Market States and COVID-19

AI, Financial Automation and Market Risk

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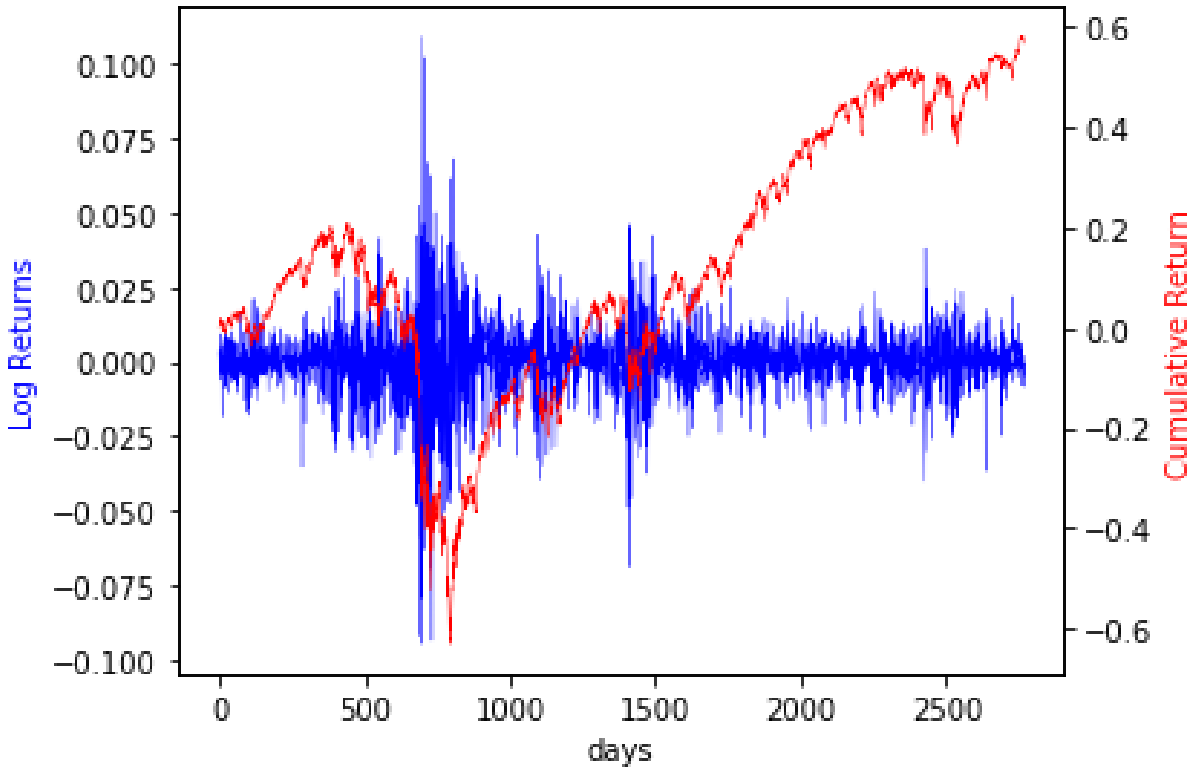
Research Question

- Financial time series characterized by non stationarity
- But we can identify homogeneous subsamples or «patterns» that are often repeated

