Dating Systemic Financial Stress Episodes in the EU Countries

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The views are those of the authors and do not necessarily reflect those of Bank of Canada, the European Central Bank, the Eurosystem or the European Systemic Risk Board.

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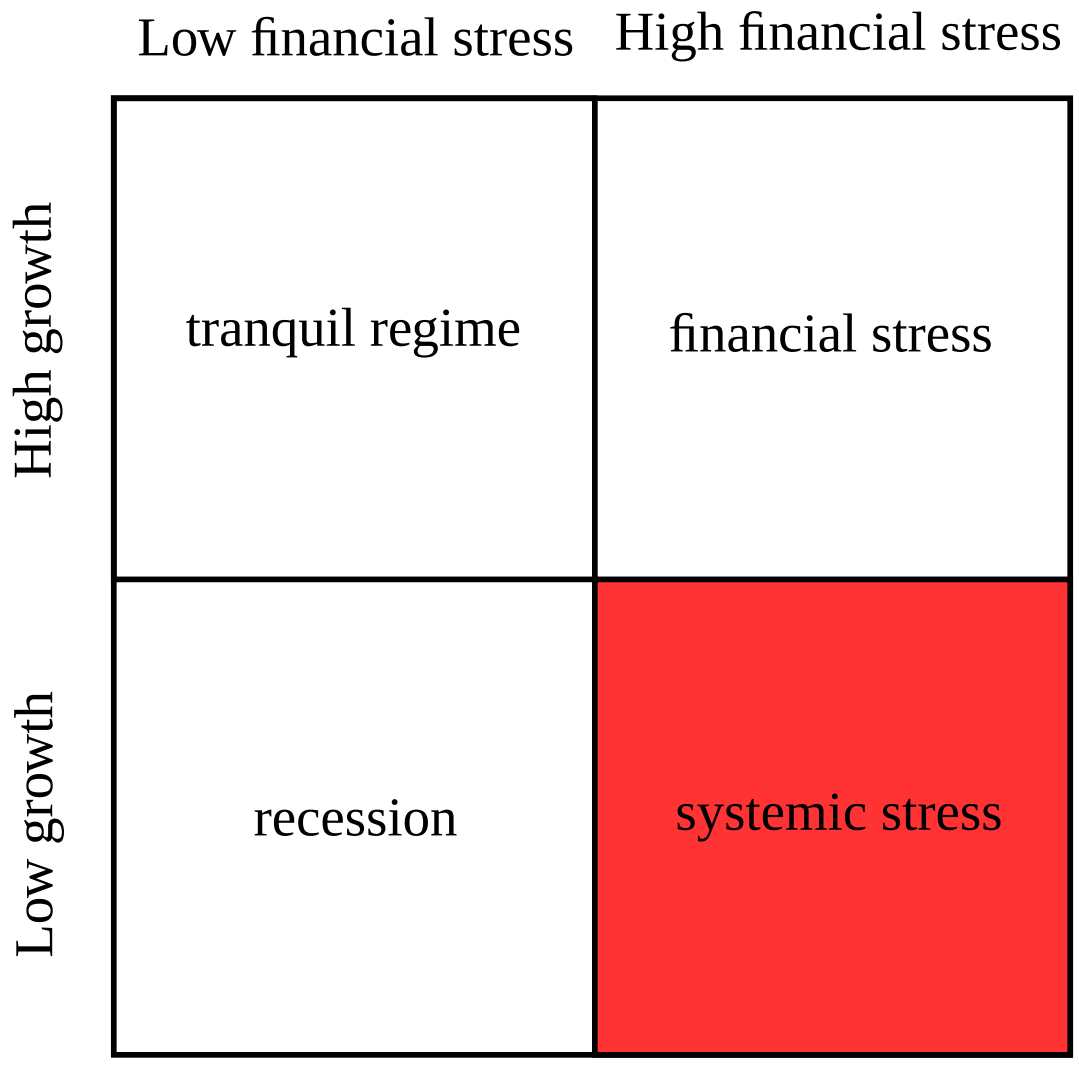
Classifying events for a better analysis of macropru

The analysis of macroprudential policies requires a chronology of **systemic** crises

- 2008 can be safely (?) regarded as a systemic financial crisis
- But the classification of all other events rely on expert **judgement**...

We provide a **mechanistic** identification of systemic financial stress

Aim = identify systemic financial stress



Overview

1. Construct 27 financial stress indices for all EU countries
   - Financial cycle research : financial stress index literature
2. Identify systemic financial stress episodes
   - Business cycle research : identifying business cycle turning points using a suite of non-linear models
     - Method 1 : Univariate Markov switching with algorithm
     - Method 2 : Markov switching vector autoregressive model
     - Method 3 : Threshold vector autoregressive model

STEP 1 : Construct 27 financial stress indices

(in the spirit of CISS : Hollo et al., 2012)

volatility stocks	cumulated drop in stocks
volatility of government bond	cumulated government bond spread
volatility effective exchange rate	cumulated change effective exchange rate
volatility idiosyncratic bank returns	cumulated drop bank stocks
mortgage lending spread	cumulated housing price drop

normalized in the [0;1] space using the empirical cumulative density

- Equity sub-index
- Bonds sub-index
- FX sub-index
- Bank sub-index
- Housing sub-index

