Analyzing the Behavior of French Stocks During Crises

A Comparative Study of Return Distributions from 2007 to 2022 Using the Tail Index

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Content

Content

Motivations and Objectives

Motivations

- Understand French stock behavior in crises
- Risk management approach
- Contribution to literature

Objectives

- Quantitative evaluation of the impact of crises on french stock behavior
- Adapt existing descriptive framework to CAC 40 components
- Evaluate sector-specific performance

Content

Review of Literature I

Main reference

Srilakshminarayana, G., 2021, "Tail behaviour of the Nifty-50 stocks during crises periods", *Advances in Decision Sciences*, 25(4), 1-36.

Objectives

- Analyze the behavior of NIFTY 50[1] stocks during crisis periods by determining the tail index for each stock. Additionally, a recommended approach for decision-makers regarding stock investments is proposed.

Review of Literature II

Data/Method

- Data: NIFTY 50 stocks from 2007 to 2020, segmented into six periods based on crisis events;
- Method: Tail index computation during crisis periods using the weighted least squares estimator[2] (WLS). Stocks were then categorized into high, moderate, and low-risk groups along with their respective periods.

Results

- Some stocks exhibited altered behavior during crises while others remained unaffected. Certain stocks managed to endure changes caused by crises in some periods but not in others;
- A classification table based on risk levels for stocks and periods was presented. Furthermore, a table highlighting severe and non-severe periods based on tail index values was provided.

[1] Index tracking the top 50 indian companies.

[2] Nair, J., Wierman, A., and B. Zwart, 2013, "The fundamentals of heavy-tails: Properties, emergence, and identification", *Proceedings of the ACM SIGMETRICS/International Conference on Measurement and Modeling of Computer Systems*, June, 387-388.

Personal Argument I

Note: All figures and tables in this presentation were created by the author.

Figure 2.1: CAC40 Index Equity Curve

Adapt the descriptive framework of the previous paper to the CAC40 index and determine to what extent French companies are sensitive or not to financial crises. Also, find if some sectors seem to be more likely to be impacted depending on the type of crisis.

Personal Argument II

Period (1)	Period (2)	Period (3)	Period (4)
Global Financial Crisis	European Sovereign Debt	Covid-19	Ukrainian War
August, 2008 to February, 2009	April, 2011 to August, 2011	January, 2020 to April, 2020	January, 2022 to February, 2022

Table 2.1: Timeline of Events Split by Period

Remark

We decided not to include Brexit as a subperiod literature such as Breinlich et al. (2018)[a] states that there is no significant correlation between it and the volatility in French stock prices. During 2015, price movements could likely be observed due to some fear of the potential impact of the UK leaving the EU. In 2016, after the Brexit vote was passed, prices (at least for French stocks, based on the CAC40 index) remained stable.

[a] Breinlich, H., Leromain, E., Novy, D., Sampson, T., and A. Usman, 2018, "The economic effects of Brexit: Evidence from the stock market", *Fiscal Studies*, 39(4), 581-623.

Content

Data Collection and Processing I

1. **Data collection**
   First, collection from Yahoo Finance of daily historical prices of the 40 components of the CAC 40 index (as of March 2024) over the period 01/01/2007 to 31/12/2022.
   Then, classification of stocks by sector regarding the Industry Classification Benchmark (ICB).

2. **Return computation**
   Arithmetic return computation:

$$R_t = \frac{P_t - P_{t-1}}{P_{t-1}} \tag{3.1}$$

   where P_t represents the closing price of the asset at time t, and P_{t-1} is the closing price at the previous time period $t-1$.

Data Collection and Processing II

3. **Estimation of the shape parameter α**
   Estimation of α using WLS estimator under the assumption of a Pareto Distribution[3] (i.e. for the left tail of the distribution) using the `alpha_wls` function of the `ptsuite` package in `R`.

   Appendix A

$$\hat{\alpha}_{wls}(w) = \frac{-\sum_{i=1}^{n} \log(\frac{n+1-i}{n})}{\sum_{i=1}^{n} \log\left(\frac{X_{(i)}}{x_m}\right)} \tag{3.2}$$

   where $X_{(i)}$ is the index of the value i in the sample in sorted, non-decreasing order and x_m is the minimum value of the sample (simplification of the Kolmogorov-Smirnov minimisation[4]).

