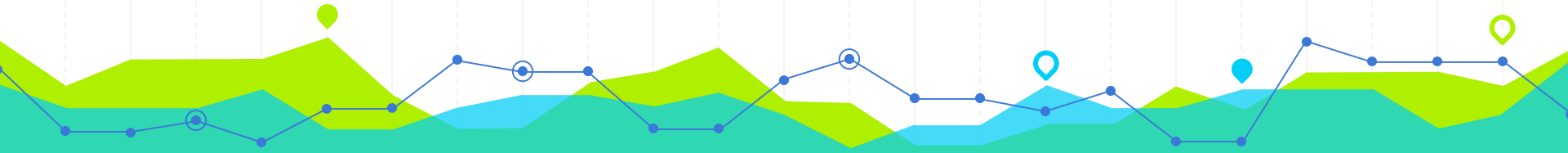


Risk Exposure of S&P 500 Companies before and after the COVID-19 Pandemic

Aleksandra Petrenko

Fama-French (1993) three-factor model

$$r - R_f = \beta_{Mkt-R_f}(Mkt - R_f) + \beta_{SMB} \times SMB + \beta_{HML} \times HML + \alpha$$

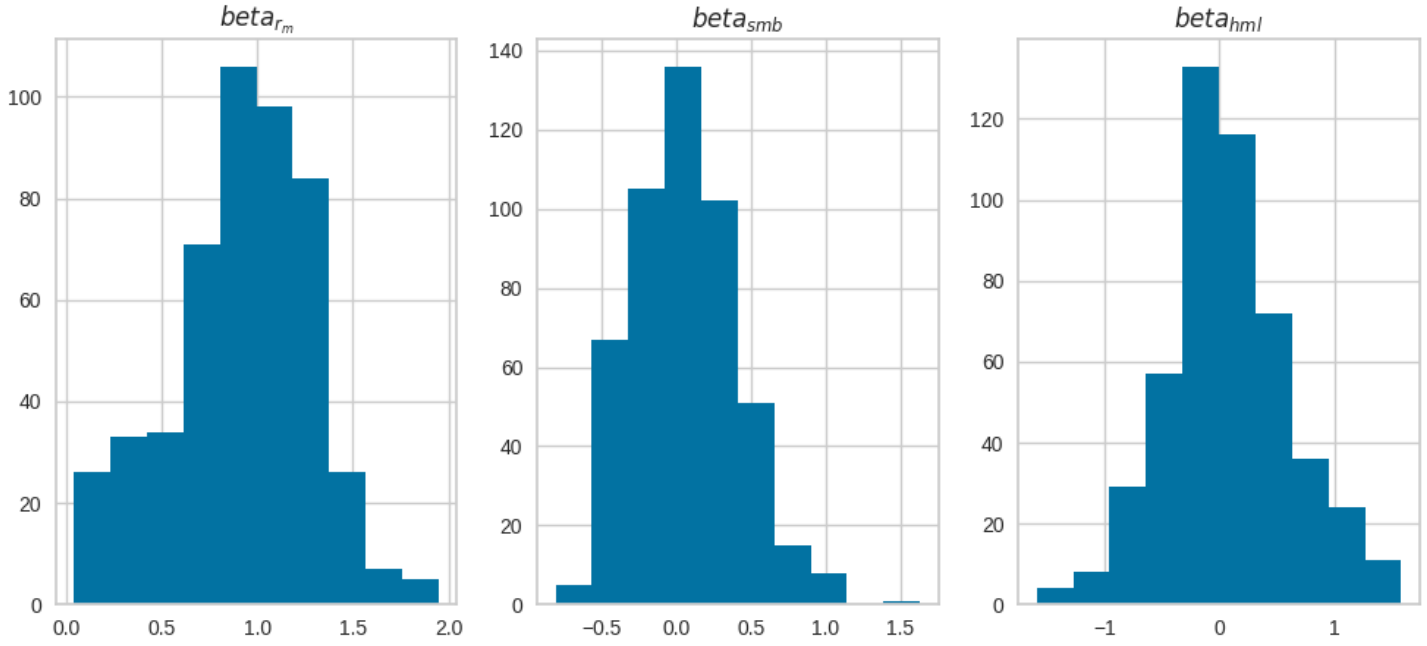
Positive beta-loadings imply:

- **Mkt-RF:** A positive relationship with a market premium, moving with the market
- **SMB:** A positive relationship with a size premium, small company size
- **HML:** A positive relationship with a value premium, a company with a high book-to-market value (exposure to value stocks)

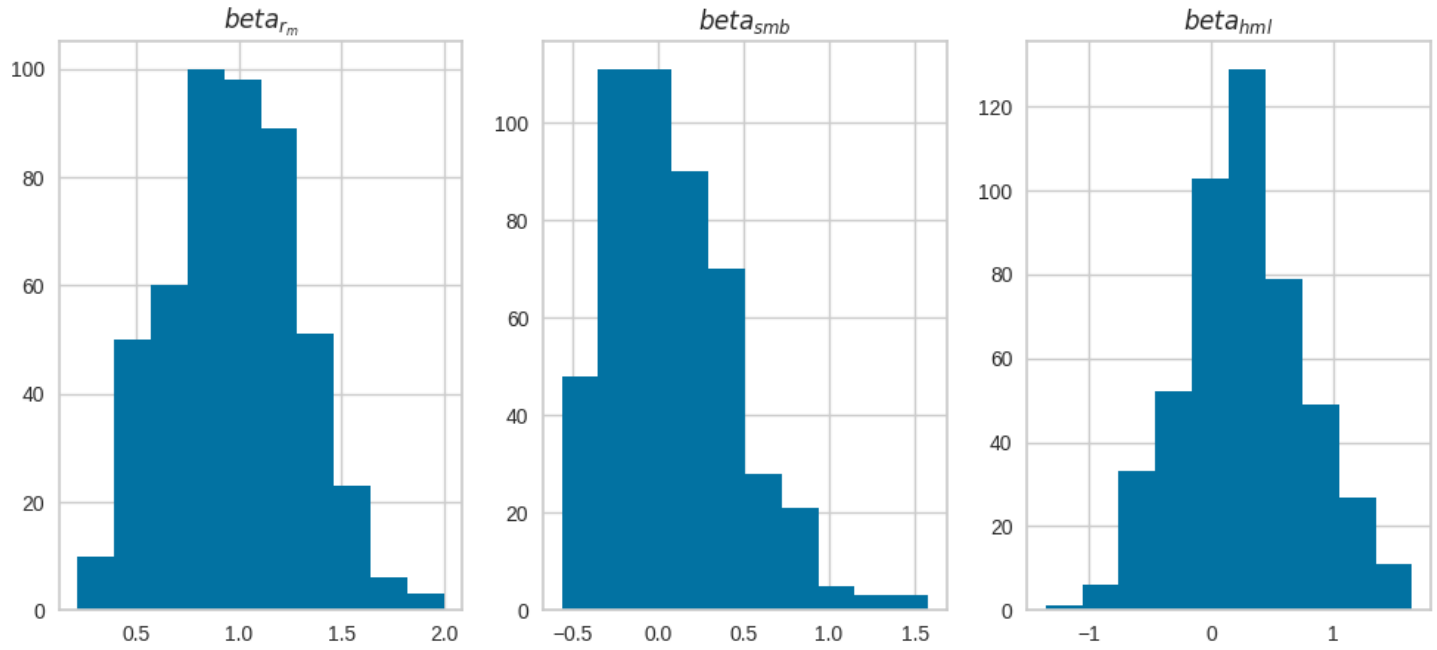
Procedure

- Discrete returns of **S&P 500** companies
- Two periods:
  - **Before COVID-19** crisis: from 2018-01-02 till 2020-01-31
  - **After COVID-19** crisis: from 2020-05-01 till 2022-12-30
- Estimation of **Fama-French models** for each company and period
- **Classification** of coefficients:
  - Hierarchical clustering
  - K-means
  - HDBSCAN
- **Comparison** and analysis of “changers”