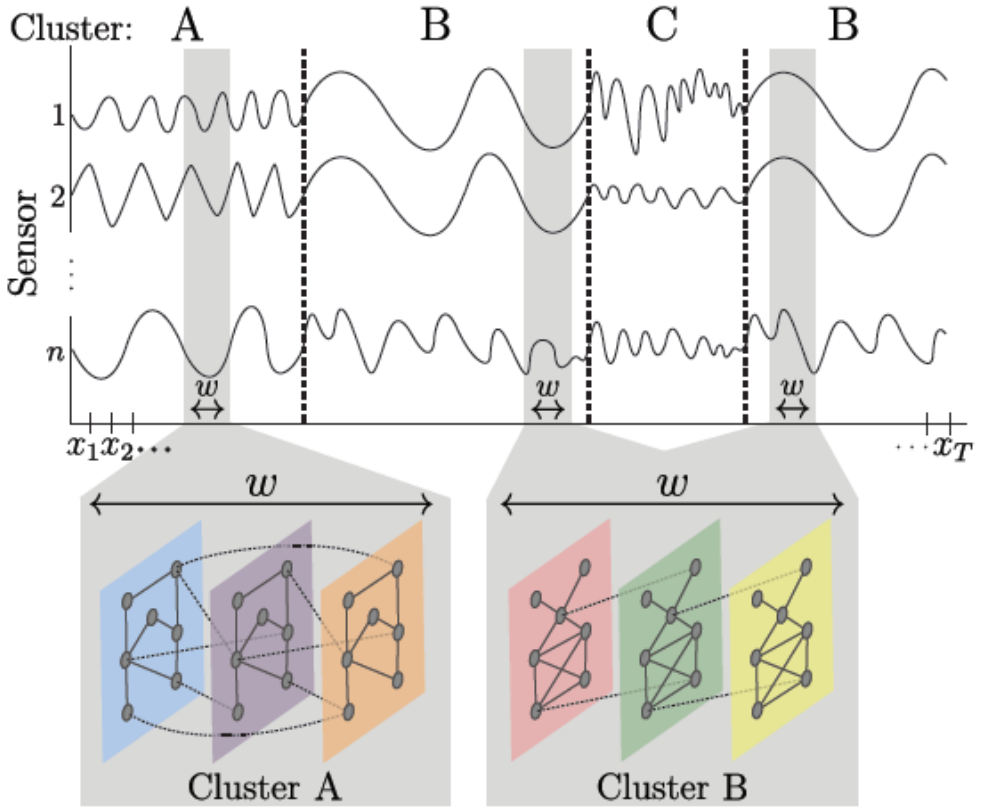


Segmenting and clustering based on correlation structure

Each cluster is represented by a MRF constructed based on the precision matrix of the cluster

Ojectives:

- Segment and cluster high dimensional multivariate time series
- Parsimonious model
- Temporal consistency



- Optimal time-consistent clusters are obtained by minimizing a distance measure penalized for switching

- Considered Euclidean distance, Mahalanobis distance and Likelihood

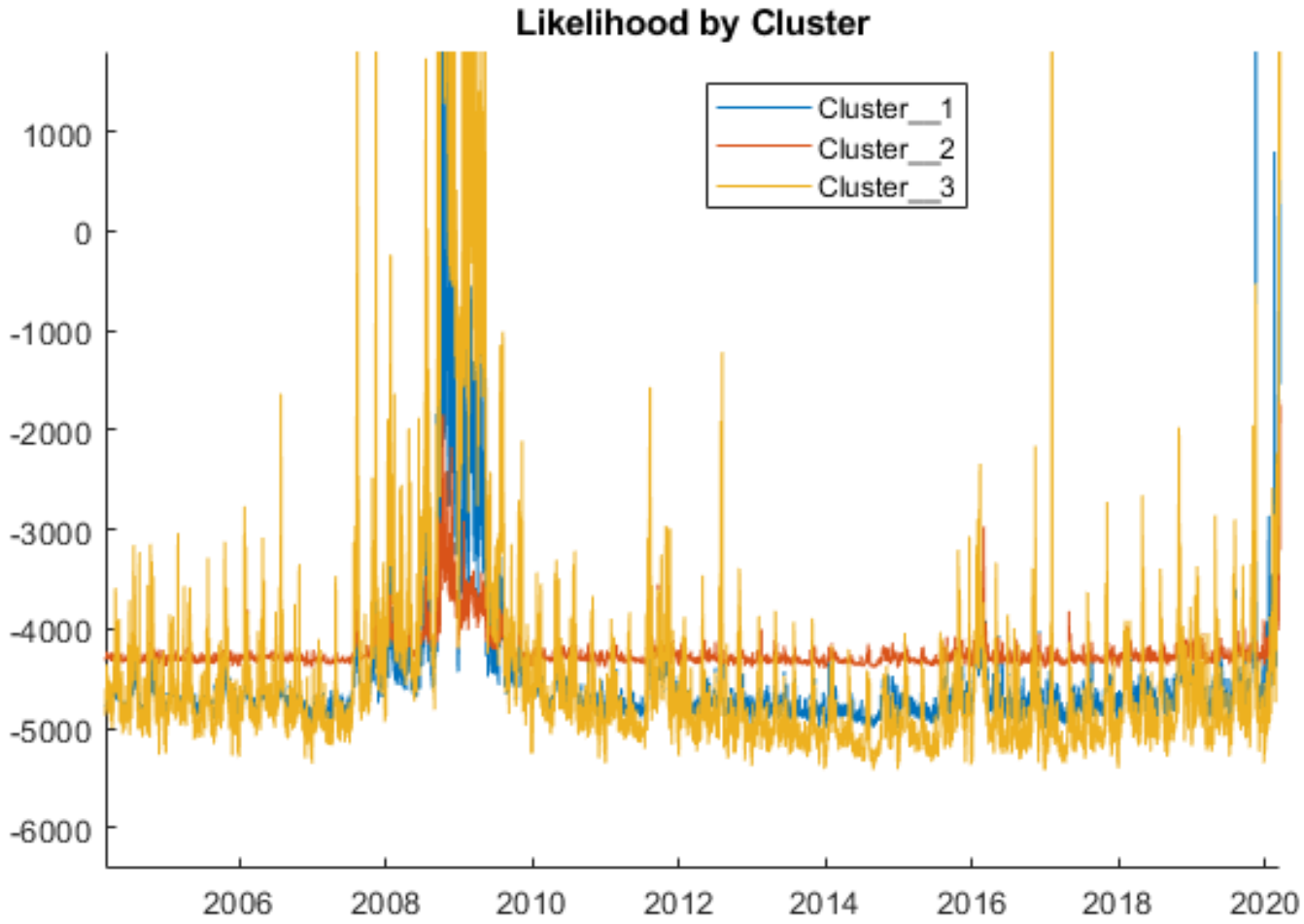
- For the purpose of clustering, we focused on Mahalanobis

