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Tail Behaviour of the Nifty-50 Stocks during Crises Periods

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Abstract

Purpose: To examine the behaviour of the NIFTY 50 stocks during the crisis periods, by estimating the tail index for each of the stocks. Also, propose an approach that can be used by the decision-makers on the stocks, before moving ahead with investments.

Design/methodology /approach: To achieve the objectives of the study, we have adopted a descriptive research design. The time horizon between 2007 to 2020 was considered and divided into six periods, based on a crisis event that had occurred during the period. The tail index for each of the stocks was estimated during the crisis periods, using the weighted least squares (WLS) estimator, proposed by Nair et.al. (2019). Based on the value of the tail index the stocks were classified as high risk, moderate risk and low-risk stocks, and also the periods.

Findings: The study finds that the crisis events have changed the tail behaviour of a few stocks, and did not for other stocks. Also, that the stocks could sustain the change caused by the crisis events during a few periods and could not during other periods. Towards the end, a classification table that divides the stocks into high risk, moderate risk and low risk, was presented based on the findings. The study also finds the periods that are severe and not severe using the tail index values, presented as a table.

Originality/value: All our findings are original and new in the literature.

Implications: We suggest the practitioners and researchers estimate the tail index of the stocks before taking any decision on its probability structure or decisions related to investments etc. This process can be adopted along with other processes. It helps in identifying the stocks that are riskier for investment. Also, identify the periods that are sensitive to the crisis events. The study also recommends estimating the tail index and then deciding upon any other methodology for analyzing the stock market prices.

JEL classifications: C0, G0

Keywords: COVID-19, Extreme events, Crisis events, Classification, Nifty 50, Tail behaviour.

Introduction

A stock market is an aggregation of buyers and sellers of stocks. It is a network of economic transactions and not a physical facility. Stocks or shares represent the ownership claims on businesses. They include securities listed on a public stock exchange, stocks traded privately, sold to investors. Companies who wish to sell their shares use these platforms and they get listed for trade. They also include banks, insurance companies, etc. While few stock exchanges are physical locations, the other is a network of computers where trades are made electronically. According to the history, price of stocks and other assets are an important part of economic activity and can act as an indicator of social mood. An economy is considered as an up-and-coming economy if the stock market is on the rise. It is also considered as the primary indicator of a nation's economic strength and development. If the prices of the share price are increasing, then there is a tendency to associate this with the increased business investment. When all the activities are smooth, it will help for the economic growth and also increase employment. Sometimes, there can be some disturbances like a stock market crash. But they again come back to the normal state after a point in time. The movements in the prices are monitored by price indices called stock market indices. For example, BSE SENSEX, NSE Nifty, S&P etc. Based on the movements of these indices, one can judge the behaviour of the stock market or a sector.

Modelling the stock market prices is an age-old problem, and for many years researchers have modelled the stock prices using a normal model. In the later years, studies have shown that the normal model is not the appropriate model (Mandelbrot (1963), Fama (1965)) and attempts have been made to find alternative models. For example, log-normal distribution, Cauchy, Pareto models have been used as alternative models to normal distribution. Fama (1963) uses a stable Pareto model to study the behaviour of the stock prices and later many have used other models. The studies of Officer (1972), Akgiray and Booth (1988), Lau et.al. (1990) argue that stable models also may not sometimes fit the market returns appropriately.

In a normal scenario, the tails are symmetric, and one can easily study the behaviour of the stock price random variable. When the tails become heavy, one has to estimate the thickness of the tail and accordingly choose the model. Sometimes, the tails become so heavy that none of the probability models can best fit the stock prices. One of the reasons for a failure of a normal model is the change in the behaviour of the stock price random variable due to the influence of extreme prices or outliers. The presence of the extremes increases the volatility of the stock price random variable and affects its symmetric nature at the tails. Also,

the kurtosis of the random variable increases with the presence of high-frequency data (Mandelbrot (1963)). The tail behaviour of a normal model is given by (Feller (1950))

$$P(Y > x) = \int_x^{\infty} f(x)dx \cong \frac{1}{x\sqrt{2\pi}} e^{-\frac{x^2}{2}} \quad (1)$$

One can note that the tail structure is valid in situations where the volatility is less. and that the tails of a normal law are lighter than a stable law and becomes fatter as variance increases. Studies by Fama (1965), Hall (1984), Csorgo et.al. (1988), Longin (1996), Gençay Selçuk (2004), Berkes et.al. (2012) help one to understand the impact of extremes on the behaviour of a random variable. One can extract the following points from these studies.

1. The presence of extreme values increases the variance, and high variance leads to high skewness and a normal model fails.
2. The presence of high-frequency values increases the kurtosis and leads to the failure of a normal model.
3. The presence of heavy tails also leads to the failure of a normal model. A heavy tail implies that there is a large probability of getting very large values.

All the above cases lead to the conclusion that the tails lose their normal behaviour due to the presence of extremes and tend to be heavier. In such cases, the appropriate models that can be used are the heavy-tailed models.

Heavy tailed distributions are those probability distributions whose tails are not exponentially bounded. That is, they are heavier than the exponential distribution. In a few cases, the right tail may be heavy, in some cases, the left tail may be heavy and in other cases, both the tails may be heavy. There are three important classes of heavy-tailed distributions: the fat-tailed distributions, the long-tailed distributions and the sub-exponential distributions. Examples of heavy-tailed distributions include Pareto, log-normal, Levy distribution, Burr distribution, log-logistic distribution, log-gamma distribution, Fréchet distribution etc. One can refer to the works of Borak et.al. (2011), Foss et.al. (2013), Embrechts et.al. (2013) for a discussion on heavy-tailed distributions.

One of the reasons that cause a change in the behaviour of the stock price random variable is, the news that gets generated in the market and this makes the stock market prices fluctuate at a faster rate as compared to other data. They keep changing with the change in the events related to them. The news can be related to an individual stock or that related to the market. In either case, the stock prices keep changing and sometimes fall drastically or sometimes increase to high values. That is, change in the events changes the levels of the stock prices. For example, the market crash in the year 2007/08 had impacted the volatility of

the majority of the stocks (Mandal and Bhattacharjee (2012)). Similarly, COVID-19 has changed the stock prices of the stocks. Taking these examples, one can expect that the stock price random variable changes its behaviour as the events change, and the corresponding tail behaviour needs to be studied to understand the behaviour. The tail behaviour is understood based on the tail index value, and the thickness of the tail decides the behaviour of the stock. In the current study, we consider the time horizon between 2007 and 2020 and divide the horizon into six sub-periods, where the major crises have occurred in the past, and study the tail behaviour of each of the stocks during these periods. This will help one to understand if the crises have affected the tail behaviour of the stocks, identify the stocks that have got affected by the crises and also the periods that are recurring in nature. These form the main objectives of the current study. This process will help the decision-makers to know the vulnerable stocks before making any investments decisions on them. Also, help them to know the types of crises that affect the stocks' behaviour.

The objectives of the study are

1. To estimate the tail index for each of the stocks considered and measure their thickness.
2. To identify the stocks that have got affected by the crises and classify them based on the tail index values.
3. To build a frequency table that gives the periods that are recurring in affecting the stocks' behaviour.