4. **Compuation of the Tail Index ξ**
   The tail index ξ is computed as the inverse of the shape parameter and its estimator is given by:

$$\hat{\xi} = \frac{1}{\hat{\alpha}_{wls}(w)} \tag{3.3}$$

[3] Koronkiewicz, G., and P. Jamroz, 2014, "Comparison of the tails of market return distributions", *Optimum. Studia Ekonomiczne*, 5(71), 63-77

[4] Danielsson J, Ergun LM, De Haan L, de Vries CG, 2019, Tail index estimation: quantile driven threshold selection, SRC Discussion Paper n°58, March.

Content

Tail Index Behavior of the CAC40 Components by Sectors Across Major Crises I

Sector (ICB)	Period (1)	Period (2)	Period (3)	Period (4)
Basic Materials	4,904392	3,425521	3,069133	3,273329
Consumer Discretionary	3,699222	3,231769	3,443678	3,374274
Consumer Staples	3,024216	3,047066	3,755365	3,181299
Energy	3,580145	2,758694	2,807957	2,792046
Financials	3,120499	2,924748	3,352047	2,896996
Health Care	3,613561	3,255951	3,018931	2,939722
Industrials	3,449408	3,695224	3,358967	3,035240
Real estate	-	-	3,981674	2,391297
Technology	3,727680	2,459669	3,475588	2,388933
Telecommunications	4,015530	3,031229	3,668728	2,841801
Utilities	4,113521	2,295966	3,764741	2,910644
Average $\hat{\xi}$	3,724817	3,012584	3,426983	2,911416

Table 4.1: Tail Index $\hat{\xi}$ by Sector and Period

Tail Index Behavior of the CAC40 Components by Sectors Across Major Crises II

- **GFC and COVID-19: Heaviest tails**
  - GFC: Basic materials sector, telecommunications, and utilities sector were the most sensitive during this period ($\hat{\xi} > 4$ in all three cases);
  - COVID-19: Energy sector more resilient ($\hat{\xi} \approx$ 2,81) while remaining sector had heavy tails ($\hat{\xi} > 3$).

- **Ukrainian War: Least impactful**
  - 7 out of 11 sectors (i.e. 64%) had tail indices $\hat{\xi} < 3$;
  - Heaviest stock tail index observed in the consumer discretionary sector (average $\hat{\xi}_{cons.discr.}$ >3,37) with $\hat{\xi} \approx$ 5,22.

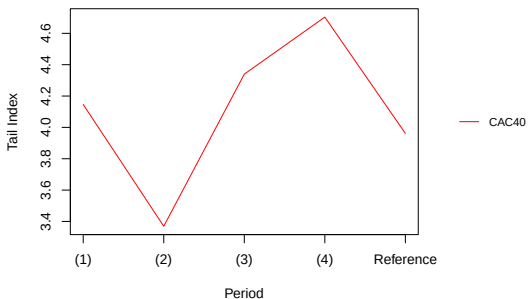
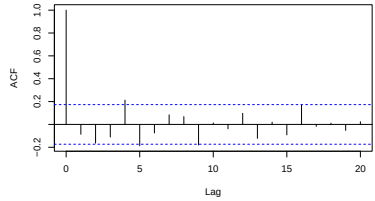


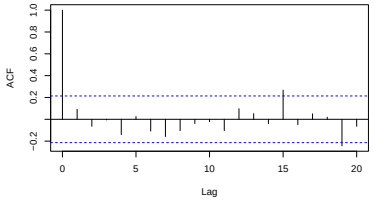
Figure 4.1: Tail Index Evolution for the Benchmark (CAC40)

Content

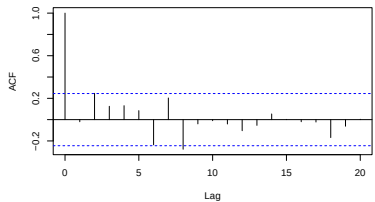
Autocorrelation Shift during Crisis



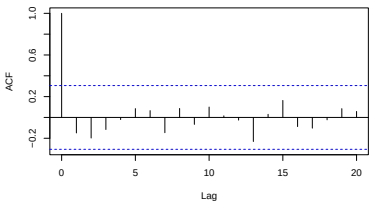
(a) ACF Plot : Period (1)



