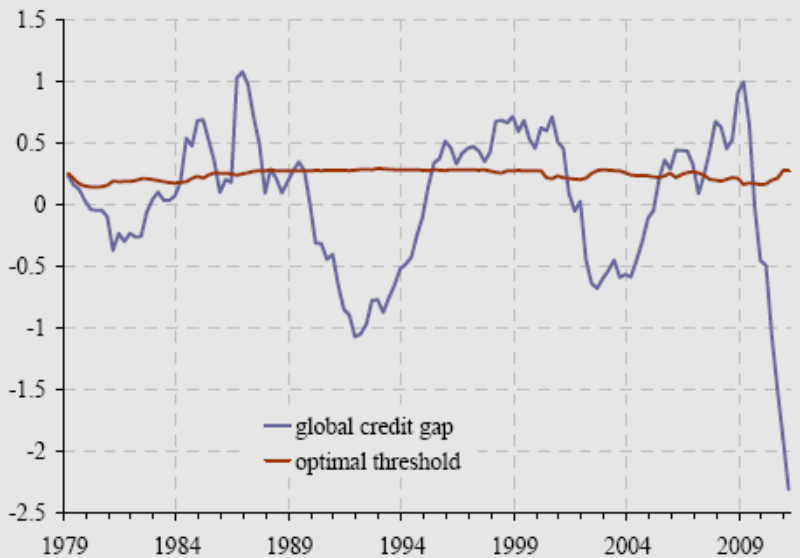
Indicators	loss	opt signal threshold	% booms called	% good signals	% bad signals	N2S ratio	cond prob	avg lead time
Global PC gap	0.30	65	71%	62%	25%	0.40	0.58	5.56
CRD fin EU	0.33	90	54%	27%	6%	0.23	0.70	3.89
CRD fin US	0.37	90	44%	20%	8%	0.41	0.58	3.45
PC/GDP gap	0.37	85	56%	27%	14%	0.51	0.57	3.83
Loan/Deposits gap	0.40	90	17%	7%	5%	0.78	0.28	2.17
Total Assets / GDP	0.42	95	6%	3%	3%	0.98	0.30	1.25
Total Assets / Capital	0.47	60	59%	39%	35%	0.89	0.29	4.72

Test sample: 11 EU countries 1984Q1/1998Q1 to 2008Q4.
Methodology as in Alessi and Detken (2011).

Credit quantities and risk: surveillance

Chart A.3.5 Global credit gap and optimal early warning threshold

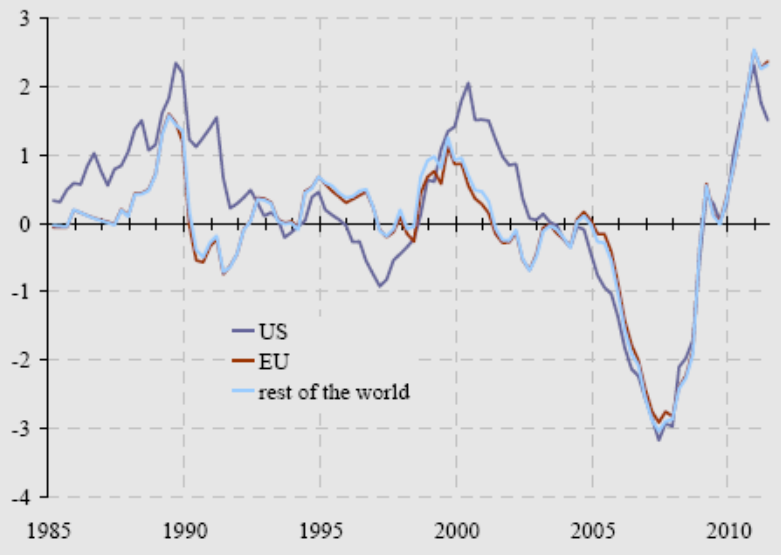
(Q1 1979 – Q1 2011; percentages)



Source: Based on L. Alessi and C. Detken, "Quasi real time early warning indicators for costly asset price boom/bust cycles: A role for global liquidity", *European Journal of Political Economy*, 27(3), 520-533, Sept. 2011.

Chart A.3.6 Deviations of credit risk conditions from macro fundamentals for financial firms

(Q1 1984 – Q2 2011; absolute deviations of credit risk conditions from fundamentals)



Source: Based on B. Schwaab, S.J. Koopman and A. Lucas, "Systemic risk diagnostics: coincident indicators and early warning signals", *ECB Working Paper*, No 1327, April 2011.

Punchlines/lessons

1. Credit risk and business cycle dynamics do not coincide. They have decoupled in the past during lending bubbles (2004-06) and credit crunches (1988-1990). Each lead to macro stress further down the road.
2. Call to action: Track credit *risk* conditions over time in addition to credit *quantities*/aggregates.
3. Factor models can be a versatile tool in an overall FS surveillance and assessment, despite complexity.

Thank you.