

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

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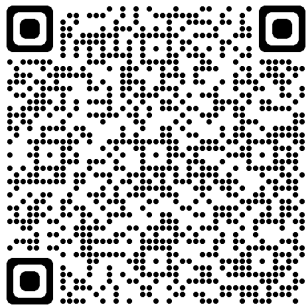
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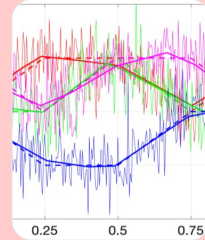
[Cliometrics And Complexity
IXXI project webpage](#)

Existing literature

Banking crisis (number)	Currency crisis (number)	Sovereign debt crisis (number)	Yt (year)
1	1	1	1
5	4	1	5
1	1	1	10
2	5	3	20
2	1	1	25
3	3	2	30
3	4	3	35
3	10	6	40
4	5	9	45
7	12	9	50
1	10	4	55
2	10	3	60
1	9	1	65

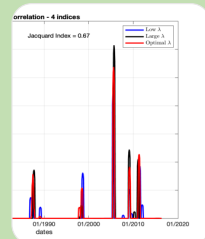
- Expert-based datations: require updates
- Model-based datations: do not handle highly multivariate data
- ▶ *Cliometrics and complexity tool for crises detection on-the-fly.*

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.*

Expert based

Model based

Economic history
« expert based »

Textual data

Early Warning
Indicators (EWI)

Regime models &
multinomial regressions

Multivariate statistical
approaches

2000

Eichengreen & Bordo 2002
Crisis criteria (banking,
currency, twin)

Kaminsky, Lizondo & Reinhart 1997
"Signals approach": ROC on macro
indicators (currency crises)

Berg & Patillo 1999
Comparison of EWI and probit

Emerging crises

Forbes & Riggobon 2002
Bias in correlations of
heteroskedastic stock
market prices

Kaminsky Reinhart 2000
"Signals approach": ROC on
macro indicators (banking
and currency crises)

Bussière & Fratzscher 2006
EWI + Multinomial probit

Baele 2005
MSM on stock
markets volatility

2010

Reinhart & Rogoff 2009
Crisis criteria (defaults,
hyperinflation, banking,
currency, etc.)

Benchmark datations

Laeven & Valencia 2012
Crisis criteria (banking,
currency, systemic sovereign)

Schularick & Taylor 2009
AUROC + Logit (long term
money/credit relationship)

Financial stability & macropru

Drehman Juselius 2014
Ranking of macro
indicators based on AUROC

Duprey et al 2017
MSM on financial
stress indicators

Aikman et al 2017
Heatmaps on time series
of aggregated financial
indicators

Romer & Romer 2017
Expert based indicator
from textual data

Brave & Butter 2018
ROC on aggregated
financial stress indicators

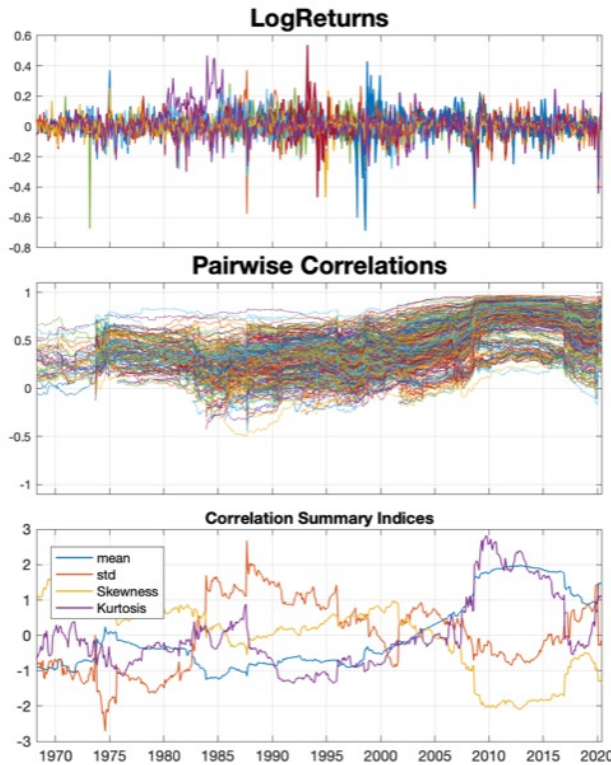
Danielsson et al 2018
Regimes based on
Hodrick Prescott filters
on vol. + AUROC