Distribution of beta-coefficients before COVID-19



Distribution of beta-coefficients after COVID-19

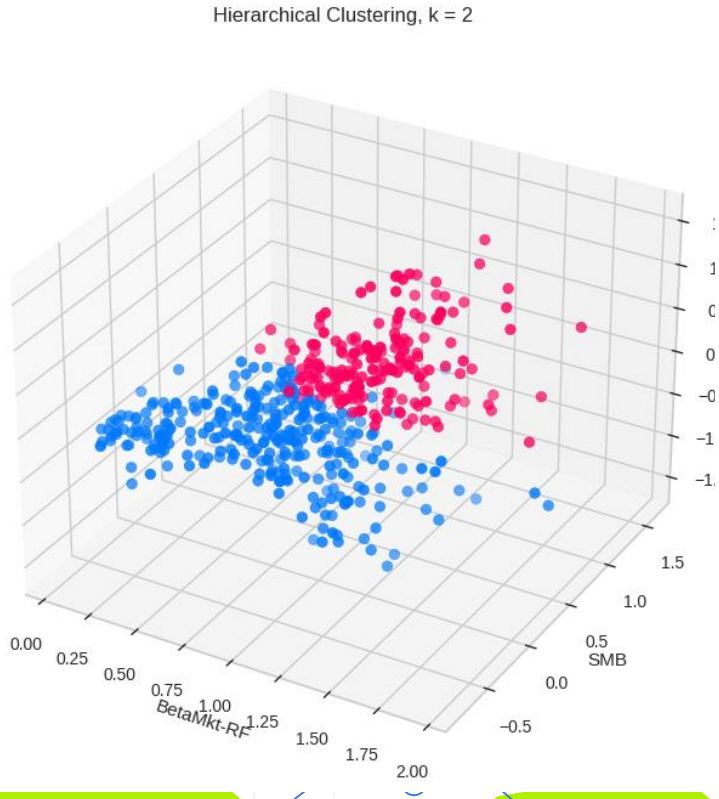


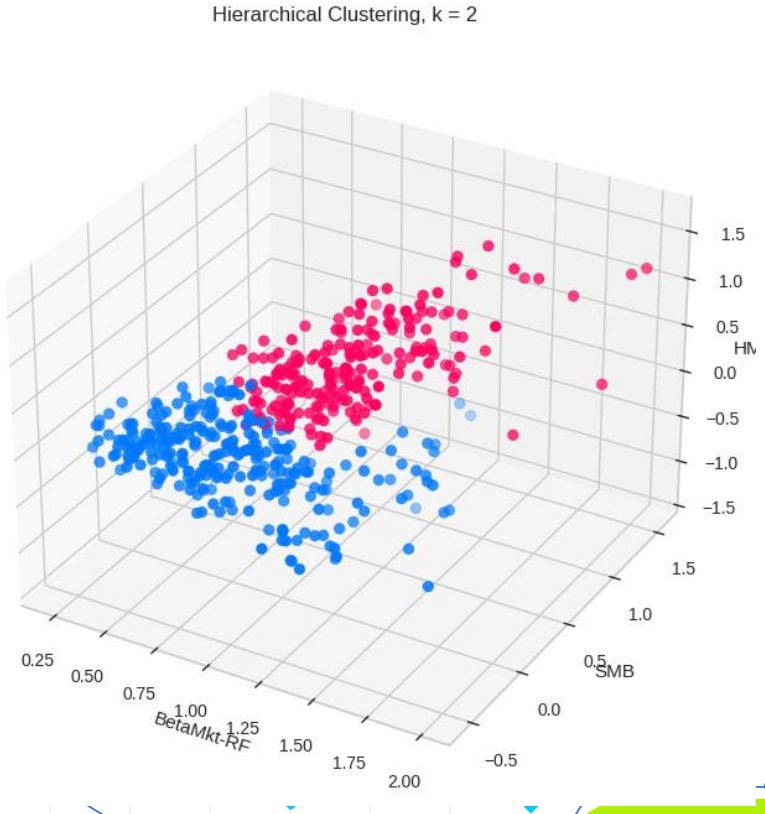
Optimal number of clusters

Methods	Before COVID		After COVID	
	Hier	K-means	Hier	K-means
Distortion Score (Elbow method)	8	9	8	9
Silhouette Coefficient	3	2	3	2
Calinski-Harabasz Index	2	2	2	2