(b) ACF Plot : Period (2)



(c) ACF Plot : Period (3)



(d) ACF Plot : Period (4)

Figure 5.1: CAC40 Autocorrelation Function during Crisis

Content

Conclusion

- **Global Financial Crisis**
  - Basic materials, telecommunications, and utilities sectors were particularly sensitive;
  - High tail index across sectors, showing widespread volatility.
- **European Sovereign Debt Crisis**
  - Basic materials remained sensitive, while industrials showed the heaviest tails;
  - Utilities sector exhibited less volatility, becoming the least sensitive.
- **COVID-19 Crisis**
  - Heavy tails across all sectors except energy;
  - Real estate was the most sensitive sector.
- **Ukrainian War**
  - Least disruptive crisis studied;
  - Lower tail indices in most sectors, with consumer discretionary showing fat tails.

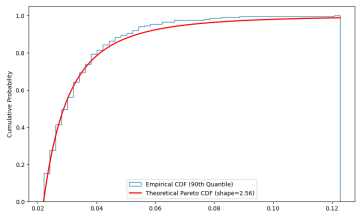
Future Improvements

- **WLS Estimator Limitations**
  - Assumes a sufficient number of extreme observations;
  - Small sample sizes may lead to unreliable or biased estimates, especially with limited negative returns.

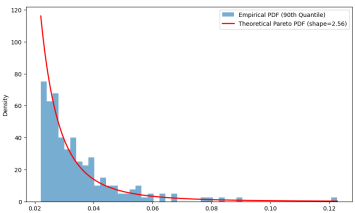
  Appendix B

- **Future Research**
  - Improve tail index estimation by reducing low-sample bias;
  - Explore causal factors behind extreme events;
  - Develop explanatory models for financial crisis triggers and dynamics;
  - Aim to build a decision-making framework for investors during market stress periods.

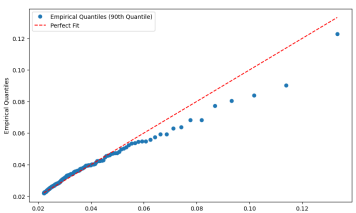
Appendix A - Pareto Distribution Assumption



(a) CDF : CAC40 vs Pareto



(b) PDF : CAC40 vs Pareto



(c) Q-Q Plot : CAC40 vs Pareto

Figure A.1: CAC40 Left Tail (90th percentile) vs Pareto Distribution

Back

Appendix B - Sample Size

Table B.1: Sample Size N_i by Period i

Symbol	N_1	N_2	N_3	N_4
AI	66	38	29	18
MT	66	42	36	22
MC	67	37	33	23
OR	67	37	30	20
RMS	67	29	28	21
KER	72	31	35	22
ML	63	41	36	22
PUB	66	45	36	18
RNO	69	41	40	20
VIV	67	41	36	22

Symbol	N_1	N_2	N_3	N_4
BN	63	38	35	18
RI	59	39	34	22
CA	65	46	29	15
TTE	62	45	37	17
BNP	68	43	39	21
CS	72	37	34	19
GLE	64	47	36	19
ACA	64	45	40	20
SAN	62	33	34	22
EL	68	33	35	23

Back

Appendix B - Sample Size

Table B.2: Sample Size N_i by Period i

Symbol	N_1	N_2	N_3	N_4
ERF	67	42	34	22
SU	66	42	33	21
AIR	60	44	40	20
DG	65	38	29	20
SAF	64	41	41	18
SGO	68	38	34	21
LR	61	43	40	24
HO	60	43	34	14
TEP	59	48	28	22
EN	67	42	35	18

Symbol	N_1	N_2	N_3	N_4
ALO	72	44	32	27
CAP	59	37	34	22
DSY	68	29	30	24
STMPA	64	48	33	23
ORA	68	40	37	14
ENGI	69	48	30	18
VIE	68	46	26	17
EDEN	-	39	32	17
URW	-	-	40	21
STLAP	-	-	-	23

Back