2020

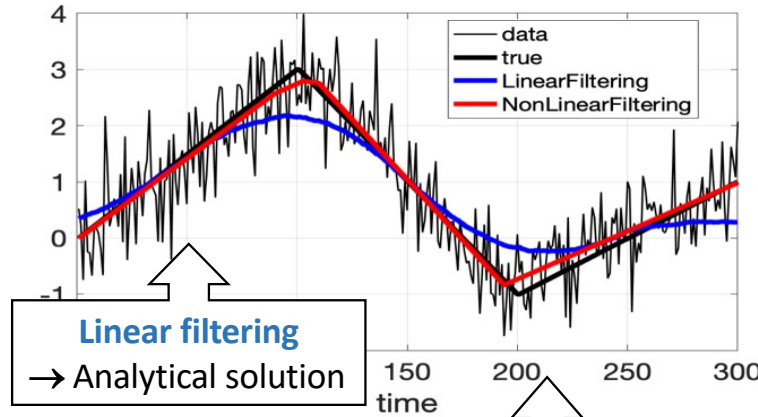
Chen & al 2020
Machine learning indicator
from textual data

Lee & al 2020
AUROC on financial stress indicators
à la Aikman et al 2017

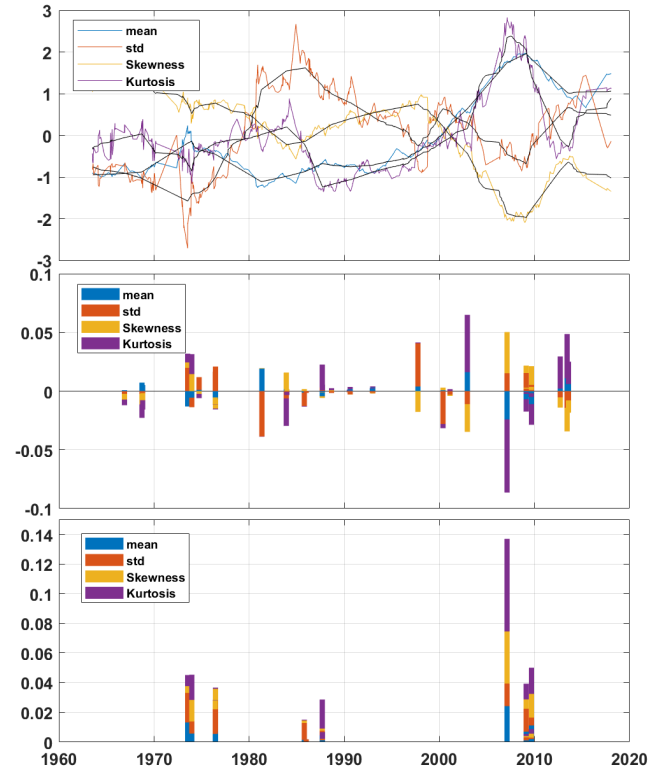
Bastidon et al 2020
Network indicators and
non linear segmentation



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



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

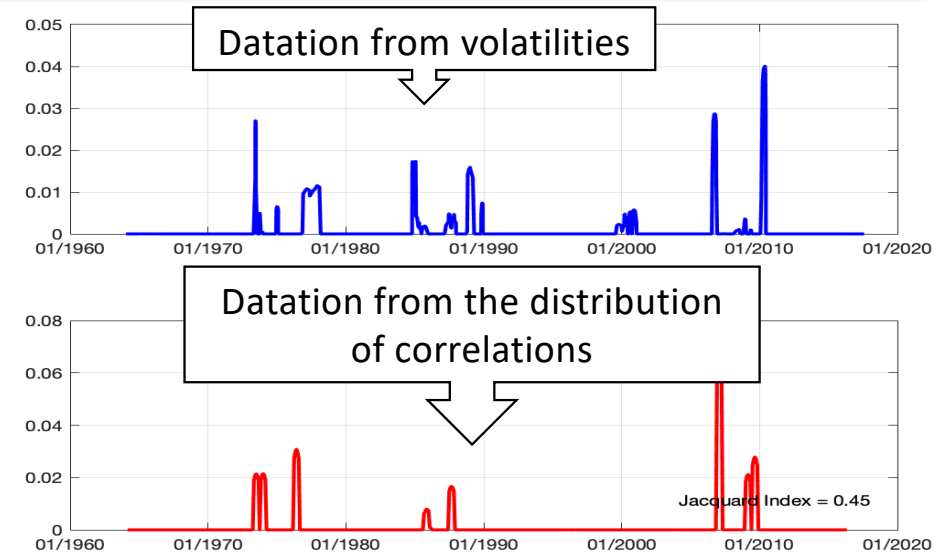
Exceptions: crises
not triggered by
financial sector
(1973, 1976, 1987)

Mean Stdev Skewness Kurtosis

Year	Mean	Stdev	Skewness	Kurtosis	Event
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