Literature Review

Chong (2011) divide the period into three: an early stage of the crisis, the recession of the US and after the bankruptcy of the Lehman brothers and study the effect of the crisis in the US stock market. The study finds that the crisis affects the stock market volatility but not on the stock returns. Mandal and Bhattacharjee (2012) considers SENSEX and studies the effect of the great recession of 2007 on the behaviour. The period was divided into the pre-recession period (January 2002-November 2007) and the post-recession period (December 2007-July 2010). The study finds that there is no significant difference between returns for both periods and that there is an increase in volatility during the post-recession period. The study also finds that during the post-recession period, there are strong co-movements in returns and volatility between SENSEX and other major stock indices and conclude that SENSEX was affected by the global factors during crisis periods. Al-rjoub and Azzam (2012) consider an

emerging market from 1992-2009 and investigate the behaviour of the returns during the financial crises. The study shows that the crises impact the returns negatively, for all the sectors, with the banking sector most affected and finds that period 2008-09 as the most severe period. Vieito et al. (2013) consider the most developed (G-20) countries and investigate weak-form of efficiency. They divide the entire study period into two parts: pre-crisis period (January 1, 2005-August 8, 2007) and during the crisis period (August 9, 2007, December 31, 2011). They show that most of the individual markets are weak-form efficient and that during pre-crisis, volatility was low but heteroskedastic and during the period of the crisis, volatility is high and homoscedastic. Dungey et al. (2014) consider advanced and emerging markets and show that there exists strong evidence of the contagion from the US market effect on advanced and emerging markets. Kenourgios and Dimitriou (2014) consider 9 sectors from the US market and developed European region and, study the contagion effects of the global financial crisis (2007-09) from the financial sector to the real economy. The study provides a regional analysis by testing the contagion on the aggregate level, sector level, global level and, domestic level. It shows that the European regional sectors were unaffected by the contagion and all the non-financial sectors were unaffected by the domestic financial systems. Moslehpour et al. (2022) looks at the global and Vietnamese stock markets impacted by the COVID-19 pandemic. Rastogi (2014) shows that the crisis had an impact on the volatility of the stock markets of emerging economies, with a mixed direction of impact. Markwat (2014) uses a rolling window estimation approach and examine the dependence among the USA, European, Latin American, and Asian stock markets. The study uses Gaussian, student's t, and survival Gumbel copulas and computes probabilities of occurrence of global crashes and concludes that irrespective of the copulas, the global crash probabilities increased drastically and significantly over the period from December 1992 to February 2010. Also, conclude that the probabilities increase due to Asian and credit crisis was rather large. Fauzi and Wahyudi (2016) study the effect of the market crash on the characteristics of stocks and firms. Grima and Caruana (2017) consider BRIC's stock market returns and examine if they were affected by US financial stress during the 2008 financial crisis. Osterrieder and Lorenz (2017) consider Bitcoin returns and studies the tail risk characteristics and provide an in-depth univariate extreme value analysis. They show that bitcoin return distribution exhibits higher volatility than G10 currencies and also stronger non-normal characteristics and heavier tails. This motivates us to study the tail behaviour of the individual stocks.

Ilomäki and Laurila (2018) show that, due to a negative shock caused by a random sentiment of noise traders, uninformed investors follow the noise because their risk increases. Duc et. al. (2019) consider 10 sectors from Vietnam and Malaysia, two countries in the Asia-Pacific regions. The study considers two periods: 2007-09 (Global Financial Crisis (GFC)) and 2010-17 (Post-GFC), and measures market risk. The study finds that sectors of Vietnam are relatively riskier than in Malaysia and that market risk has reduced in the Post-GFC period. Especially, Banks, diversified financials and insurance were strongly recommended as it was considered relatively risky in Vietnam but ranked as very safe in Malaysia. Gupta et. al. (2019) uses a non-parametric quantile-based methodology and show that the Organization of the Petroleum Exporting countries (OPEC) variables' impact on oil futures markets is confined to Brent Crude futures and no effect was observed for the WTI market. This shows the impact of the information generated on the global markets and motivates one to study the behaviour of the markets in connection with various events that happen globally. In the current study, we observe the behaviour of the stock market prices at points where crises have occurred. Samsi et.al. (2019) studies the impact of the Asian financial crisis (AFC) and the Global financial crisis (GFC) on the economic growth of the ASEAN-5 countries. Zhu et.al. (2019) considers 7 Latin American stock markets and study the impact of the global financial crisis (GFC) on these markets. They show that the markets are less volatile and investors prefer to invest in the stocks post-GFC period and that randomness and efficiency have improved post-GFC and shows that markets are efficient. They confirm that the 2008 GFC have a positive impact on the stock markets. Mazur et.al. (2020) considers the US stock market during the crash and shows that natural gas, food, healthcare, and software stocks have high positive returns. The study also notes the downfall of equity values for petroleum, real estate, entertainment, and hospitality sectors and that the loser stocks exhibit extreme asymmetric volatility that correlates negatively with stock returns. Ali et.al. (2020) examines the reaction of global financial markets to the pandemic and observe that, while China stabilized, global markets have faced turbulence in the later phase of the spread of the virus. Al-Awadhi et.al. (2020) through panel data analysis, examine if contagious diseases affect the stock market outcomes to examine the effect of COVID-19 on the Chinese stock market and show that both the daily growth in total cases and cases of death have a significant negative effect on the stock returns. Graham et.al. (2020) shows that global investors' fears impact the volatility of the stock index returns. Thach and Duc (2019) considers 10 industries in China, ASEAN-3, including Malaysia, Singapore, and Thailand, and examine the relative systematic risk of these industries. They consider weekly data from 2004 to 2016 and divide

the data into four sub-periods: pre-crisis, crisis, post-crisis, and normal periods, and determine the sectoral systematic risk. The study finds that the rankings of 10 industries vary from one country to another, with respect to systematic risk and the risk-return framework. Also, the sub-periods analysis informs that the rankings of systematic risk are unstable across different economic periods. This motivates us to consider dividing the periods at the crisis points and study the behaviour of the stock prices.

Salisu and Vo (2020) show that the predictability of stock returns is affected by the health news generated about the pandemic. Ziemba (2020) examines the changes in the US equity market during the COVID-19 period in the first half of 2020 and show that throughout the period there was extreme volatility. Engelhardt et.al. (2020) consider a sample of 64 national stock markets covering 94% of the world's GDP and examine the impact of the pandemic on the economy. They show that stock markets decline due to higher news attention than rational expectation. Contessi and De Pace (2021) finds robust evidence of instability and crashes spreading from China to 18 major countries (European countries) during the pandemic period. Duong et. al. (2021) investigate the impact of limit-to-arbitrage factors on the returns of the idiosyncratic volatility (IVOL) in Taiwan. They consider the Taiwan stock market data before and during the Covid-19 pandemic. They find that there is a negative relationship between IVOL and stock returns. Taking this as a motivation, we consider the data during the pandemic and study the behaviour of the individual stocks.

We draw the motivation to study the behaviour of the Nifty 50 stocks, from the above studies and also from the fact that not many have studied the tail behaviour of the individual stocks in the Indian context.

Research Methodology

In the current study, the main objective is to observe the changes in the tail behaviour of the stocks, with changes in the crisis periods. That is, observe how the behaviour of the stocks is shifting from normal to heavy tail and vice-a-versa. Also, observe the periods that impact the stocks maximum (minimum) number of times. Hence to address these issues, we adopt a descriptive research design.

Time horizons and Crisis periods considered in the study

Table-1 gives the details of the market crashes from the year 2007 to 2020.

Table-1*Market Crash details*

The financial crisis of 2007–08	2009 Dubai debt standstill	European sovereign debt crisis	2010 flash crash	August 2011 stock markets fall	2015–16 Chinese stock market crash	2015–16 stock market selloff	2018 Global Stock Market Downturn	2020 stock market crash
16-Sep-08	27-Nov-09	27-Apr-10	06-May-10	01-Aug-11	12-Jun-15	18-Aug-15	20-Sep-18	24-Feb-20

Note: Retrieved from

https://en.wikipedia.org/wiki/List_of_stock_market_crashes_and_bear_markets as on 08.04.2020

We have considered daily stock prices of the 50 stocks listed on NSE (refer to appendix-1), from the year 2007 to 2020 and the same is divided into six blocks. The first block has the daily stock prices from the year 2007 to 2009, the daily stock prices for the year 2010 is the second block, the daily prices for the period 2011 to 2014 form the third block, the fourth block comprises of prices taken for the years 2015 and 2016, the prices from the year 2017 to 2019 form the fifth block and the sixth block has the daily stock prices for the year 2020. The time point at which the crisis has occurred was considered as the cut-off point and the blocks were decided based on this.

Methods used for analysing the data

For estimating the tail index for each of the stocks considered, the weighted least squares estimator proposed by Nair et.al. (2019), was used. Here the weight W_i and tail index are given by

$$w_i = \left[\ln \left(\frac{x_i}{\hat{x}_{\min}} \right) \right]^{-1} \quad \hat{\alpha} = \frac{-\sum_{i=1}^N \ln(\hat{y}_i/N)}{\sum_{i=1}^N \ln(x_i/\hat{x}_{\min})}$$

where x_i is the data point for $i = 1, \dots, N$, The minimum value, x_{\min} is estimated from the data set and hence denoted \hat{x}_{\min} . For each value, i (of N data points) y_i is the number of points greater than the i th data point. We use the package “ptsuite” available in R for calculation purposes.