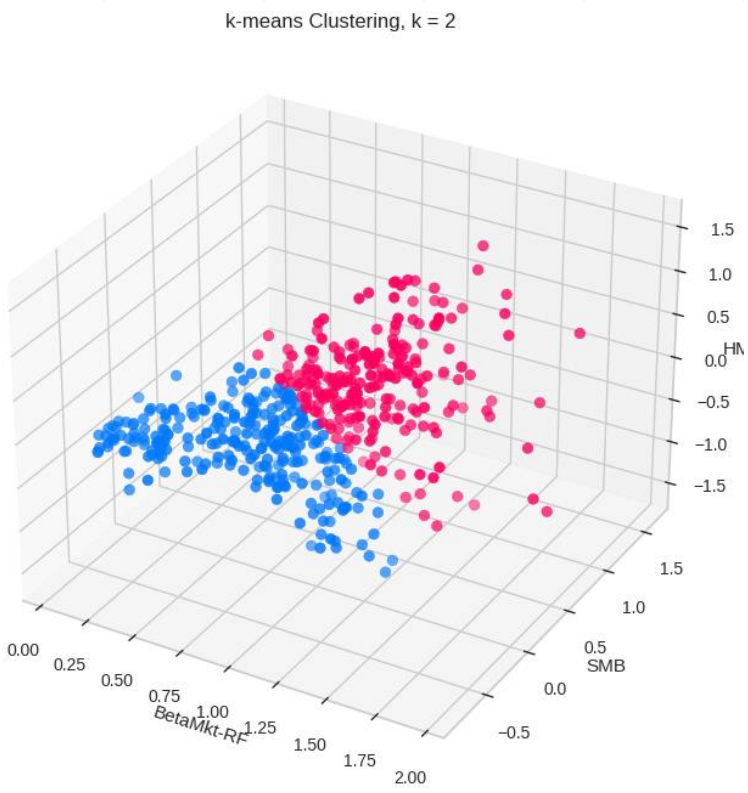
=> 2 clusters

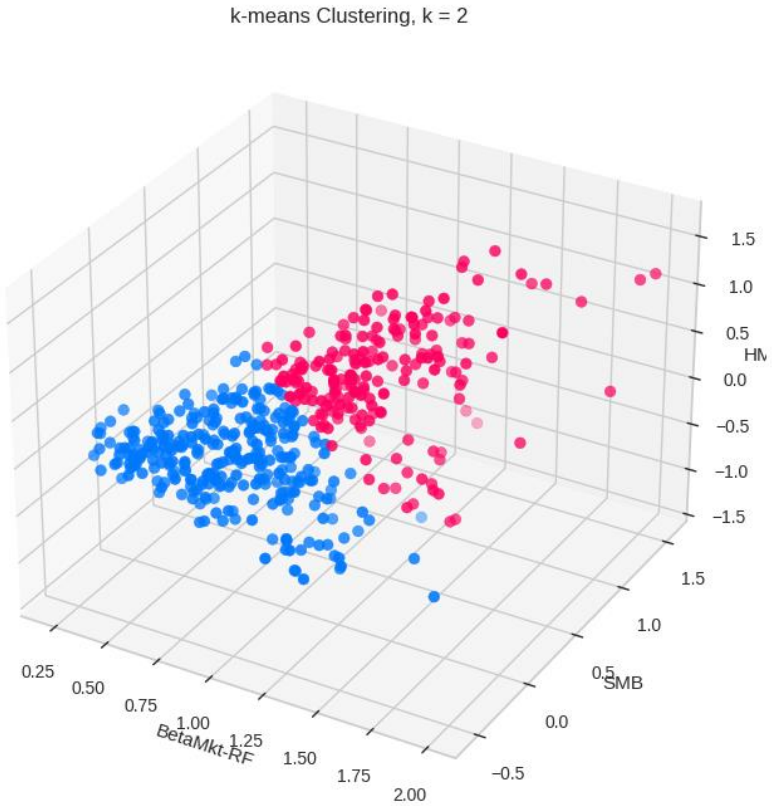
Hierarchical clustering before and after COVID-19