$$\mathcal{M}_{t,k} = d_{t,k}^2 + \gamma \mathbb{1}\{\kappa_{t-1} \neq \kappa\}$$

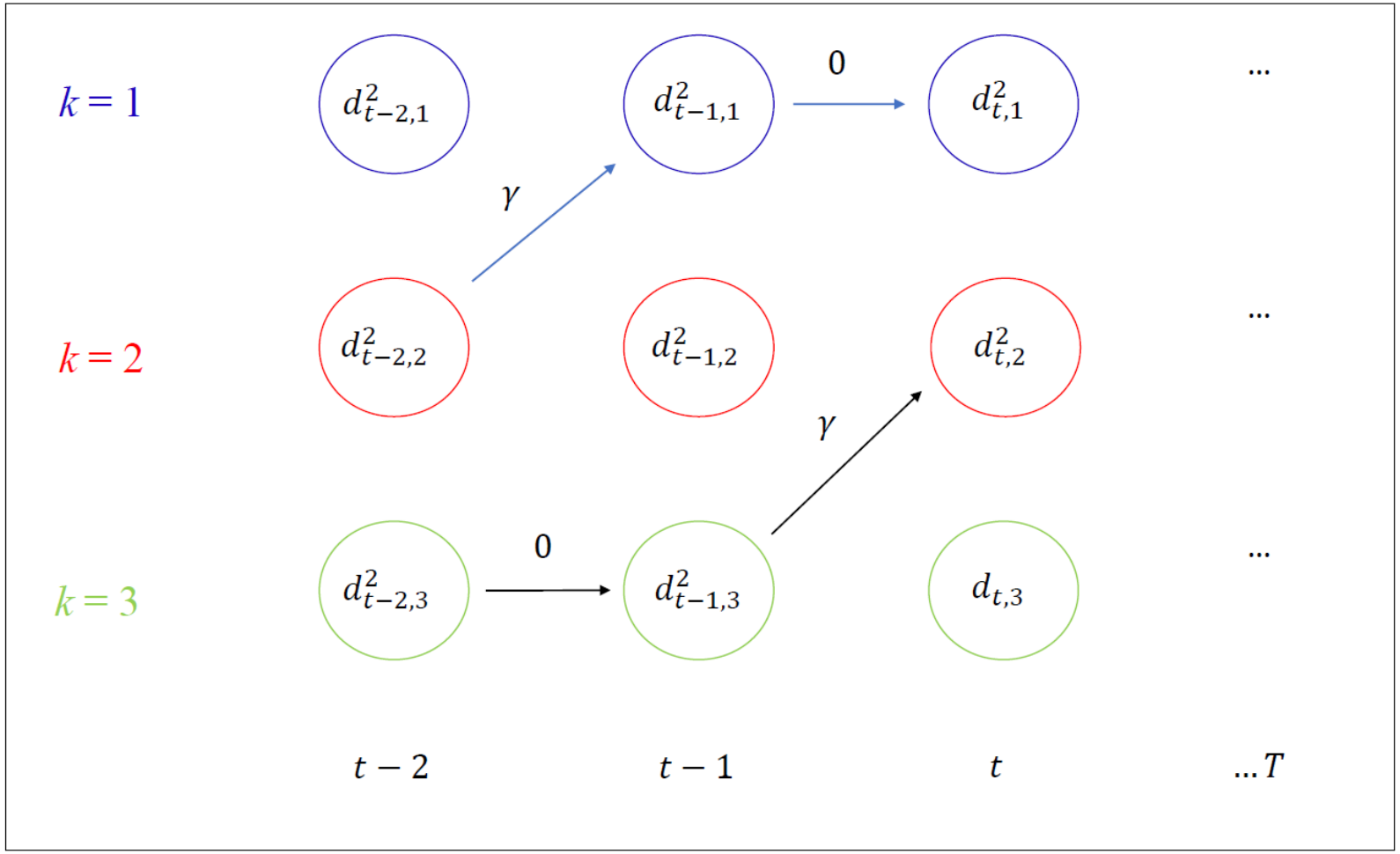
Where

- $d_{t,k}^2$ is the squared Mahalanobis distance for cluster k at time t
- γ is a time consistency parameter
- κ_t is the cluster assignment at time t

- Distance measures computed observation observation-wise for each cluster
- Number of clusters is an hyperparameter