Note that, based on the value of alpha, the behaviour of the random variable is decided. The following gives the existence of moments for the value of alpha.

- $1 \leq \alpha < 2$, all moments diverge, ie. $E(X) = \infty$

- $2 < \alpha \leq 3$ all second and higher – order moments diverge, ie. $E(X^2) = \infty$
- $3 < \alpha \leq m + 1$, all m and higher – order moments diverge, ie. $E(X^m) = \infty$
- All moments are finite when the distribution is normal.

Data Analysis and Key findings

In this section, we present the data analysis for each of the stocks listed under NSE. We use R, for data analysis. The following tables give the results for each of the stocks, divided based on the sector they belong to. Each table has the tail index estimated for the time horizons considered and discussion was presented below the results.

The behaviour of Automobile Stocks

Table-2

Automobile Stocks

Stock	Year	2007-2009	2010	2011-2014	2015-16	2017-19	2020
BajajAuto	Sample size	392	252	992	495	739	54
	Tail Index	1.1175	3.4327	2.5292	4.2843	6.1695	3.5163
Eicher Motors	Sample size	738	252	992	495	739	54
	Tail Index	1.3095	1.7695	0.9265	3.6555	2.1099	5.9705
Hero MotoCorp	Sample size	-	-	842	495	739	55
	Tail Index	-	-	2.7992	4.7557	2.9788	3.1756
Mahindra & Mahindra	Sample size	738	252	992	495	739	55
	Tail Index	1.0393	2.7191	2.695	7.0415	1.8258	2.3615
Maruti Suzuki	Sample size	738	252	992	495	739	55
	Tail Index	1.5783	6.9386	1.9893	3.7093	3.218	4.0091
Tata Motors	Sample size	738	252	992	495	739	55
	Tail Index	0.7509	3.195	0.979	2.1479	1.081	1.3037

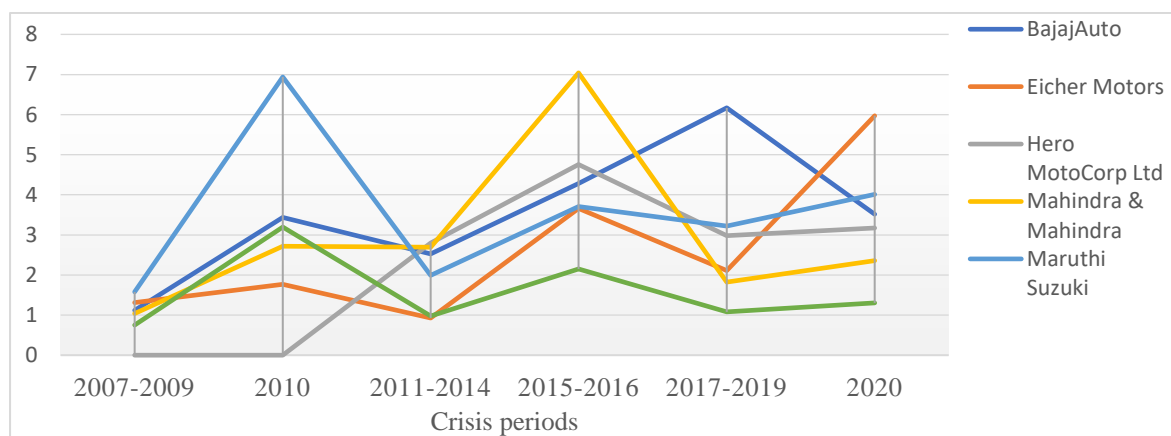
Note: The table gives the tail index for the stocks considered

From the above table, one can note that Tata Motors has a heavy tail (index value < 3) during most of the crises periods and can be considered as the stock that is highly riskier followed by Mahindra & Mahindra and Eicher motors. This is because these stocks have a

tail index value maximum number of times less than 3, among the automobile stocks. The other three stocks (Maruti, Bajaj Auto, Hero Motors) have a tail index value at a level that classifies them at medium level risk. Also, among these stocks, Baja Auto, Maruti have tail index values greater than 3, more times. This indicates that these stocks could sustain the crises that occurred during these time points. Based on this, the decision-makers can choose the stocks appropriately for investment. This can be a starting point to understanding the automobile stocks' behaviour and then move on to the next level of analysis, which can be either statistical or financial for deciding on investing in these stocks. This also motivates one to investigate and identify the reasons, specific to each of the stocks, that made the stocks volatile leading to heavy tails during the crises periods considered. Based on the specific reasons identified, one can develop a strategy that can be used to handle these stocks during crisis periods. That is, a plan for each of the stocks separately, which can be used while deciding on investing in these stocks.

Figure-1

Fluctuation of index values-Automobile stocks



Note: The figure gives the fluctuation of the index values across the crisis periods

Concerning the periods, 2007-09 (index <2) and 2011-14 (index <3) have impacted Bajaj Auto and it could sustain to change caused by crisis events during other periods. Eicher has got affected during the periods 2007-09 (index<2), 2010 (index<2), 2011-14 (index<1), 2017-19 (index<2). Hero MotoCorp Ltd was affected during the periods 2011-14 (index<3) and 2017-19 (index<3). Mahindra & Mahindra was affected during all the periods except for 2017-19. Interestingly the tail value for this period is very high, which indicates that the tails are not heavy, or events did not impact the stock during this period. Periods 2007-09 (index<2) and 2011-14 (index<2) have affected Maruti Suzuki. Tata Motors was the most

vulnerable stock that had got affected during all the periods except for 2010 (index>3). Overall, Automobile stocks have got severely affected by the crisis events. Figure-1 shows the fluctuation in the index values for automobile stocks.

The behaviour of Banking Stocks

Table-3

Banking Stocks

Stock	Year	2007-2009	2010	2011-2014	2015-2016	2017-2019	2020
Axis	Sample size	584	252	992	495	739	54
	Tail Index	1.0496	3.6623	0.9171	3.2302	3.4922	2.5624
HDFC Bank	Sample size	738	252	992	495	739	55
	Tail Index	2.2372	3.8258	1.6185	6.3855	1.9525	3.0019
ICICI Bank	Sample size	738	252	992	495	739	55
	Tail Index	0.9494	4.7363	0.8755	2.522	3.4102	2.5592
Indus Bank	Sample size	738	252	992	495	739	55
	Tail Index	1.1634	2.4204	1.712	4.8859	2.6725	1.0038
Kotak Mahindra Bank	Sample size	738	252	992	495	739	55
	Tail Index	0.97798	2.4215	1.5911	2.9551	1.9146	2.8736
SBI	Sample size	738	252	992	495	739	55
	Tail Index	1.8352	3.6205	0.5208	2.1707	4.6649	2.657
Yes Bank	Sample Size	738	252	992	495	739	54
	Tail Index	0.8019	3.8198	1.9059	2.8037	0.4326	1.1325

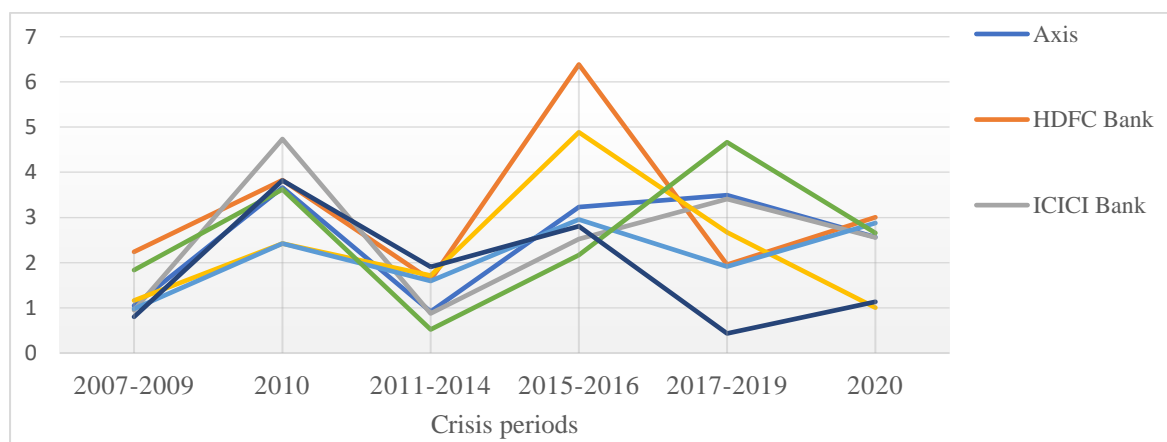
Note: The table gives the tail index for the stocks considered