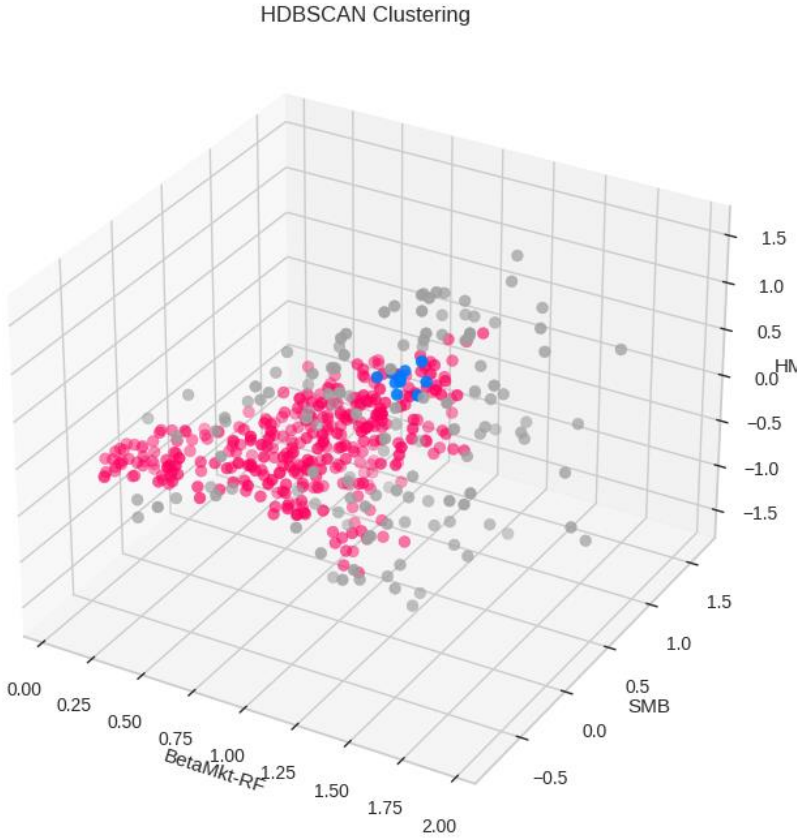


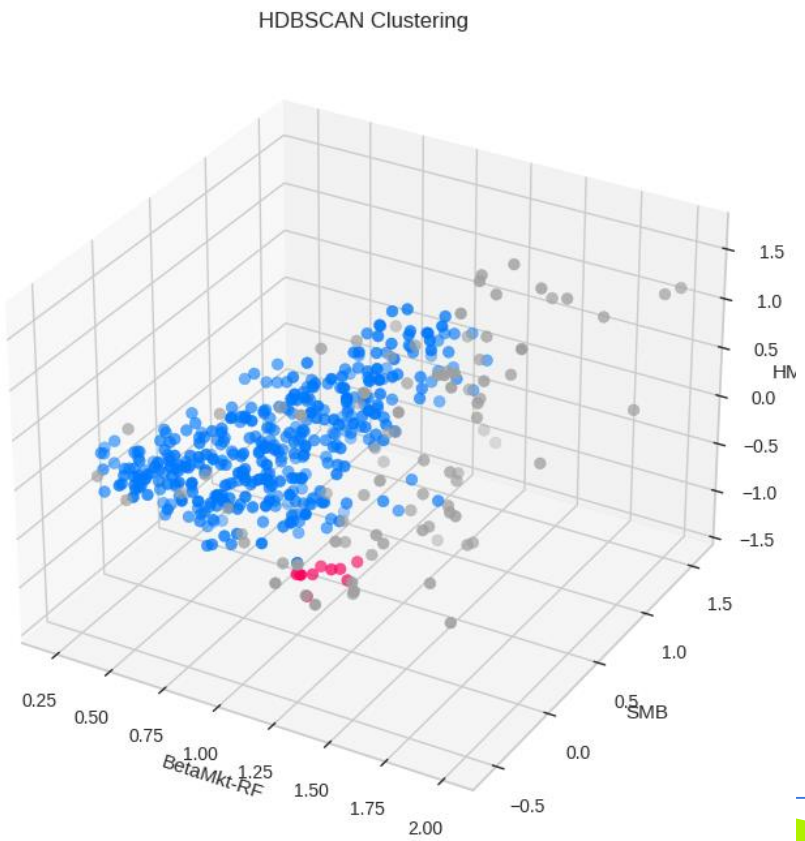
K-means before and after COVID-19





HDBSCAN before and after COVID-19





Adjusted rand index

	Before COVID-19			After COVID-19			Before vs. after COVID-19		
	K-means	HDBSCAN	Hier	K-means	HDBSCAN	Hier	K-means	HDBSCAN	Hier
K-means	1.0	0.0463	0.6393	1.0	0.0799	0.5628	0.3022	0.0379	0.2546
HDBSCAN	0.0463	1.0	0.0631	0.0799	1.0	0.0009	0.0929	0.1882	0.0203
Hier	0.6393	0.0631	1.0	0.5628	0.0009	1.0	0.3824	0.0373	0.3582

- K-means and hierarchical clustering are similar within one period, whereas HDBSCAN is completely different
- Clusterings changed after COVID-19

Cluster mapping with intersection tables

Similar clusters that can be **mapped**:

- For **hierarchical** clustering and **k-means** similar:

  - Cluster 0 before and cluster 0 after COVID-19

  - Cluster 1 before and cluster 1 after COVID-19

- For **HDBSCAN**:

  - Small cluster 0 vanished in a large cluster 0 after COVID-19, small new cluster 1 was formed

  - Cluster 1 before and 0 after COVID-19

  - A half of a noise cluster has changed

Clusters' description

For **hierarchical clustering** and **k-means**:

Cluster 0 before and after COVID-19:

- Growth stocks of large companies, moving with the market
- After COVID-19: Larger exposure to value stocks, larger movement with the market, same company size
- Industries: Cheap goods and services for ordinary consumers, high technologies and utilities

Clusters' description

For **hierarchical clustering** and **k-means**:

Cluster 1 before and after COVID-19:

- Value stocks of small companies, strongly moving with the market
- After COVID-19: Larger exposure to value stocks, same movement with the market, almost same company size
- Industries: Expensive goods, energy, industrials and materials

Clusters' description

For **HDBSCAN**:

Large clusters:

Cluster 1 before COVID-19 and **0** after COVID-19:

- Value stocks of small companies, strongly moving with the market
- After COVID-19: Larger exposure to value stocks, larger movement with the market, almost the same company size
- All industries are represented

Clusters' description

For **HDBSCAN**:

Small clusters:

Cluster 0 before COVID-19:

- Value stocks of large companies, moving with the market
- Industries: Financials

Cluster 1 after COVID-19:

- Growth stocks of large companies, moving with the market
- Industries: Information Technology

Clusters' description

For **HDBSCAN**:

Noise cluster -1 before COVID-19 and after COVID-19:

- Value stocks of small companies, strongly moving with the market
- After COVID-19: Stronger movement with the market, larger exposure to small company size, same exposure to value stocks
- Industries: Before: Financials and IT, after: IT and Consumer Discretionary
- Some large representatives: Google, Tesla, Amazon, PayPal, Nvidia, Microsoft

Observations

- The reason for increased sensitivity to the market for all clusters could be caused by a similar adaptation of companies after the crisis
- A larger exposure to value stocks can be a sign of the growth slowing down after the crisis

Analysis of changers

- Industries with the largest Euclidean distances from point (0, 0, 0): Consumer Discretionary, especially Hotels, Resorts and Cruise Lines and Real Estate, especially Retail REITs
- Industries in changers: Consumer Discretionary, Industrials, Information Technology, Real Estate
- Some of the changer industries were directly impacted by the lockdown (no travelling, high demand in health care, etc.). Real estate sector has also grown during the pandemic.
- After COVID-19: Larger movement with the market, larger exposure to small company size, larger exposure to value stocks

THANKS!

Any questions?