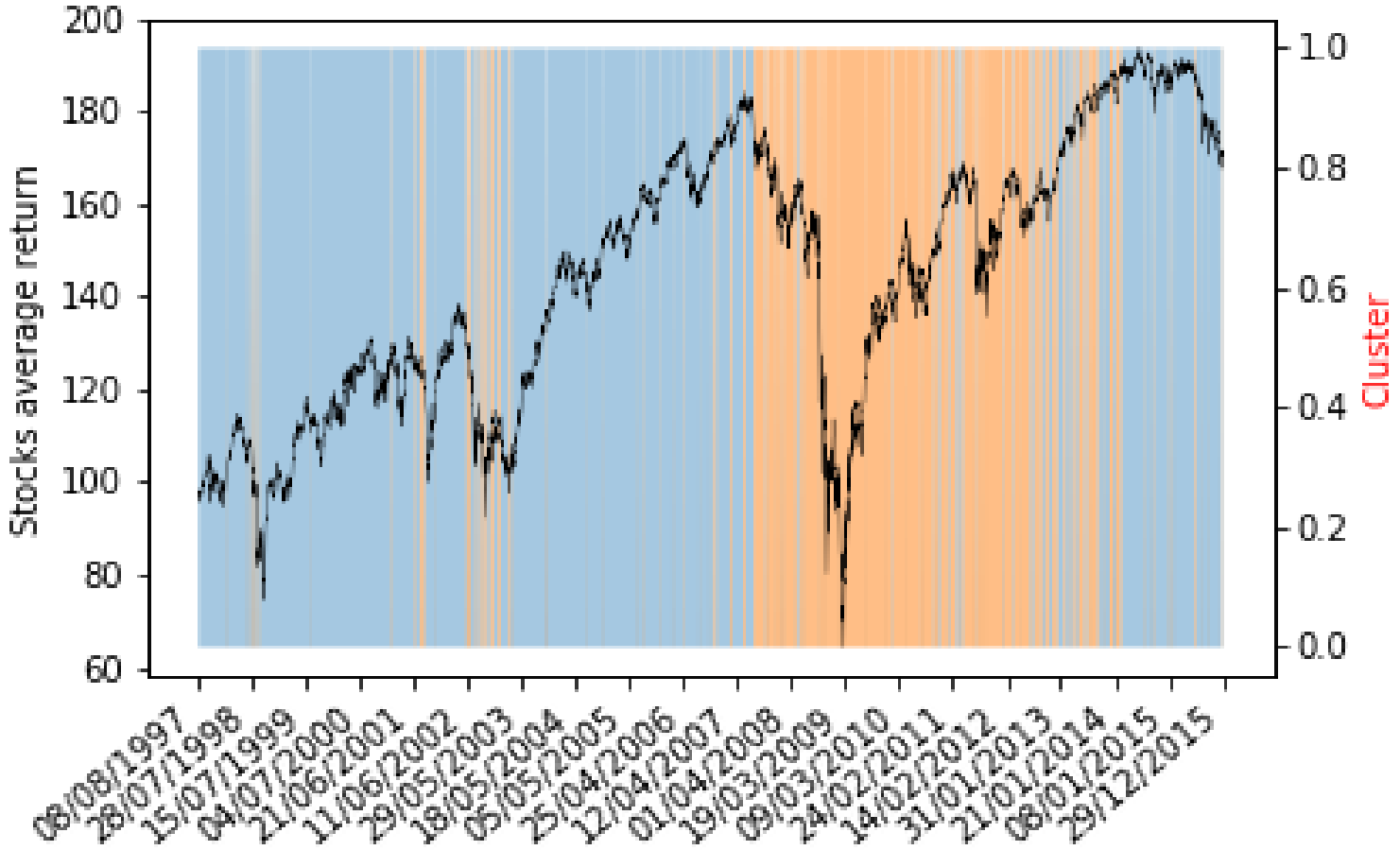
Best path using the Viterbi Algorithm



1st Experiment - Clustering