It is interesting to note that all the stocks are highly volatile during crisis periods and indicates that they are severely affected by the crises. This indicates that the banking stocks are sensitive to crises events and one has to consider other aspects related to these stocks before making any investments. Among the stocks, Kotak and Yes and Indus banks are highly volatile, relative to other banks. This is because they have tail index values less than 3 maximum number of times during the crisis periods. Other bank stocks have relatively less number of times the value of the tail index less than 3. Overall, we conclude that banking stocks have got severely affected due to the crisis events. This allows one to identify the

specific events that impact them during the crisis periods and classify the events as most critical, moderately critical and low critical. This will help the decision-makers to appropriately act while investing in these stocks. This will also help the policy-makers to design the right course of actions to make the banking sector sustainable to the crisis and help the economy to sustain the crises events. This is important if the economy has a dependence on the growth of the banking sector.

Figure-2

Fluctuation of index values-Banking stocks



Note: The figure gives the fluctuation of the index values across the crisis periods

Among the periods, 2011-14 (index<1), 2007-09 (index<2) and 2020 (index<3), have impacted Axis bank. Also, the tail index during the other periods is close to 3, and this indicates that Axis bank has got impacted due to crisis events severely. Periods 2007-09 (index<3), 2011-14 (index<2), and 2017-19 (index<2), have impacted HDFC bank and it has an index value close to three in the year 2020. This indicates that the pandemic has a moderate impact on the stock. 2007-09 (index<1), 2011-14 (index<1), 2015-16 (index<3), and 2020 (index<3), have impacted ICICI bank. Among the banks, Indus bank has got impacted during the periods 2007-09 (index<2), 2011-14 (index<2), 2020 (index<2), 2010 (index<3), and 2017-19 (index<3) have impacted the bank the most. Kotak bank was impacted during the periods 2007-09 (index<1), 2011-14 (index<2), 2017-19 (index<2), 2010 (index<3), 2020 (index<3), and 2015-16 (index<3). This indicates that Kotak bank was affected the most among the banks. SBI was affected during the periods 2011-14 (index<1), 2007-09 (index<2), 2015-16 (index<3), and 2020 (index<3). Overall banking stocks were affected the most among the stocks. One can observe the same from the figure-2.

The behaviour of Cement Stocks

Table-4

Cement

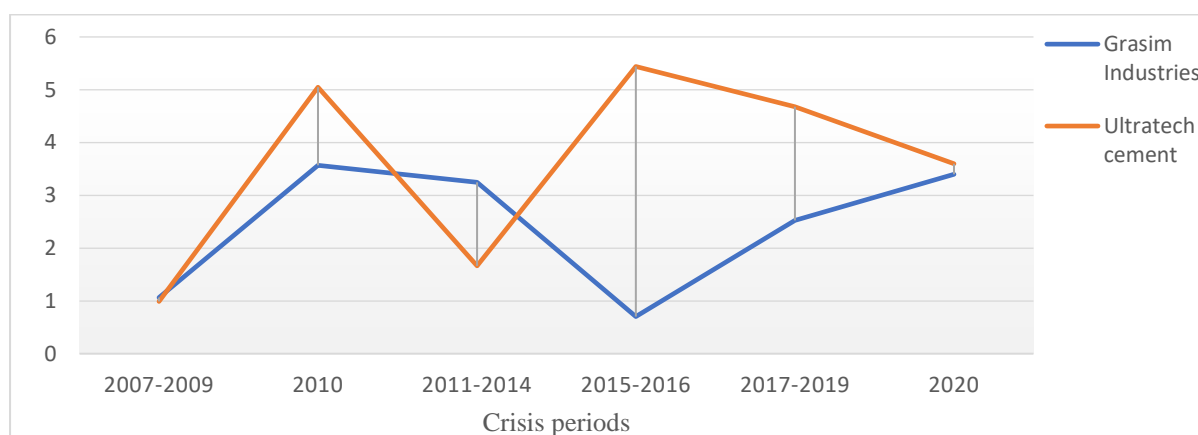
Stock	Year	2007-2009	2010	2011-2014	2015-2016	2017-2019	2020
Grasim Industries	Sample size	738	252	992	495	739	54
	Tail Index	1.0638	3.5682	3.2485	0.7036	2.5226	3.3953
Ultratech cement	Sample size	738	252	992	495	739	55
	Tail Index	0.9901	5.0468	1.6649	5.44	4.6749	3.5991

Note: The table gives the tail index for the stocks considered

Both the stocks under the cement sector have index values of more than 3 maximum number of times, during the crises periods and this makes them less volatile to the crisis events. This could be possible because of the demand for cement even during the crisis periods and the sustenance of real estate during the crisis periods. One can identify the specific events that will make the sector further sustainable to the crisis and help the investors to make the right decisions.

Figure-3

Fluctuation of index values-Cement stocks



Note: The figure gives the fluctuation of the index values across the crisis periods

Periods 2015-16 (index<1), 2007-09 (index<2) and 2017-19 (index<3) have affected Grasim Industries, 2007-09 (index<1) and 2011-14 (index<2) have affected Ultratech cement.

Relatively, Grasim industries have got affected more times due to crisis events and is evident from Figure-3.

The behaviour of Consumer Goods Stocks

Table-5

Consumer Goods

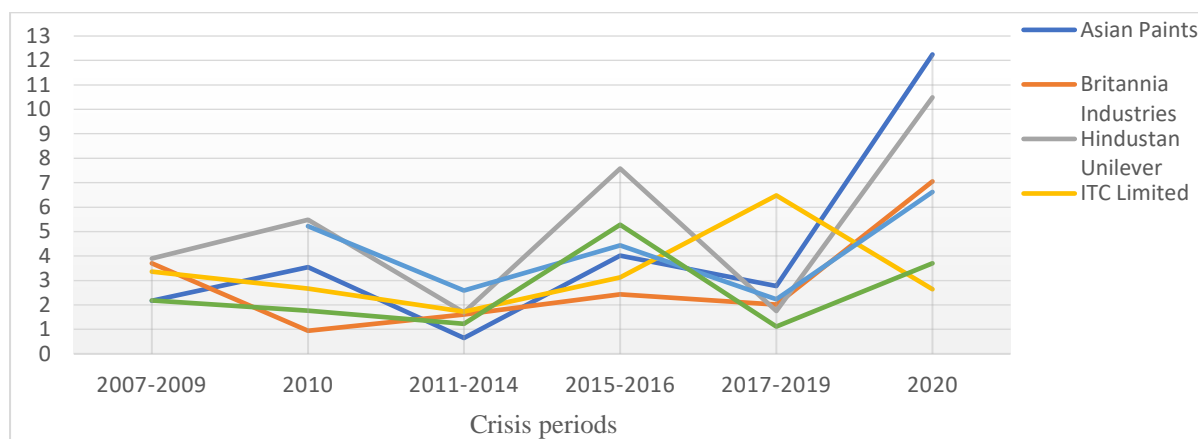
Stock	Year	2007-2009	2010	2011-2014	2015-2016	2017-2019	2020
Asian Paints	Sample size	738	252	992	495	739	54
	Tail Index	2.1764	3.5479	0.648	4.0154	2.7762	12.2448
Britannia Industries	Sample size	737	252	992	495	739	54
	Tail Index	3.7019	0.94413	1.6035	2.4309	2.0201	7.0526
Hindustan Unilever	Sample size	603	252	992	495	739	55
	Tail Index	3.8983	5.4804	1.6948	7.5815	1.7523	10.4887
ITC Limited	Sample size	738	252	992	495	739	55
	Tail Index	3.3643	2.6675	1.7251	3.1285	6.4791	2.6388
Nestlé India	Sample size		248	992	495	739	55
	Tail Index		5.2191	2.5854	4.4302	2.2329	6.6215
Titan Company	Sample size	738	252	992	495	739	55
	Tail Index	2.1779	1.7708	1.2311	5.2809	1.1157	3.7065

Note: The table gives the tail index for the stocks considered

Among the consumer goods, Titan is affected more by crisis events and is highly volatile as compared to other stocks. Britannia is the next stock that has been affected by the crisis events. Asian paints and ITC are moderately affected by the events and, Hindustan Unilever and Nestle India are least affected by the crisis events. This implies that these stocks could sustain the crisis events and maybe good for investments. But, one has to consider other aspects before taking any decision on these stocks. For example, their performance in the market in terms of sales, their financial position, future strategies for growth etc.