Pairwise cross-correlations ρ of indices I

$$CLIFS_t = I_t * C_t * I_t^{'}$$

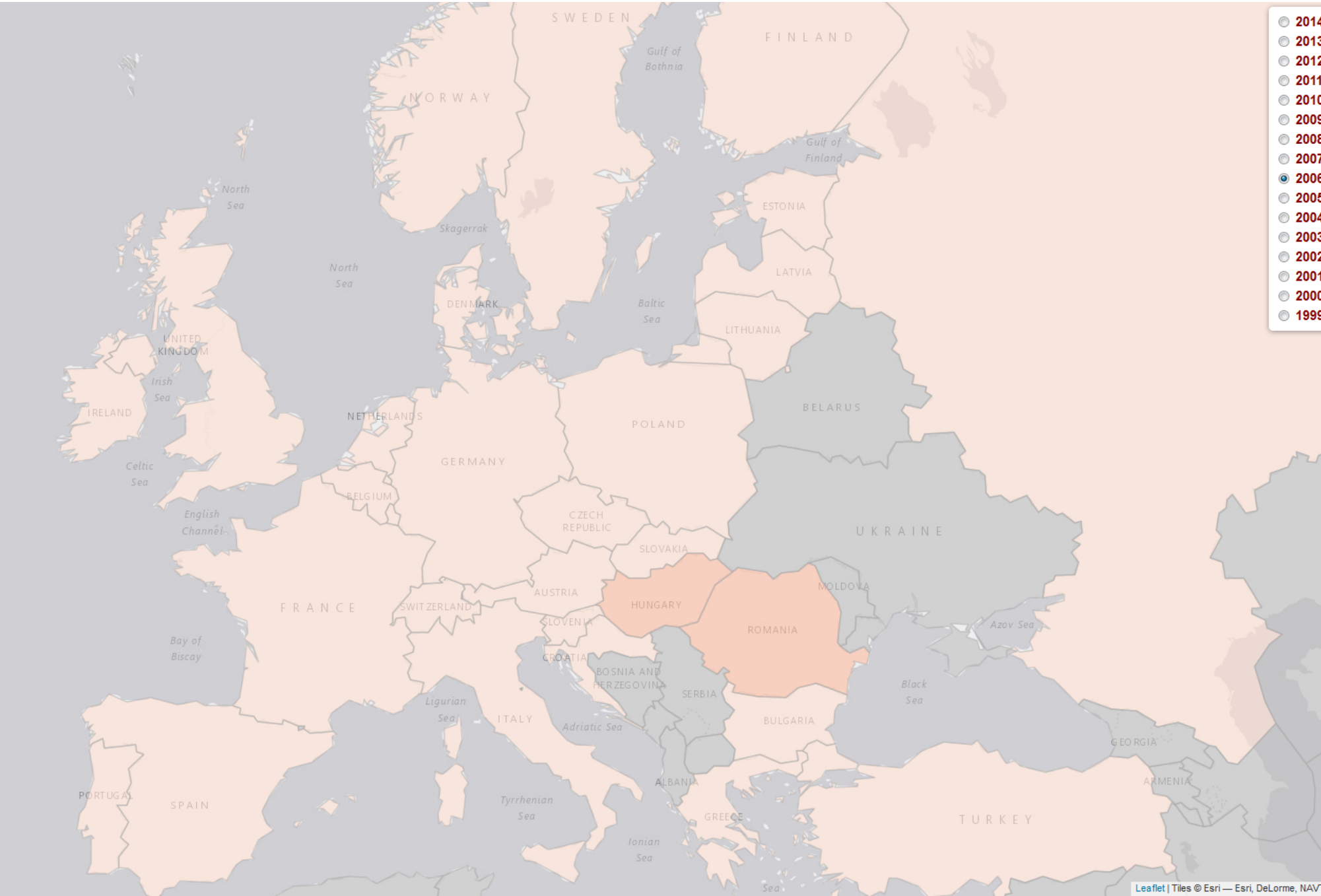
Country-Level Index of Financial Stress (CLIFS)

$$I_t = [I_{i,t} \dots I_{j,t}]_{1*5}$$

$$C_t = \begin{bmatrix} 1 & \dots & \rho_{i,j,t} \\ \vdots & \ddots & \vdots \\ \rho_{i,j,t} & \dots & 1 \end{bmatrix}_{5*5}$$

End of 2006 Dataset publicly available :

`http://sdw.ecb.europa.eu/browse.do?node=9693347`



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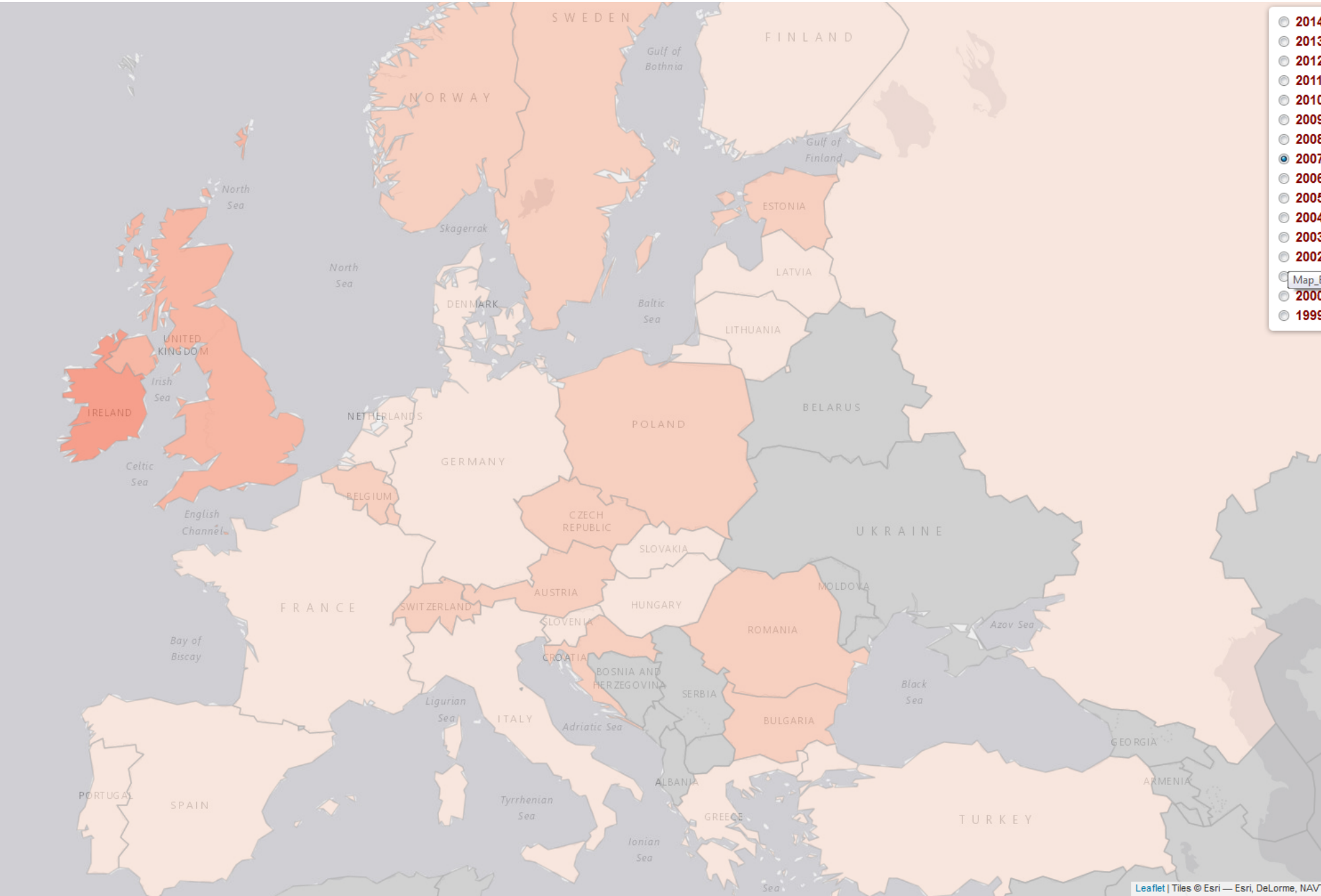