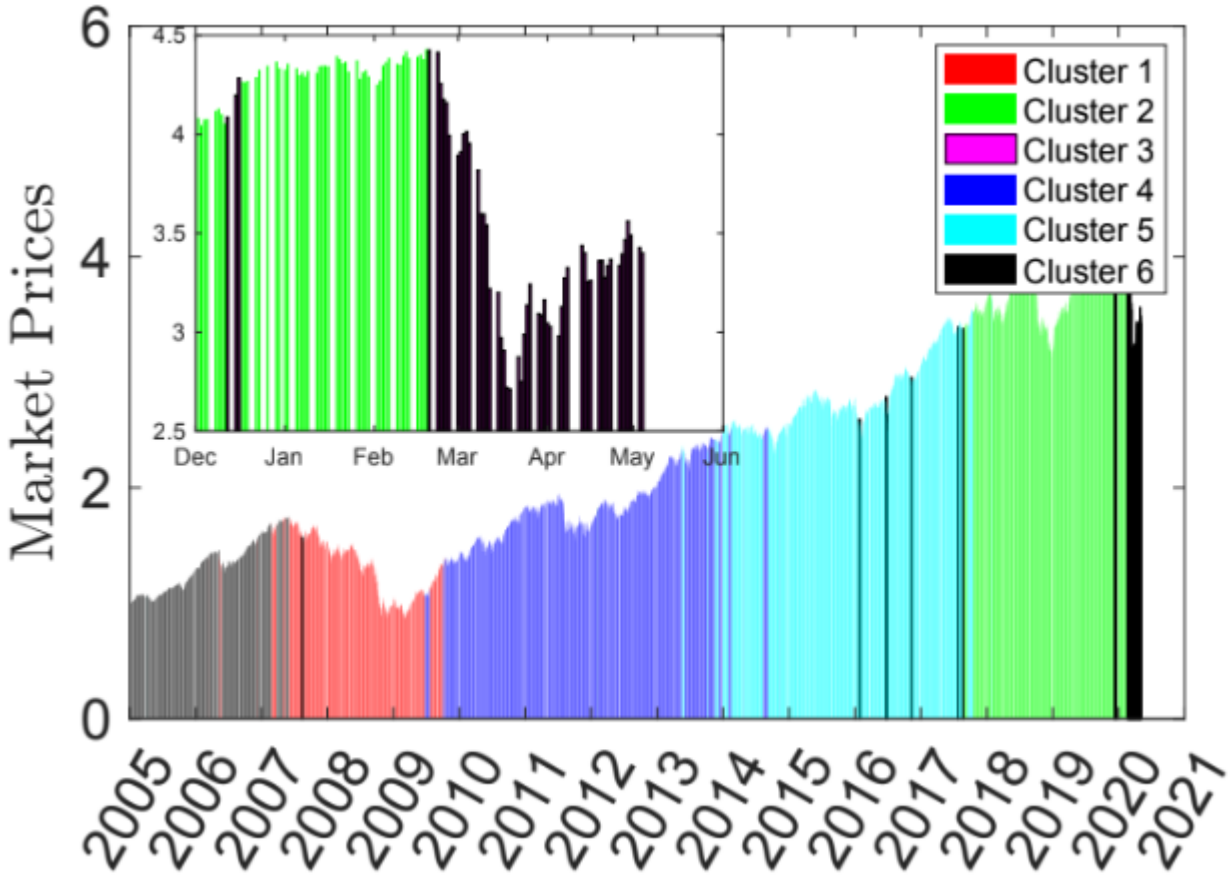
- Dataset - Daily log returns from 1995 to 2015 on 100 stocks from RYI, randomly sampled.