Figure-4

Fluctuation of index values-Consumer Goods stocks



Note: The figure gives the fluctuation of the index values across the crisis periods

Periods 2011-14 (index<1), 2007-09 (index<3), and 2017-19 (index<3) have affected Asian paints. Britannia Industries was affected during the periods 2010 (index<1), 2011-14 (index<2), 2017-19 (index<3), 2015-16 (index<3). Hindustan Unilever was not much affected by the crisis events. Only periods 2011-14 and 2017-19 have affected the stock behaviour. One can understand the fluctuation of tail index values for the stocks from Figure-4. ITC got affected by the events during 2011-14 (index<2), 2010 (index<3) and 2020 (index<3). Nestle India got affected during the periods 2011-14 (index<3) and 2017-19 (index<3). Titan Company got affected during many periods. It got affected during periods 2017-19 (index<2), 2011-14 (index<2), 2010 (index<2), and 2007-09 (index<3).

The behaviour of Energy Oil and Gas

Table-6

Energy Oil and Gas

Stock	Year	2007-2009	2010	2011-2014	2015-2016	2017-2019	2020
Bharat Petroleum	Sample size	738	252	992	495	739	54
	Tail Index	1.7513	4.0308	1.5869	2.6797	1.787	3.4553
GAIL	Sample size	746	253	1254	496	748	54
	Tail Index	1.7365	6.8058	3.2885	3.2599	0.9315	2.1441

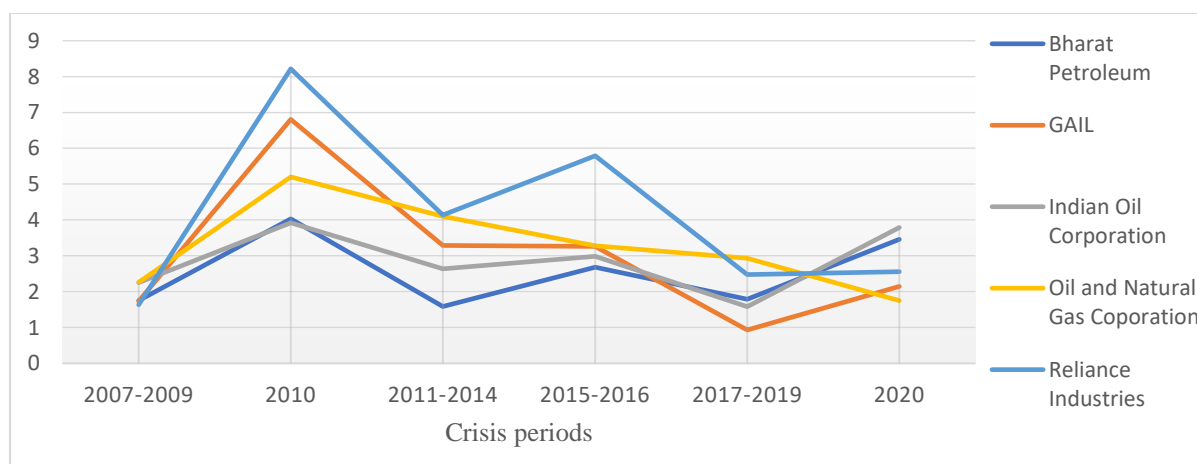
Indian Oil Corporation	Sample size	738	252	992	495	739	55
	Tail Index	2.2496	3.9215	2.6363	2.9876	1.5816	3.7922
ONGC	Sample size	738	252	992	495	739	55
	Tail Index	2.2656	5.2016	4.0991	3.2798	2.9317	1.7505
Reliance Industries	Sample size	738	252	992	495	739	55
	Tail Index	1.6357	8.2165	4.1341	5.7918	2.4756	2.5562

Note: The table gives the tail index for the stocks considered

As compared to other stocks, Energy Oil and Gas stocks are affected moderately by the crisis events and during the crisis periods. Bharat Petroleum (BPCL) has a tail index value less than 3 more times as compared to other stocks, followed by Indian Oil Corporation (IOC). GAIL, ONGC and Reliance industries were moderately affected with the index value less than 3, 3 times each. Based on this, one can decide to invest in these three stocks, relative to other stocks. One can also take into consideration the financial position and other growth-related aspects of these stocks, and act on them appropriately. Studying specific events (both global and local) related to these will help the decision-makers to identify the events that are impacting the stocks during the crisis periods. Also, compare their behaviour with the normal periods.

Figure-5

Fluctuation of index values-Energy Oil and Gas stocks



Note: The figure gives the fluctuation of the index values across the crisis periods

Bharat Petroleum has got affected during the periods 2011-14 (index<2), 2007-09 (index<2), 2017-19 (index<2), and 2015-16 (index<3). GAIL has got affected during the

periods 2017-19 (index<2), 2007-09 (index<2), 2020 (index<3). Indian Oil Corporation (IOC) has got affected during the periods 2017-19 (index<2), 2007-09 (index<3), 2011-14 (index<3), and 2015-16 (index<3). ONGC has got affected during the periods 2020 (index<2), 2007-09 (index<3), and 2017-19 (index<3). Reliance Industries has got affected during the periods 2007-09 (index<2), 2017-19 (index<3), and 2020 (index<3). One can understand the fluctuation from Figure-5.

The behaviour of Energy Powere stocks

Table-7

Energy Power

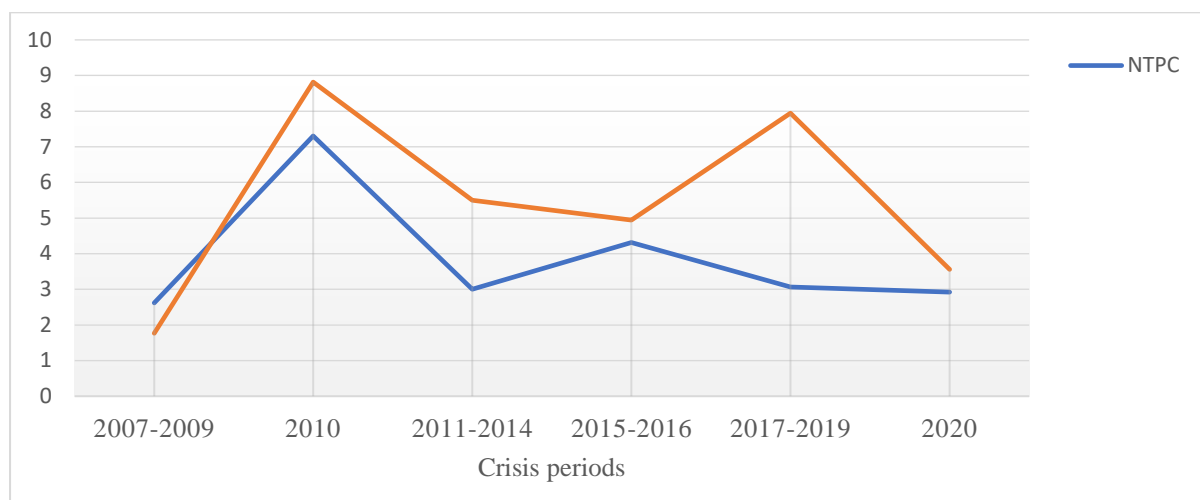
Stock	Year	2007-2009	2010	2011-2014	2015-2016	2017-2019	2020
NTPC	Sample size	738	252	992	495	739	55
	Tail Index	2.6188	7.3038	3.0002	4.3179	3.0631	2.9218
Power Grid Corp of India	Sample size	549	252	992	495	739	55
	Tail Index	1.7667	8.8153	5.4958	4.9398	7.9442	3.5635

Note: The table gives the tail index for the stocks considered

Among the two stocks, NTPC is highly volatile and has the maximum number of times the value of the index with a level of more than 3. This indicates that the crisis events have affected the NTPC stock, leading to high risk. Powergrid was least affected by the events during the crises periods and can be considered by the investors. One reason could be the policies adopted by the government to bring the stock out of the crisis. One can find other reasons for the stock not getting affected by the crisis events and monitor them to ensure that they continue to be sustainable to the crisis events.