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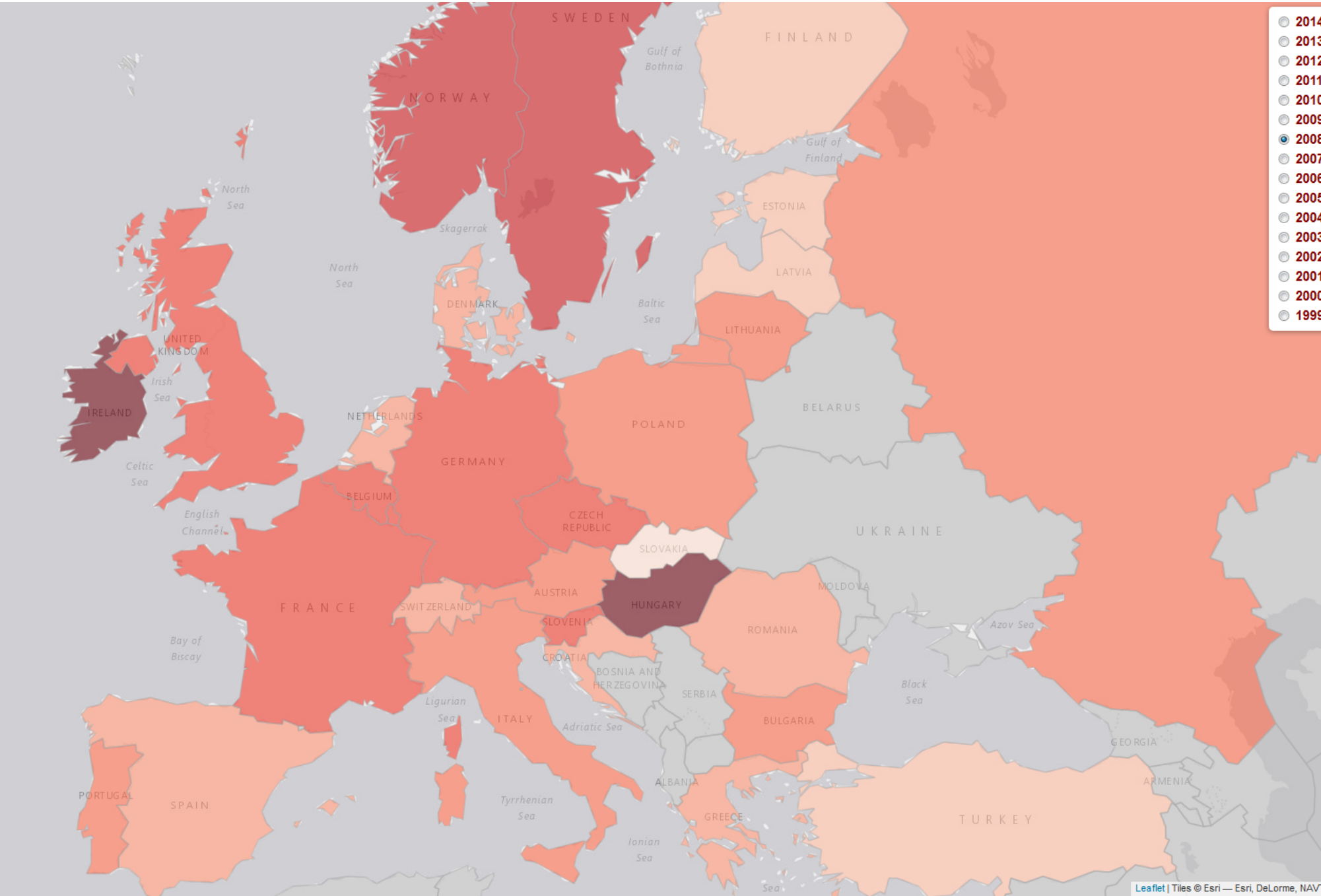
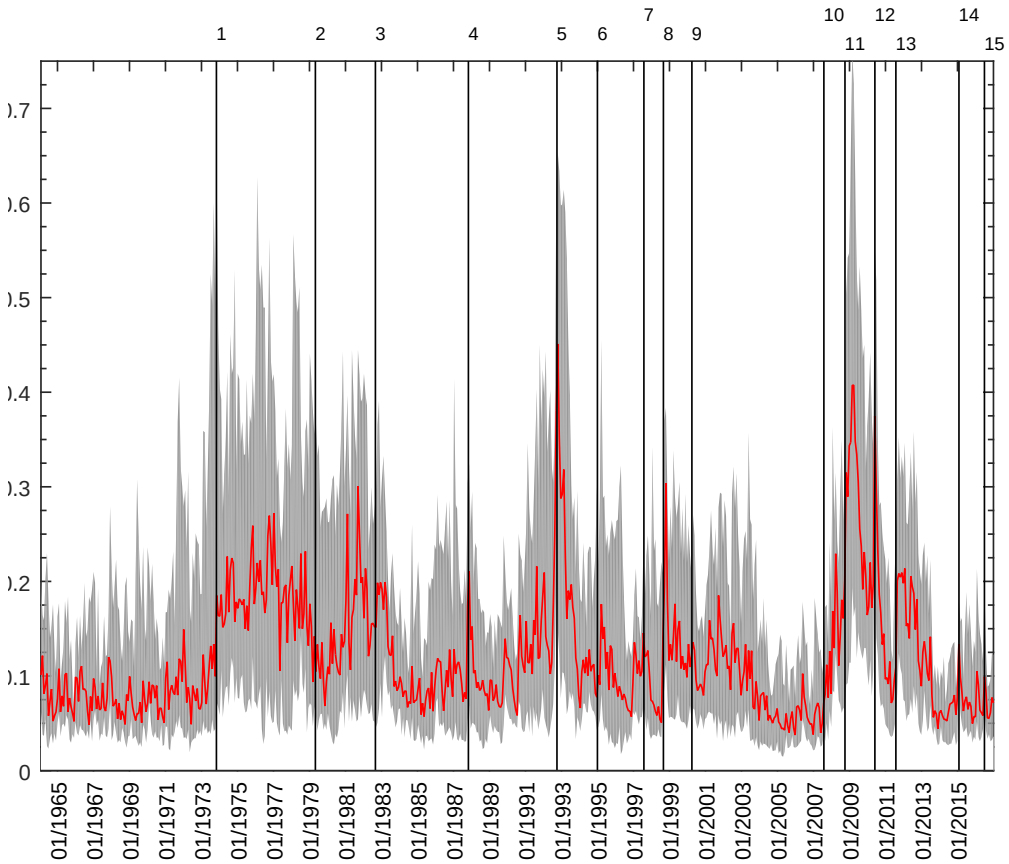
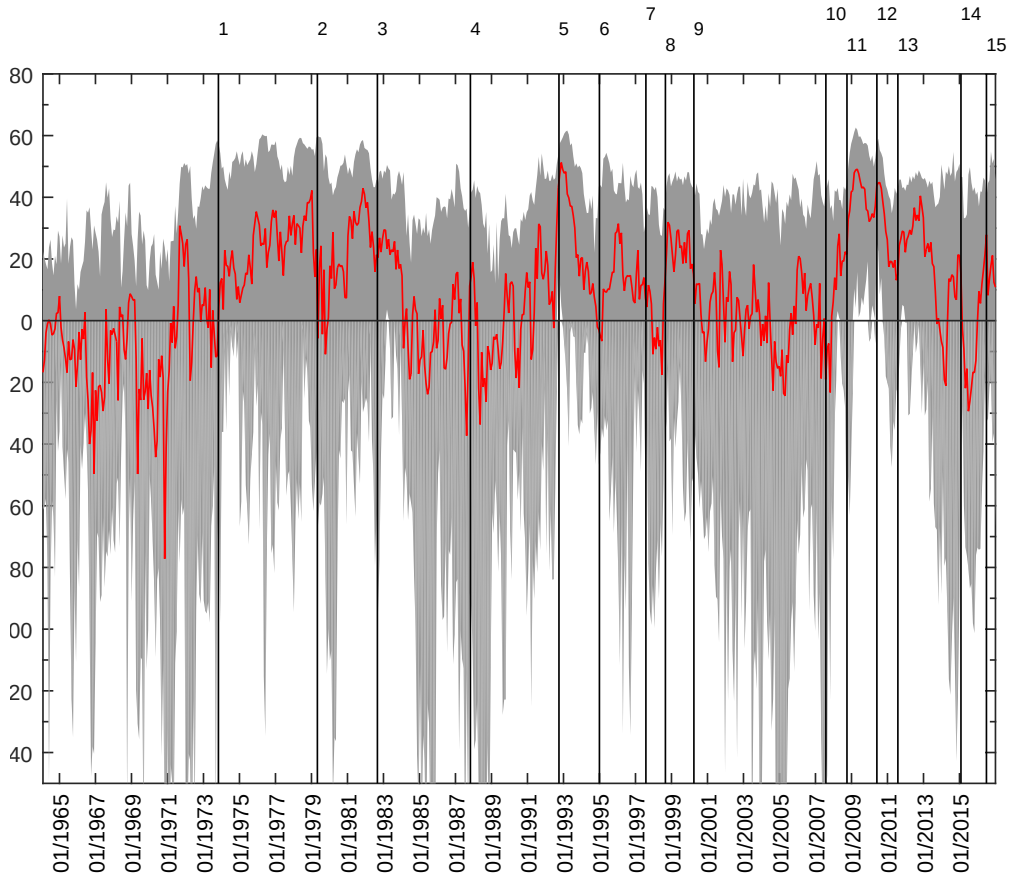