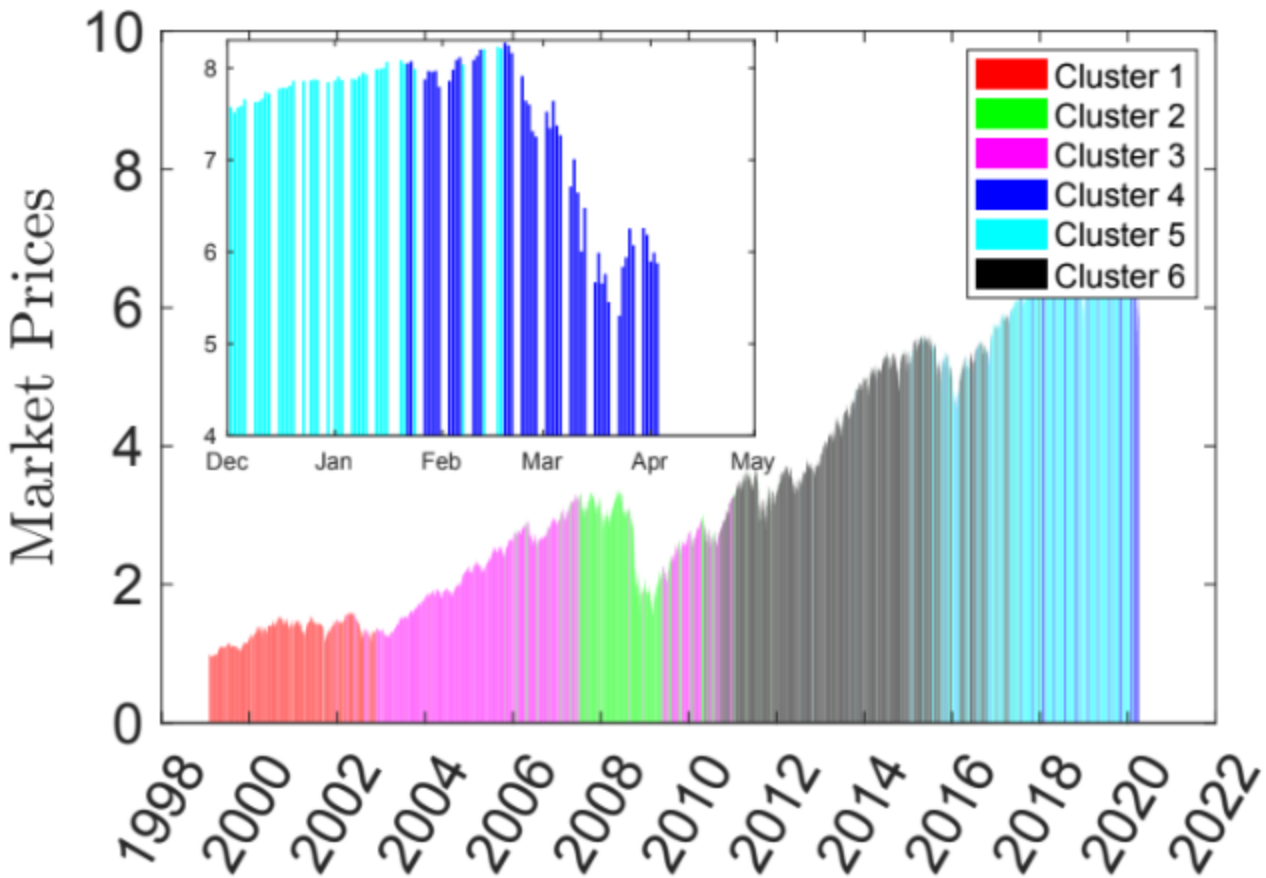
- The segmentation obtained is temporally consistent with only 208 regime switches



What is happening under COVID?