Figure-6

Fluctuation of index values-Energy Power stocks



Note: The figure gives the fluctuation of the index values across the crisis periods

NTPC has got affected during the periods 2007-09 (index<3) and 2020 (index<3). Power grid corp has got affected during the period 2007-09 (index<2) and had high tail index values during the other periods. During 2020 its value had come closer to 3 and this indicates the pandemic had an influence on the stock but it could sustain the shock created by the pandemic.

The behaviour of Financial Services Stocks

Table-8

Financial Services

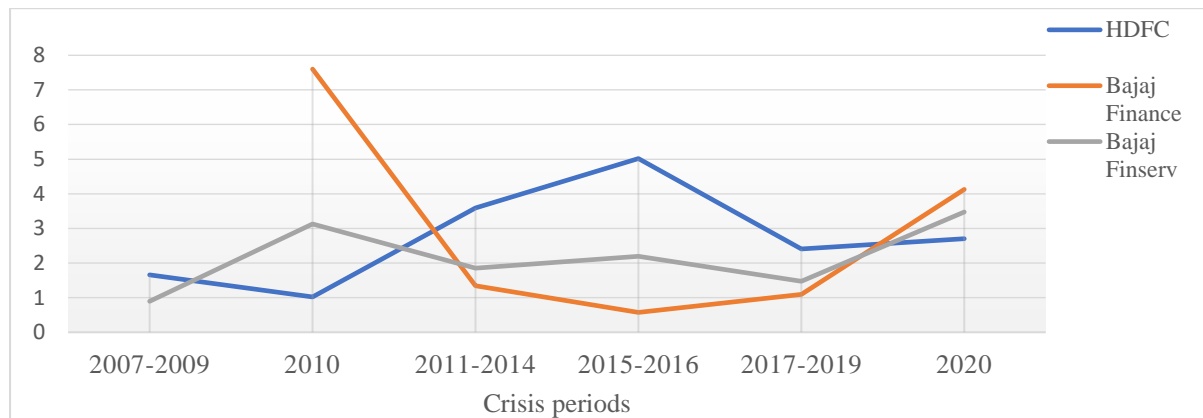
Stock		2007-2009	2010	2011-2014	2015-2016	2017-2019	2020
HDFC	Sample size	738	252	992	495	739	55
	Tail index	1.6531	1.02	3.5905	5.0168	2.4079	2.7023
Bajaj Finance	Sample size		66	992	495	739	54
	Tail index		7.6014	1.3386	0.5733	1.09191	4.1291
Bajaj Finserv	Sample size	391	252	992	495	739	54
	Tail index	0.8948	3.1239	1.854	2.1904	1.4762	3.474

Note: The table gives the tail index for the stocks considered

Among the stocks of the financial services, Bajaj Financial services stock was affected by the crisis events, followed by HDFC financial services. Bajaj finance is less affected by the crisis events.

Figure-7

Fluctuation of index values-Financial Services



Note: The figure gives the fluctuation of the index values across the crisis periods

Among the stocks related to Financial Services, HDFC has got affected during the period 2007-09 (index<2), 2010 (index<2), 2017-19 (index<3), and (index<3). Bajaj Finance was affected during the periods 2011-14 (index<2), 2015-16 (index<1), and 2017-19 (index<2). Bajaj Finserv was affected during the periods 2007-09 (index<1), 2011-14 (index<2), 2017-19 (index<2), and 2015-16 (index<3). One can note that Bajaj Finserv was affected the most during the crisis periods. One can observe the fluctuation of the tail index from figure-7.

The behaviour of Information Technology stocks

Table-9

Information Technology

	Year	2007-2009	2010	2011-2014	2015-2016	2017-2019	2020
HCL Technologies	Sample Size	738	252	992	495	739	55
	Tail Index value	0.9623	6.0987	1.3955	3.8564	1.7482	3.353
Infosys	Sample Size	553	250	870	495	739	55

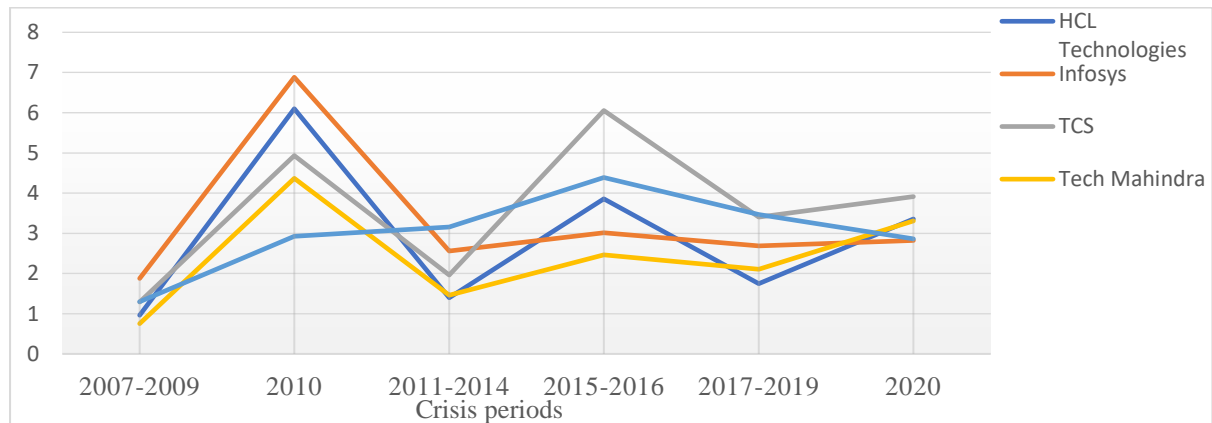
TCS	Tail Index value	1.8775	6.8814	2.5632	3.016	2.6834	2.8216
	Sample Size	738	252	992	495	739	55
Tech Mahindra	Tail Index value	1.2906	4.9298	1.9644	6.0549	3.4052	3.9111
	Sample Size	738	252	992	495	739	55
Wipro	Tail Index value	0.753	4.3681	1.4632	2.4675	2.1069	3.3093
	Sample Size	738	252	992	495	739	55
	Tail Index value	1.2984	2.9219	3.15591	4.3877	3.471	2.8617
	Sample Size						

Note: The table gives the tail index for the stocks considered

Among the IT stocks, HCL stock was affected the most, but the risk was at a medium level. Infosys stock was affected the most, followed by HCL, WIPRO and TCS

Figure-8

Fluctuation of index values-Information Technology stocks



Note: The figure gives the fluctuation of the index values across the crisis periods

Periods 2007-09 (index<1), 2011-14 (index<2), 2017-19 (index<2) have affected HCL technologies. Infosys stock has got affected during the periods 2007-09 (index<2), 2011-14 (index<3), 2017-19 (index<3), and 2020 (index<3). TCS was affected during the periods 2007-09 (index<2) and 2011-14 (index<2). Tech Mahindra was affected during the periods 2007-09 (index<1), 2011-14 (index<2), 2015-16 (index<3) and 2017-19 (index<3). Wipro

has got affected during the periods 2007-09 (index<2) 2010 (index<3) and 2020 (index<3). Figure-8 gives the fluctuation of the index values during the crisis periods.