Country-Level Index of Financial Stress (CLIFS)



1 - first oil shock ; 2 - second oil shock ; 3 - Mexican debt crisis ; 4 - Black Monday ; 5 - crisis of the European exchange rate mechanism ; 6 - Peso crisis ; 7 - Asian crisis ; 8 - Russian crisis ; 9 - dot-com bubble ; 10 - subprime crisis ; 11 - Bankruptcy of Lehman Brothers ; 12 - 1st bailout Greece ; 13 - 2nd bailout Greece ; 14 - Election of Alexis Tsipras in Greece ; 15 - Brexit vote.

Contribution of the cross-correlations



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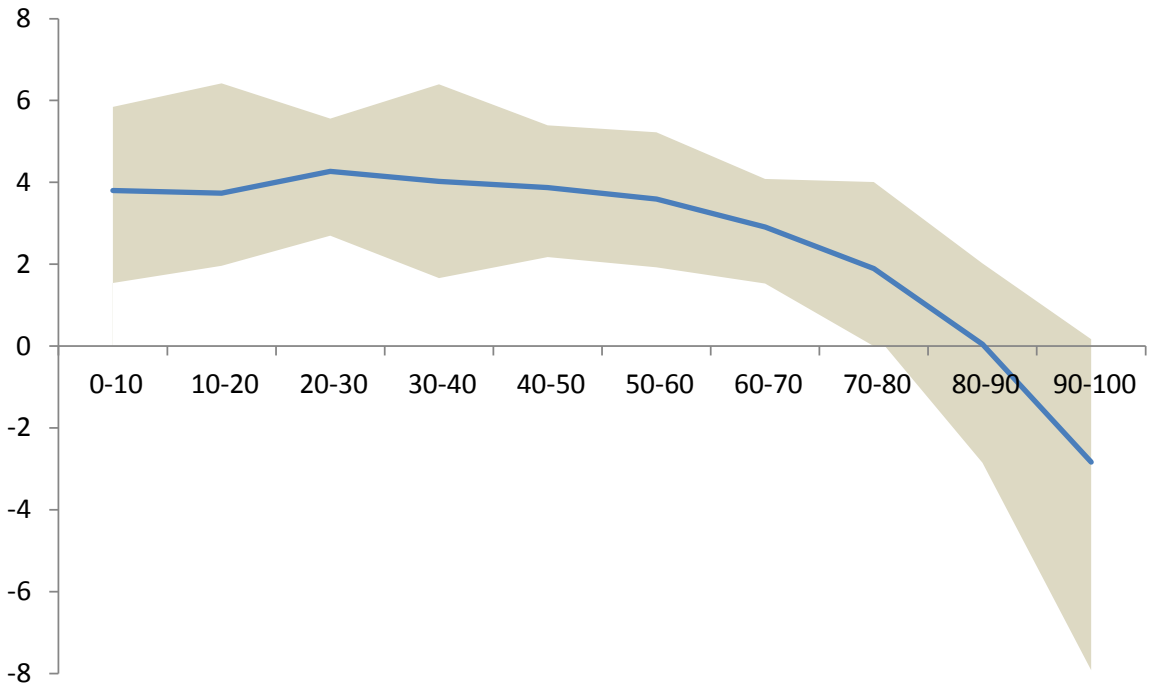
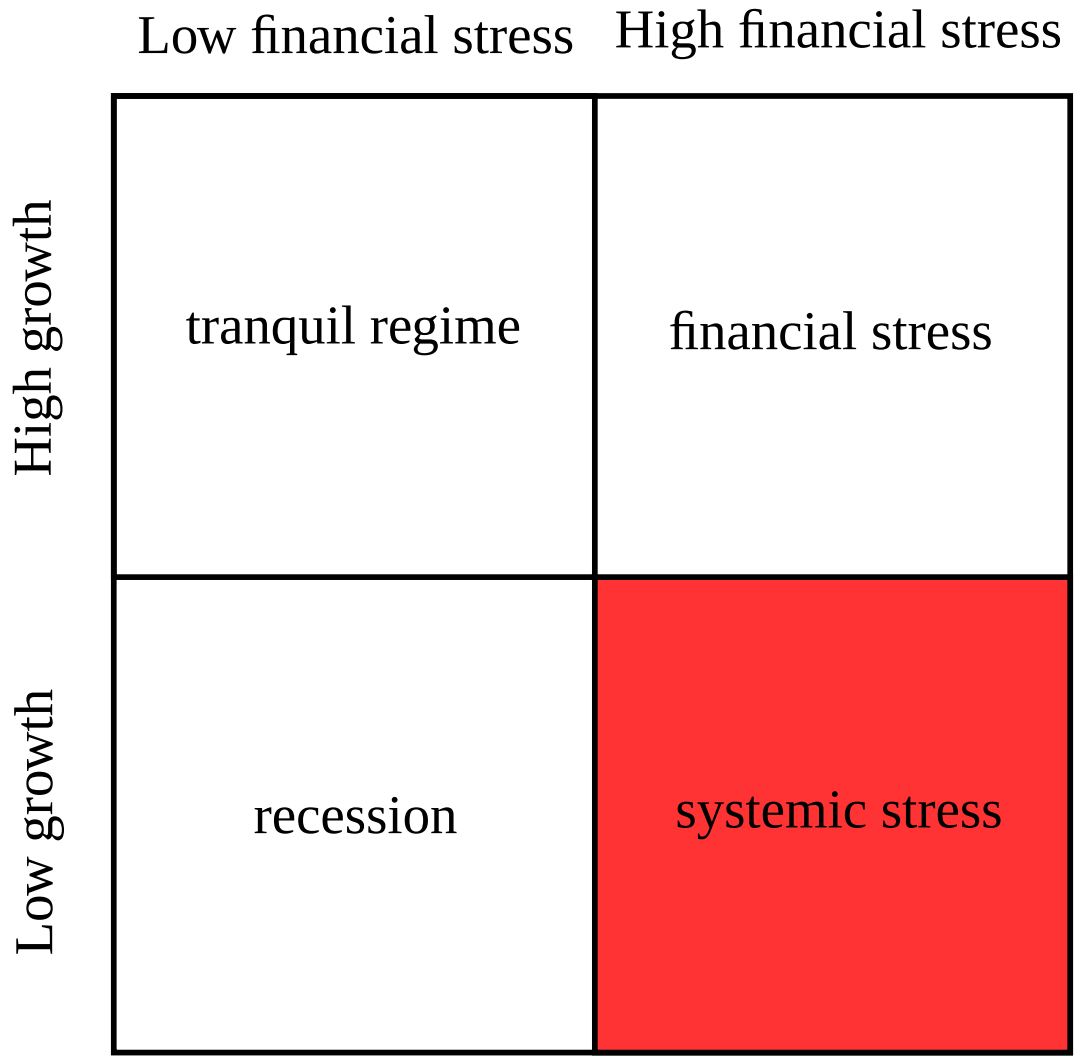
Does financial stress matter ?

Industrial production growth per quantiles of CLIFS



Average annual industrial production growth on the y-axis.
Quantiles of the country-specific financial stress indices on the x-axis.

STEP 2 : How to identify systemic financial stress episodes ?



Method 1 : Markov-Switching with selection algorithm

Hamilton (1989) Markov-Switching framework

1. Identify periods of high financial stress :

$$CLIFS_t = \mu^{S_t} + \beta CLIFS_{t-1} + \sigma^{S_t}\epsilon_t$$

Transition probability across regimes $S_t \in \{L, H\}$ driven by a hidden two-state Markov chain :

$$P(S_t|S_{t-1}) = \begin{bmatrix} p = \frac{\exp(\theta_p)}{1+\exp(\theta_p)} & 1-p \\ 1-q & q = \frac{\exp(\theta_q)}{1+\exp(\theta_q)} \end{bmatrix}$$

regime H when $\mu_H > \mu_L$, and financial stress period when :

$$\mathbb{1}_{financialstress} = \{P(S_t = H) > 0.5\}$$

2. Overlap with at least six consecutive months of real economic stress (drop in industrial production and GDP correction)

Method 2 : Markov switching vector autoregression

builds on toolbox of Haroon Mumtaz

Bivariate model to capture joint change in dynamics of industrial production growth (*gIPI*) and *CLIFS*

$$\begin{cases} gIPI_t = \mu_1^{S_t} + \sum_{p=1}^{n} \left(\beta_{1,1,p}^{S_t} gIPI_{t-p} + \beta_{1,2,p}^{S_t} CLIFS_{t-p} \right) + \epsilon_{t,1} \\ CLIFS_t = \mu_2^{S_t} + \sum_{p=1}^{n} \left(\beta_{2,1,p}^{S_t} CLIFS_{t-p} + \beta_{2,2,p}^{S_t} gIPI_{t-p} \right) + \epsilon_{t,2} \end{cases}$$

The tranquil or systemic financial stress state $S_t \in \{L; H\}$ is unobservable : same hidden two-state Markov chain as before.

Method 3 : Threshold vector autoregressive model

builds on toolbox of Gabriel Bruneau

Different joint dynamics above (H) or below (L) an estimated percentile of the CLIFS

$$\begin{cases} CLIFS_t = \mu_1^{S_t} + \sum_{p=1}^{n} \left(\beta_{1,1,p}^{S_t} CLIFS_{t-p} + \beta_{1,2,p}^{S_t} gIPI_{t-p} \right) + \epsilon_{t,1} \\ gIPI_t = \mu_2^{S_t} + \sum_{p=1}^{n} \left(\beta_{2,1,p}^{S_t} gIPI_{t-p} + \beta_{2,2,p}^{S_t} CLIFS_{t-p} \right) + \epsilon_{t,2} \end{cases}$$

The observed regime is given by :

$$S_t = \begin{cases} H & \text{if } CLIFS_{t-1} \geq \tau \\ L & \text{if } CLIFS_{t-1} < \tau \end{cases}$$

where τ is estimated.

