Detecting global financial crises over history: A multivariate nonlinear denoising strategy

Patrice Abry[1,5], Cécile Bastidon[2,5], Pierre Borgnat[1,5], Pablo Jensen[1,5], Antoine Parent[3,5], and Barbara Pascal[4,5]
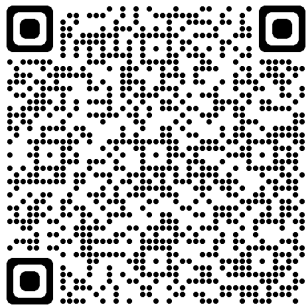
[1] CNRS, ENS de Lyon, Laboratoire de Physique, France
[2] LEAD, Université de Toulon, France
[3] LED, Université Paris 8, & OFCE, France
[4] CNRS, Université de Lille, CRIStAL, Lille, France
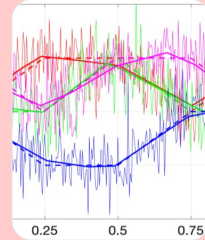[5] Institut Rhône-alpin des Systèmes Complexes

Cliometrics And Complexity
IXXI project webpage

Existing literature

- Expert-based datations: require updates
- Model-based datations: do not handle highly multivariate data
- ▶ *Cliometrics and complexity tool for crises detection on-the-fly.*

3-step original model-based method

- Information from pairwise correlations in stock market prices
- Nonlinear multivariate denoising
- Crises detection from changepoint filtering
- ▶ *Applies to any quantitative historical data.*

Main results
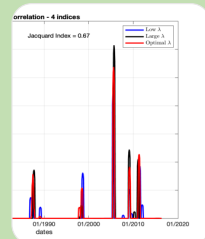
- Detects all major benchmark crises
- Major crises impact jointly the 1st four moments of correlation distributions
- ▶ *Original crisis typology.*

LogReturns

Pairwise Correlations

Correlation Summary Indices

$$Y = Arg\ Min\ _U\|X - U\|^2 + \lambda \sum_t [U_{t+1} - U_t]$$

- data
- true
- LinearFiltering
- NonLinearFiltering

Linear filtering
→ Analytical solution

Nonlinear filtering
→ No analytical solution
→ Iterative minimization
→ **Original toolbox**
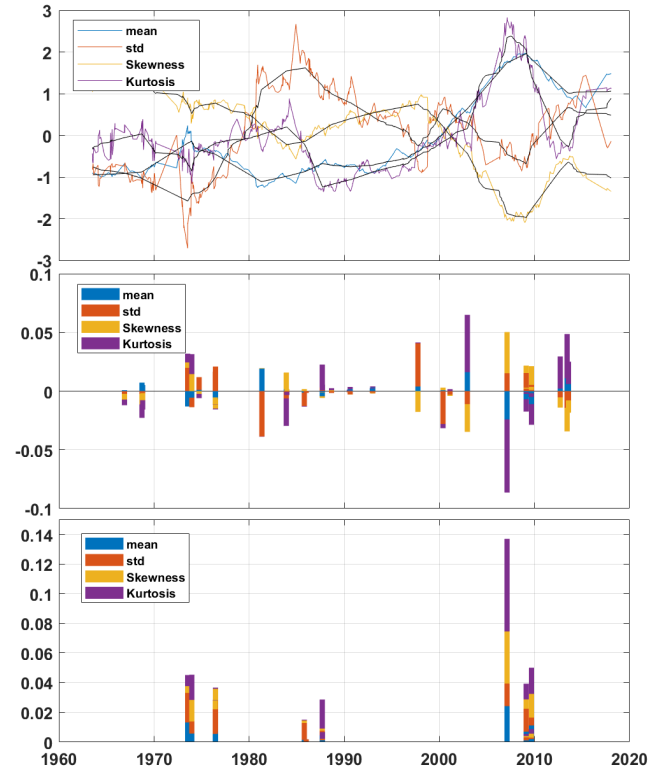
Step 1. Correlations

From log returns of stock market prices to correlations summary indices

Step 2. Denoising

Multivariate piecewise linear segmentation of the correlation structure

Step 3. Crisis indicator

Segmentation and filtering of the changepoints

Achieved typology of crises

- **Main results from summary of correlations**
- **Robustness from all pairwise correlations**
- **Complementary results from volatilities**

Typical crises increase Stdev
Exceptions: short duration crisis (1987) / strong regional dimension (2010)

Major crises decrease Kurtosis
Exceptions: crises not triggered by financial sector (1973, 1976, 1987)

Datation from volatilities

Datation from the distribution of correlations

Jacquard Index = 0.45

	Mean	Stdev	Skewness	Kurtosis	
1973	-	+	+	+	1st oil shock
1976	0-	+	0-	0	End of the IMS
1987	-	0+	0-	+	Stock market crash
2007	-	+	+	-	GFC
2009	-	+	+	-	GFC
2010	-	0+	+	-	European debts crisis

Major crises increase Skewness derivative
Exceptions: institutional events of crisis resolution decreasing uncertainty (1976, 1987)
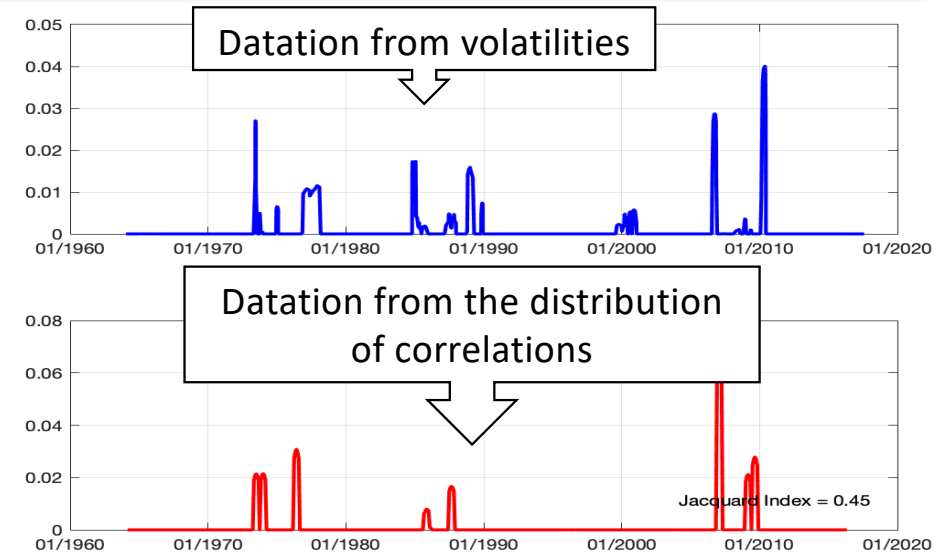
- **Fully data-driven method**
- **Handles unbalanced panels**
- **Handles non stationary data**
- **Applies to any multivariate historical time series**