The behaviour of Metal stocks

Table-10

Metals

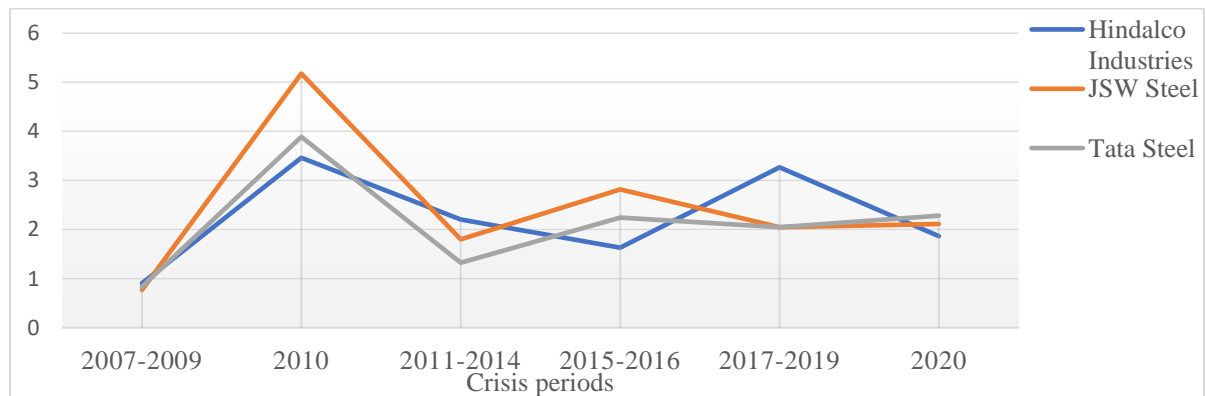
Year		2007-2009	2010	2011-2014	2015-2016	2017-2019	2020
Hindalco Industries	Sample Size	577	252	992	495	739	55
	Tail index value	0.904	3.4617	2.2025	1.6314	3.2656	1.8667
JSW Steel	Sample Size	738	252	992	495	739	55
	Tail index value	0.7677	5.1759	1.7978	2.8173	2.0481	2.1137
Tata Steel	Sample Size	738	252	992	495	739	55
	Tail index value	0.8349	3.8876	1.3208	2.2458	2.0457	2.2827

Note: The table gives the tail index for the stocks considered

Among the metal stocks, JSW steel was affected the most due to the crisis events followed by Tata Steel, and Hindalco industries. JSW has a tail index value of less than 3 during all the periods except 2010. This may be because of a fall in the demand for steel and a fall in real estate. Focusing on events related to individual stocks will help one to appropriately take decisions related to investments in these stocks.

Figure-9

Fluctuation of index values-Metal stocks



Note: The figure gives the fluctuation of the index values across the crisis periods

Hindalco Industries has got affected during the periods 2007-09 (index<1), 2011-14 (index<3), 2015-16 (index<2), and 2020 (index<2). JSW steel was affected during the periods 2007-09 (index<1), 2011-14 (index<2), 2015-16 (index<3), 2017-19 (index<3), and 2020 (index<3). Tata steel was affected during the periods 2007-09 (index<1), 2011-14 (index<2), 2015-16 (index<3), 2017-19 (index<3), and 2020 (index<3). One can note that Metal stocks were highly affected by the crisis periods. Figure-9 give the fluctuation of the index values.

The behaviour of Pharmaceutical stocks

Table-11

Pharmaceuticals

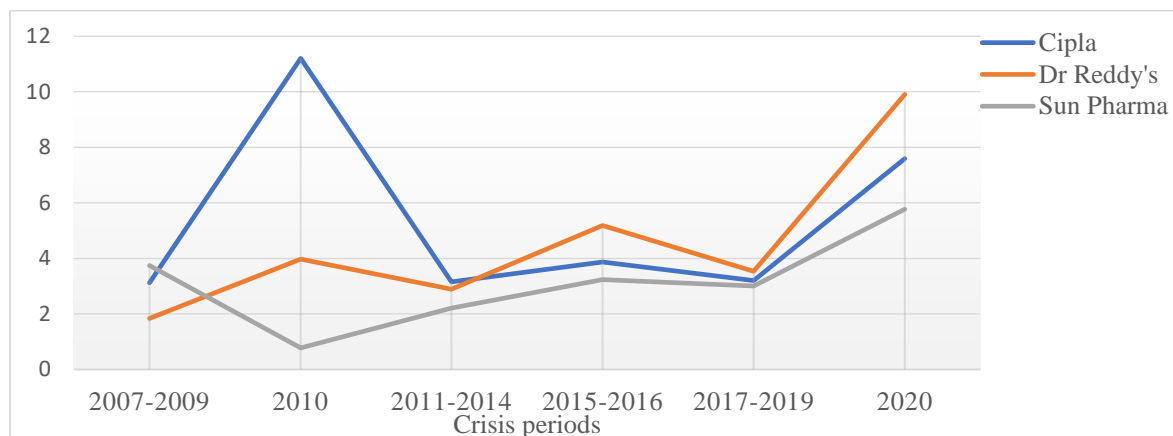
Year		2007-2009	2010	2011-2014	2015-2016	2017-2019	2020
Cipla	Sample Size	738	252	992	495	739	54
	Tail index value	3.1222	11.2048	3.1597	3.8739	3.1981	7.5954
Dr Reddy's	Sample Size	738	252	992	495	739	54
	Tail index value	1.8393	3.9786	2.8913	5.1845	3.5417	9.9061
Sun Pharma	Sample Size	738	252	992	495	739	55
	Tail index value	3.7456	0.7762	2.2071	3.2364	3.004	5.7729

Note: The table gives the tail index for the stocks considered

From the above table, one can note that Cipla was not affected by the crisis events. Dr Reddy's was affected such that the risk associated with the stock was at a medium level, followed by Sun Pharma. One can study the global events that are associated with each of these stocks before drawing conclusions or making decisions related to investments.

Figure-10

Fluctuation of index values-Pharmaceutical stocks



Note: The figure gives the fluctuation of the index values across the crisis periods

Interestingly, Cipla stock was not affected much by the crisis events during any of the periods. Dr. Reddy’s was affected during the periods 2007-09 (index<2) and 2011-14 (index<3). Sun Pharma was affected during the periods 2010 (index<1) and 2011-14 (index<3). From this one can note that except for a few periods, Pharma stocks were not much affected by the crisis events. Especially during the current pandemic, they have a high tail index value and this indicates that they were not affected by the changes due to the Pandemic. In fact, due to the demand for specific medicines and vaccines, the stock prices of these stocks have gone up and made the tails heavier. One can observe the fluctuations in the index values from Figure-10.

The behaviour of other stocks

Table-12

Other Stocks

	Year	2007-2009	2010	2011-2014	2015-2016	2017-2019	2020
Adani Ports	Sample Size	506	250	983	492	736	53
	Tail Index Value	1.354	3.3556	2.6867	2.1628	3.2085	3.0035
Bharati Airtel	Sample Size	738	252	992	495	739	54
	Tail Index Value	1.06084	5.1754	3.0968	5.0869	3.6893	7.6252
Infratel	Sample Size			496	495	739	55