Robustly identifying systemic financial stress events

For each 27 countries we have up to 12 models

- different framework, with different specifications, using CLIFS or the banking and housing extensions

For each country, combine dummies $S_{m,t}$ for periods of systemic financial stress over all models m

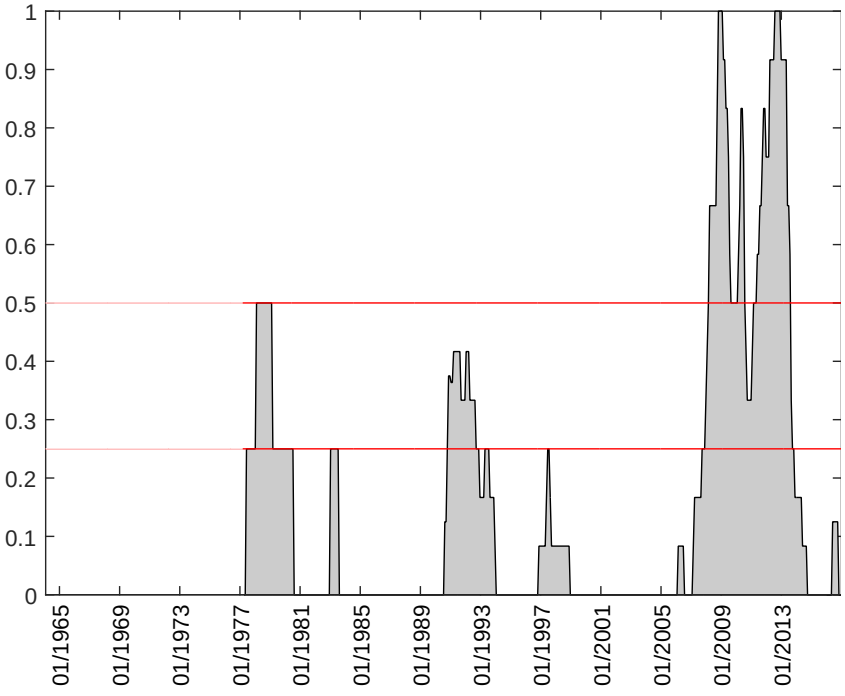
- robust to model uncertainty

$$\text{Systemic Stress Index } SSI_t = \frac{\sum_m S_{m,t}}{\sum_m \mathbb{1}_m} \in [0; 1]$$

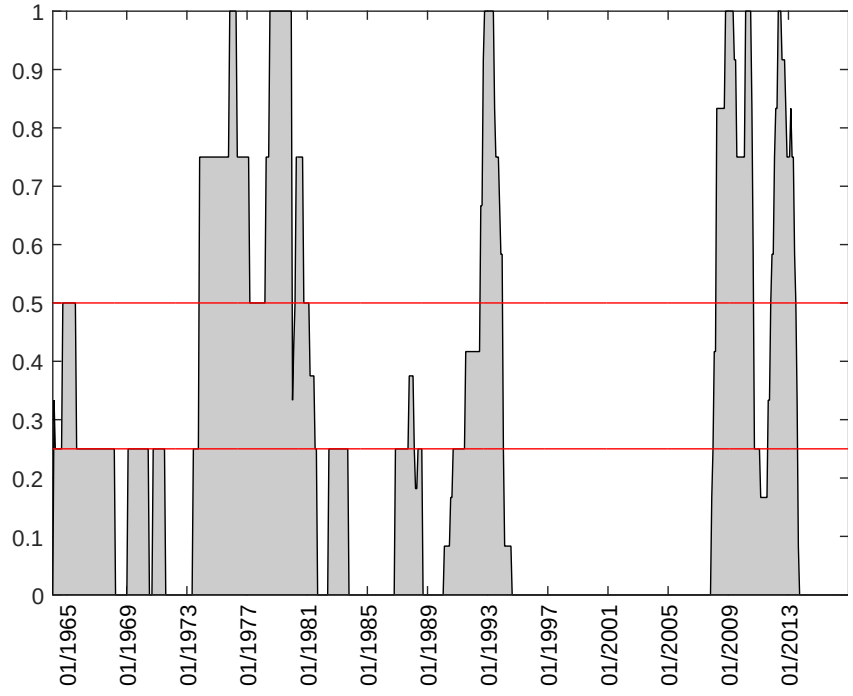
Definition of systemic financial stress :

