

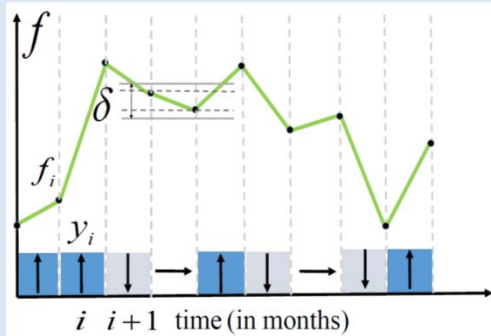
Abstract

Recessions are economic downturns that can be recognized from macro-indicators such as the Dow Jones Industrial Average (DJIA) and the Federal Reserve Interest Rate (FRIR). To provide early-warning signals of recessions and similar systemic transitions, here we propose a new approach based on pattern recognition, called inclination analysis [1, 2]. For this purpose, we develop a stochastic model based on time-series analysis to assess the probability of a recession to occur at a given moment in the past, present, or future. Calibrating our model to data proceeds in three steps, involving the coarse-graining of the available input time series, the identification of short series motifs that foreshadow recessions, and the optimization of key model parameters according to the model's desired forecasting horizon.

Methodology

Key steps:

- Time series mapped onto sequence of **inclination signals**: $\{\rightarrow \uparrow \downarrow\}$ $f_i \mapsto y_i$

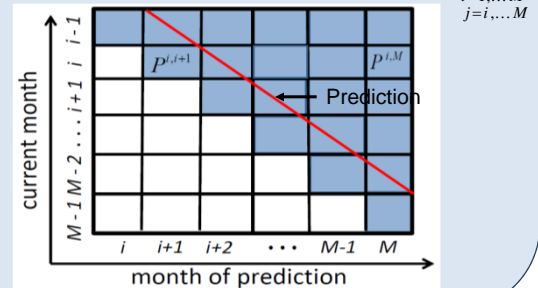


- A set of **binary coding** of time series y is assigned: $y \mapsto s, s \in \Omega, \Omega = \{\sigma_i : \sigma_i \text{ - binary code}\}$
- Based on frequency in historical path of s **transition probabilities** are defined: $\rho_{\sigma_i}^{\sigma_{i+1}} = \rho(\sigma_i | \sigma_{i+1}), i = 1, \dots, N$

	11	10	01	00	
ρ_{11}^{11}	0	ρ_{11}^{01}	0	11	
ρ_{10}^{11}	0	ρ_{10}^{01}	0	10	
0	ρ_{01}^{10}	0	ρ_{01}^{00}	01	
0	ρ_{00}^{10}	0	ρ_{00}^{00}	00	

Model parameters are optimized so that to maximize prediction power for the past recessions

- The **recession probability** is evaluated for the optimized parameters: $\{P^{i,j}\}_{i=1, \dots, M, j=i, \dots, M}$



Preliminary Results

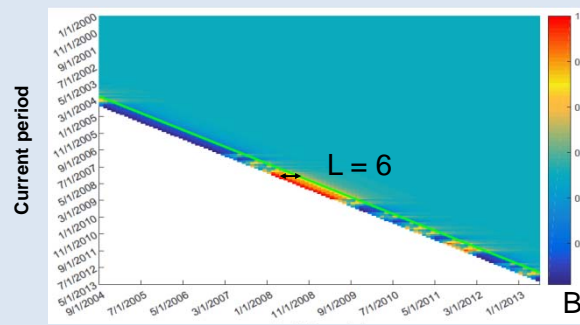
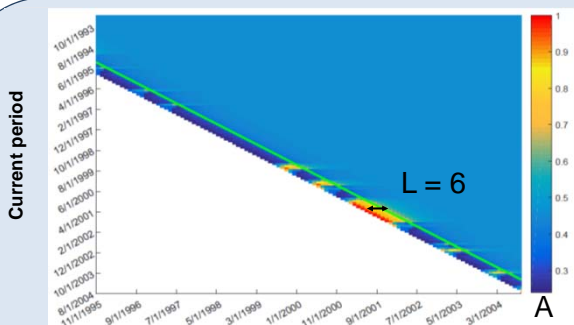
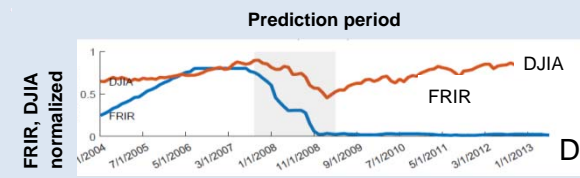
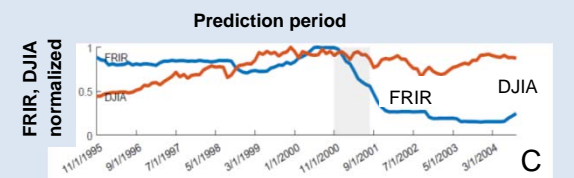


Fig. (A)(B) Recession matrix. High values indicate the likely commencement of recession.



(C)(D) FRIR and DJIA time series with recession periods indicated by shading.

Conclusions

- The method provides an assessment of **recession probability** through a new kind of **pattern-recognition algorithm**: using the economic time series, it provides an early warning signal.
- The applicability of our method is shown for a set of $n = 2$ **economic macro-indices (DJIA, FRIR)**; in general, more macro-indices can be used

References

- [1] A. Puchkova, A. V. Kryazhimskiy, U. Dieckmann. *Inclination Analysis Can Yield Early-Warning Signals of Economic Recessions*, Internal Report, IIASA
- [2] A. Puchkova, A. V. Kryazhimskiy. *Towards detection of early warning signals on financial crises*. IIASA, IR-12-001, 2012

Acknowledgments

We acknowledge support from the IIASA cross-cutting project "Systemic Risk and Network Dynamics".