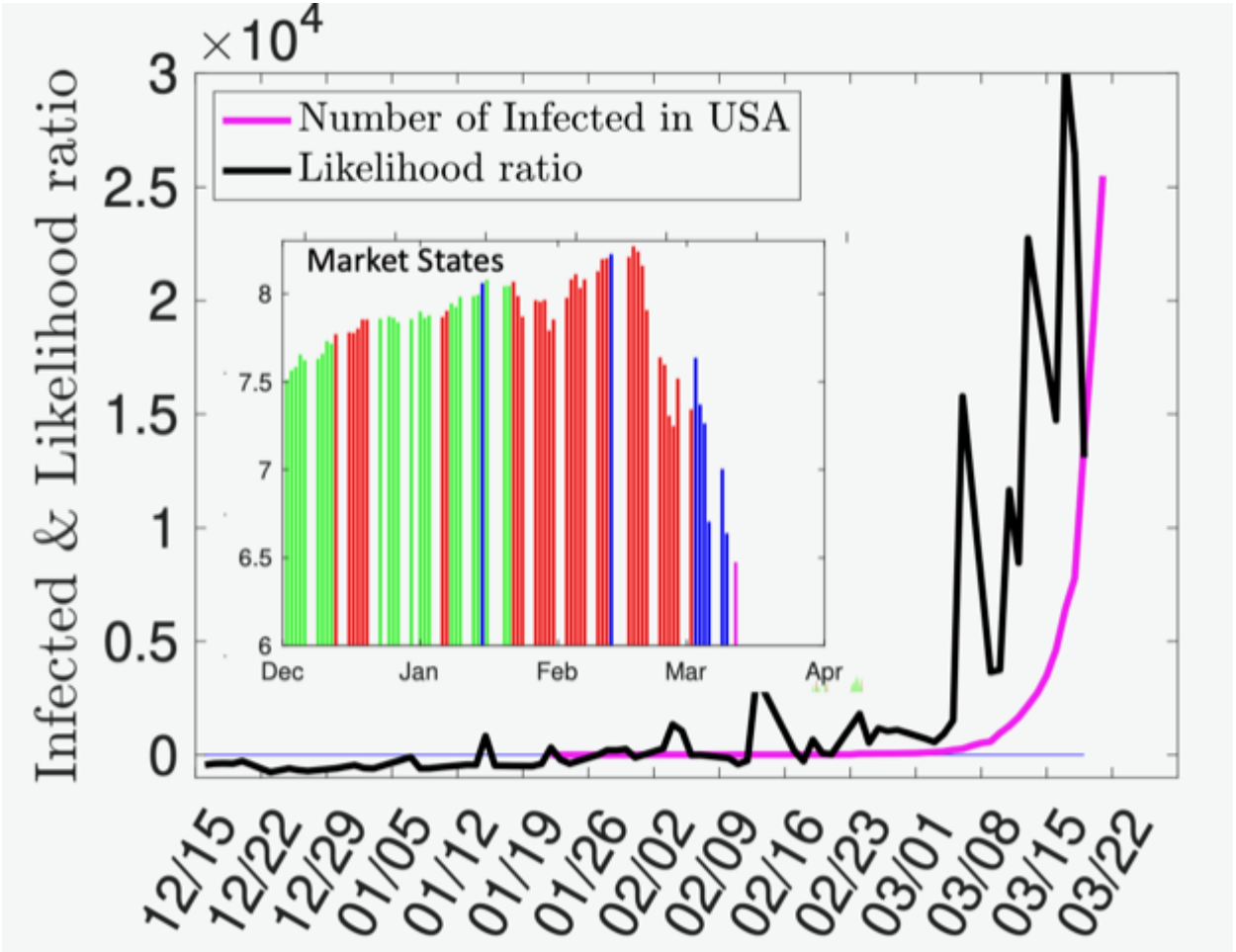
- New high volatility state, different from GFC
- Persistent state from mid February
- Similar Market Structure action in UK (FTSE, *left*) and USA (RY1000, *right)*





What is happening under COVID?

- Market structure changed with same timing as COVID spread



For more on COVID and market structure, follow our blog
https://financial-computing.com/2020/03/23/market-structure-dynamics-during-covid-19-outbreak/

Main References

- Procacci, PF; Aste, T; (2019) Forecasting market states. **Quantitative Finance** , 19 (9) pp. 1491-1498.

- Hallac, D; Vare, S; Boyd S; Leskovec, J; (2018) Toeplitz Inverse Covariance-based Clustering of Multivariate Time Series Data. **IJCAI-18**.

- Barfuss, W; Massara, GP; di Matteo, T; and Aste, T; Parsimonious Modeling with Information Filtering Networks. **Phys. Rev. E**, 16 (94).