- starts when $SSI_t > 0.5$
- ends when $SSI_t < 0.25$

Zoom-in : Systemic Stress Indices, selected countries

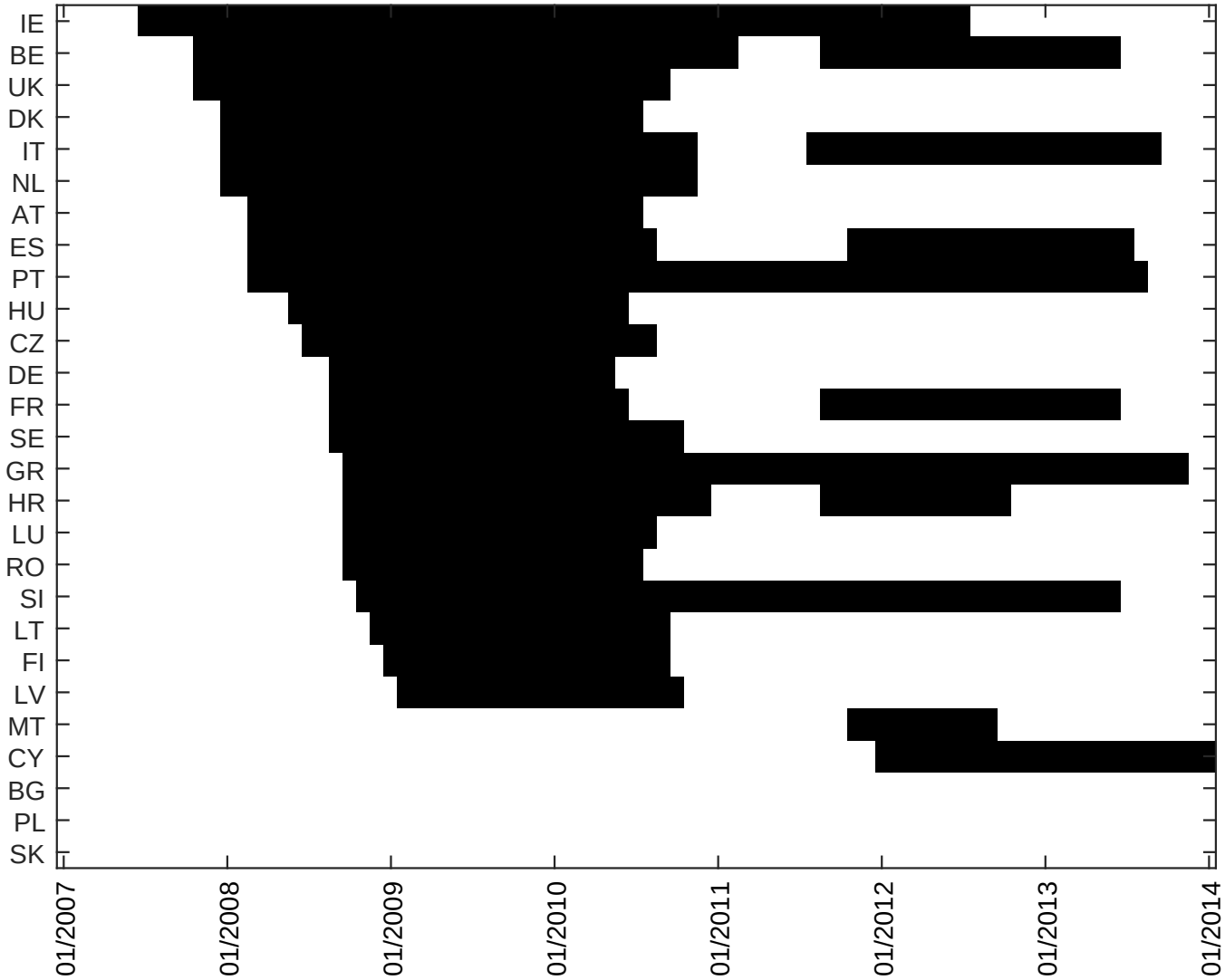


(a) Portugal

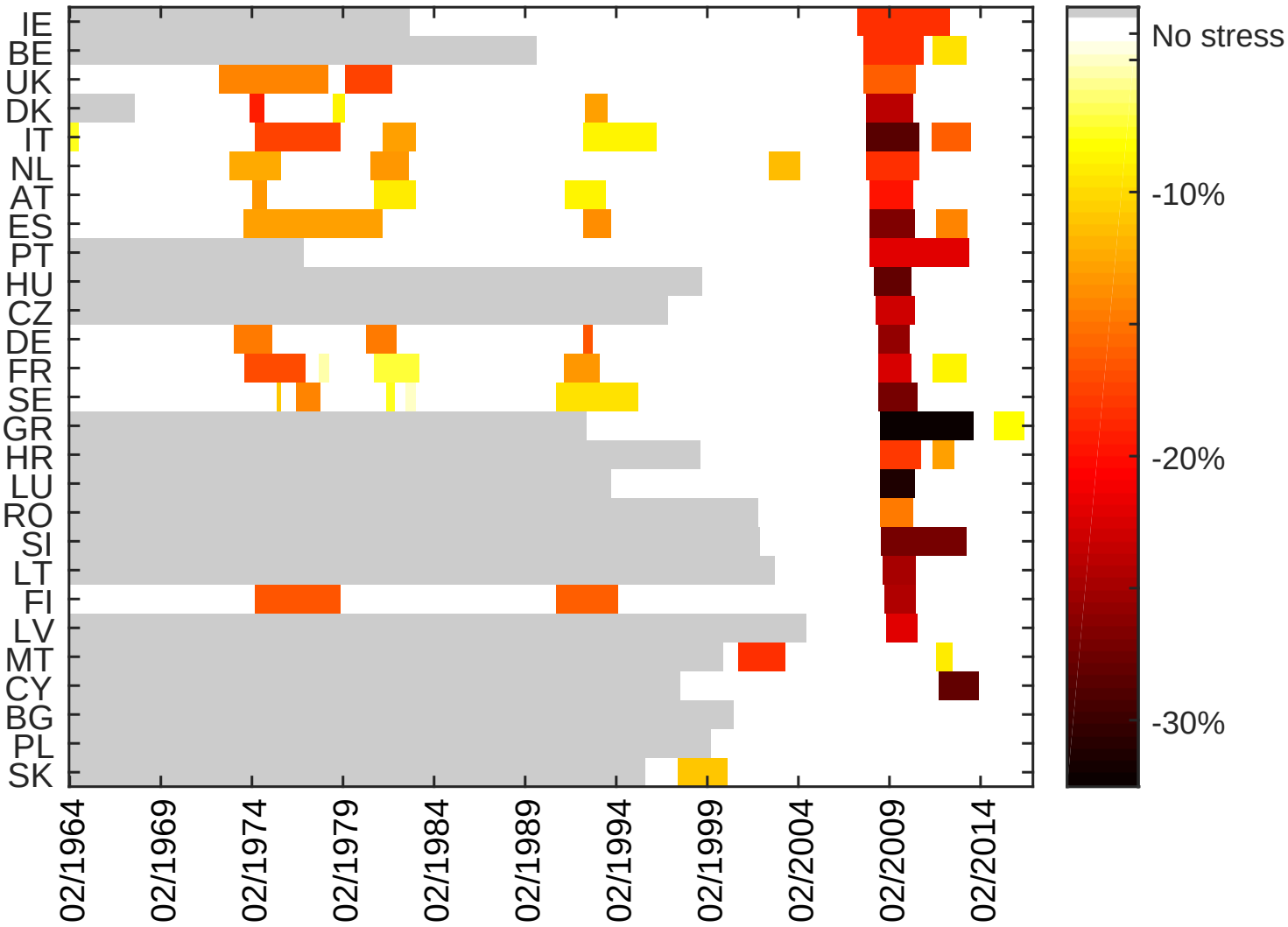


(b) Spain

Zoom out : Timing of systemic financial stress in 2008



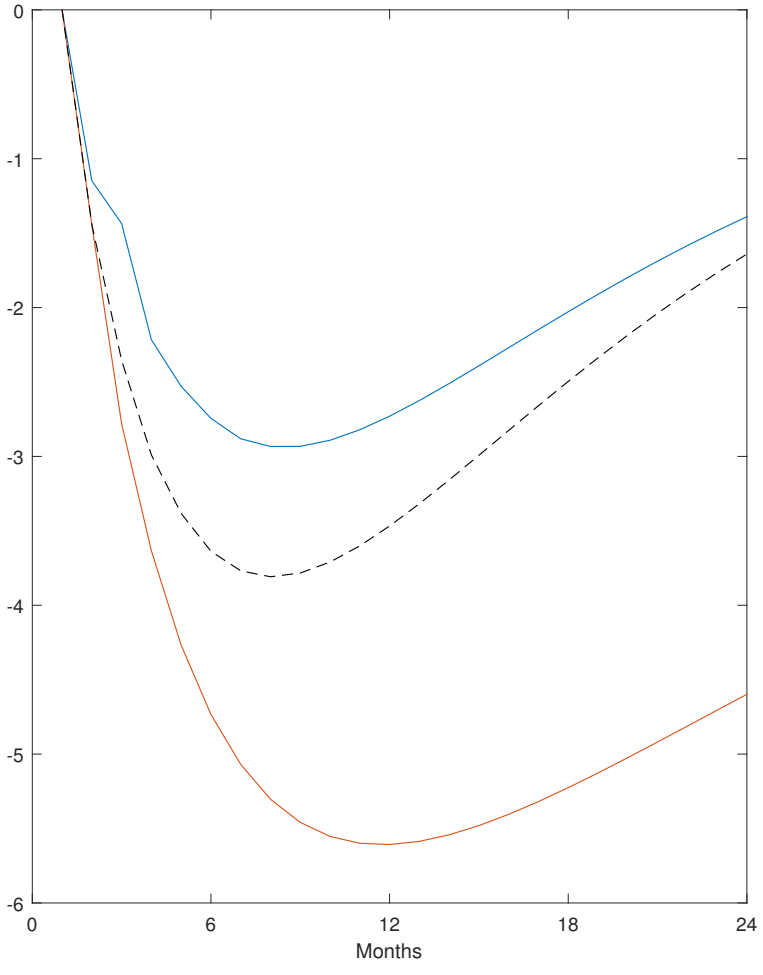
Zoom out further : Financial market stress and intensity of real economic stress



No zoom : Systemic financial stress is costly

Bi-product of the Threshold VAR

Response of industrial production to a shock of 1% on CLIFS
(black : VAR without regime change ; red : high stress ; blue : tranquil)

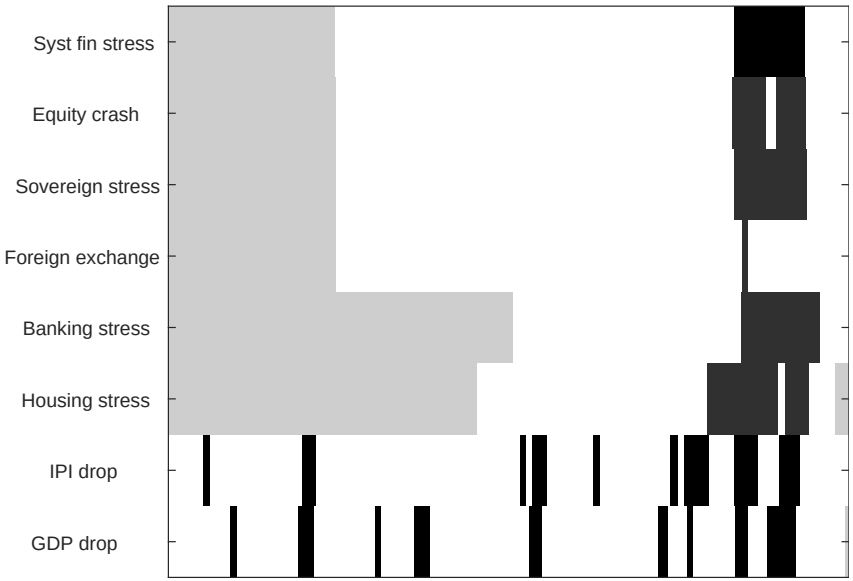


What are systemic financial stress episodes ? Not ordinary recessions

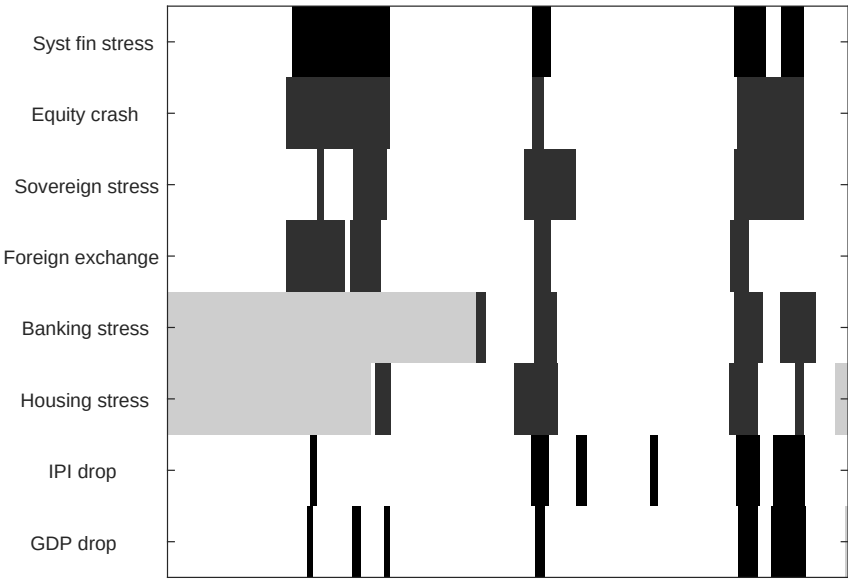
Definition of recession :	Number events	Length	GDP loss	CLIFS pcent	mean corr
	Ordinary recessions				
Two quarters	76	11	-0.79	50	-7
Two consecutive quarters	45	7	-1.52	50	-18
Before 2008, two quarters	57	10	-0.77	51	-16
	Recessions with financial market stress				
Two quarters	74	18	-4.10	66	28
Two consecutive quarters	42	13	-4.17	70	31
Before 2008, two quarters	39	14	-1.71	72	28

What are systemic financial stress episodes ? Sectoral decomposition for selected countries

Bi-product of the Markov-switching model



(c) Portugal



(d) Spain

Comparison of continuous stress measures with expert-based crises : AUROC

	CLIFS		SSI	
	panel	average	panel	average
Detken et al. (2014)				
Banking	0.71	0.76	0.82	0.83
Babecky et al. (2012)				
Banking	0.66	0.72	0.80	0.83
Currency	0.71	0.68	0.82	0.74
Debt	0.94	0.94	0.91	0.95
Leaven and Valencia (2013)				
Banking	0.75	0.77	0.87	0.88
Reinhart and Rogoff (2011)				
Banking	0.70	0.75	0.84	0.87
Currency	0.53	0.51	0.67	0.69
Equity	0.66	0.68	0.74	0.77

Comparison of model-based systemic financial stress episodes with expert-based crises

	Share of model identified events also captured by experts	Share of expert identified crises also captured by models
Spain	1.00	0.43
Portugal	1.00	0.14
Total	0.81	0.43
Mean	0.83	0.55

In particular, we capture 96% of the systemic banking crises of Leaven and Valencia (2012)

Wrap-up

Paper combines measurement of financial stress with detection of turning points for a mechanistic dating of systemic financial stress episodes

Upsides :

- Get model-implied systemic financial stress periods
- Integrate real and financial cycle dynamics (=systemic)
- Consistent with most expert-based datasets
- Robust to alternative measures of financial stress
- Robust to model uncertainty
- Robust to event reclassification once new data arrive

Downsides :

- Hard to capture causal relation between financial stress and real economic stress

Follow up work : "A new database for financial crises in European countries", ECB Occasional Paper No. 194, July 2017.