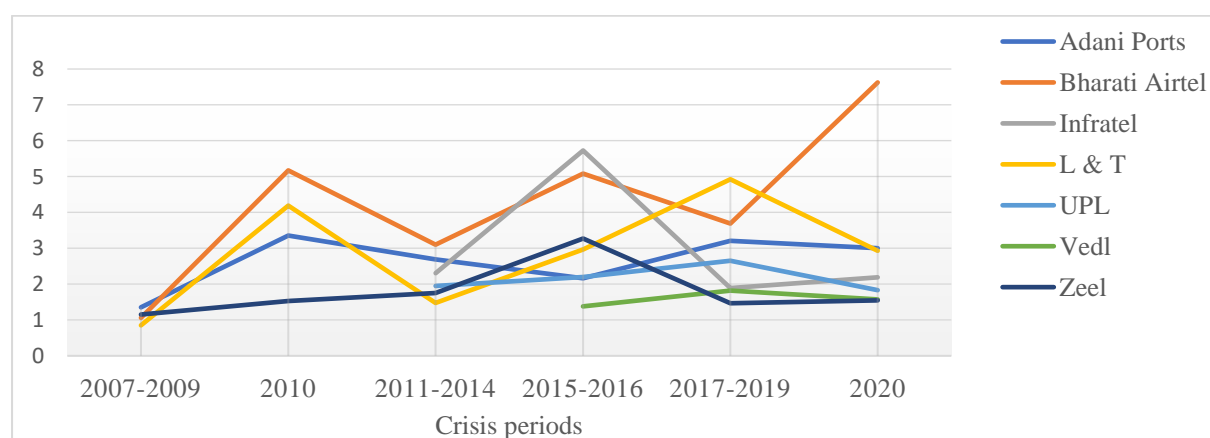
	Tail Index Value			2.3037	5.7274	1.8909	2.1864
L & T	Sample Size	738	252	992	495	739	55
	Tail Index Value	0.8516	4.1867	1.4718	2.9695	4.9245	2.9274
	Sample Size			292	495	739	55
UPL	Tail Index Value			1.9473	2.199	2.6519	1.8321
	Sample Size				411	739	55
Vedl	Tail Index Value				1.3799	1.8195	1.578
Zeel	Sample Size	700	252	992	495	739	55
	Tail Index Value	1.1529	1.5285	1.7568	3.2718	1.4655	1.5497

Note: The table gives the tail index for the stocks considered

Among other stocks, Zeel was severely affected by the crisis events. One can observe that the tail index value was less than 2 more times and this indicates that Zeel stock was one of the stocks that have a high risk for investment. The second stock that got affected was L&T, followed by UPL. Adani ports, VEDL and INFRA TEL were affected by the events such that the risk associated with them is medium. Bharti Airtel was not affected much and the associated risk is low.

Figure-11

Fluctuation of index values-Others stocks



Note: The figure gives the fluctuation of the index values across the crisis periods

Table-13

Coal Stock

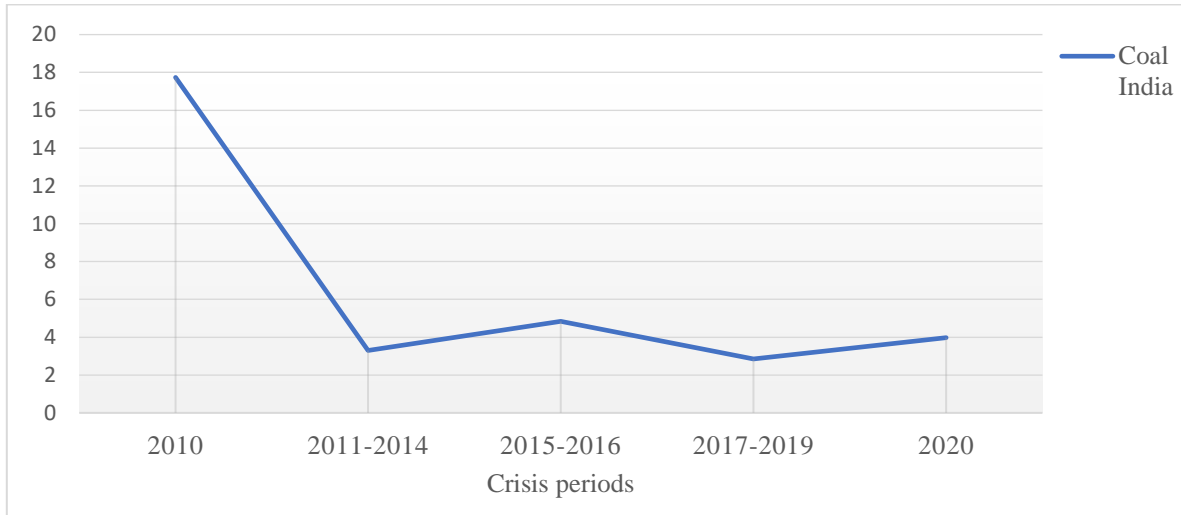
Year	2007-2009	2010	2011-2014	2015-2016	2017-2019	2020
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Coal India	17.734	3.2927	4.8322	2.8497	3.9771
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Note: The table gives the tail index for the stocks considered

Figure-12

Fluctuation of index values-Coal stock



Note: The figure gives the fluctuation of the index values across the crisis periods

Adani ports stock was affected during the periods 2007-09 (index<2), 2011-14 (index<3), 2015-16 (index<3). Bharati Airtel was affected during the period (index<2) and was not affected much during other periods. It was the stock that has got least affected by the crisis events. Studying the specific events during these periods will help one to know the behaviour better. Coal India was affected only during the period 2017-19 (index<3) and has a high tail index value during the period 2010 and has got value more than 3 during the other periods. Infra Tel was affected during the periods 2011-14 (index<3) 2017-19 (index<2), and 2020 (index<3). L&T was affected during the periods 2007-09 (index<1), 2011-14 (index<2), 2015-16 (index<3), 2020 (index<3). UPL was affected during all the periods with an index value less than 2. VEDL stock was affected during the periods 2015-16, 2017-19, and 2020 (index<2). Zeel stock was affected during 2007-09, 2010, 2011-14, 2017-19, and 2020 (index<2). Studying these stocks during these periods concerning specific events will help one to get more information about these stocks.

Classification of the stocks based on the tail index

Based on the number of times the index value is less than 3, we classify the stock as riskier or volatile and rank them appropriately. We classify the stocks into high risk (if the frequency is

between 4 and 6), medium risk (if the frequency is between 2 and 3), low risk (if the frequency is between 0 and 1).

Table-14

Crossings and Classification of the stocks

Symbol	<1	1<alpha<=2	2<alpha<=3	Total	alpha>3	Risk
TATAMOTORS	2	2	2	6	0	High
KOTAKBANK	1	2	3	6	0	High
YESBANK	2	2	1	5	1	High
JSWSTEEL	1	1	3	5	1	High
TATASTEEL	1	1	3	5	1	High
ZEEL	0	5	0	5	1	High
TITAN	0	3	2	5	2	High
INDUSINDBK	0	3	2	5	1	High
M&M	0	2	3	5	1	High
INFY	0	1	4	5	1	High
ICICIBANK	2	0	2	4	2	High
BAJAJFINSV	1	2	1	4	2	High
BRITANNIA	1	2	1	4	2	High
EICHERMOT	1	2	1	4	2	High
HINDALCO	1	2	1	4	2	High
LT	1	1	2	4	2	High
SBIN	1	1	2	4	2	High
TECHM	1	1	2	4	2	High
BPCL	0	3	1	4	2	High
UPL	0	2	2	4	0	High
HDFC	0	2	2	4	2	High
HDFCBANK	0	2	2	4	2	High
IOC	0	1	3	4	2	High
ADANIPTS	0	1	3	4	2	High
NTPC	0	0	4	4	2	High
ASIANPAINT	1	2	0	3	3	medium
BAJFINANCE	1	2	0	3	2	medium

HCLTECH	1	2	0	3	3	medium
AXISBANK	1	1	1	3	3	medium
GAIL	1	1	1	3	3	medium
GRASIM	1	1	1	3	3	medium
SUNPHARMA	1	0	2	3	3	medium
VEDL	0	3	0	3	0	medium
ITC	0	1	2	3	3	medium
ONGC	0	1	2	3	3	medium
RELIANCE	0	1	2	3	3	medium
WIPRO	0	1	2	3	3	medium
INFRATEL	0	1	2	3	1	medium
ULTRACEMCO	1	1	0	2	4	medium
MARUTI	0	2	0	2	4	medium
TCS	0	2	0	2	4	medium
HINDUNILVR	0	2	0	2	4	medium
BAJAJ-AUTO	0	1	1	2	4	medium
DRREDDY	0	1	1	2	4	medium
NESTLEIND	0	0	2	2	3	medium
HEROMOTOCO	0	0	2	2	2	medium
POWERGRID	0	1	0	1	5	Low
BHARTIARTL	0	1	0	1	5	Low
COALINDIA	0	0	1	1	4	Low
CIPLA	0	0	0	0	6	Low

From the above table, one can observe the stocks that are at high, medium and low-risk levels, respectively. Note that, this classification was done based on the index values. This will help one to understand the process of identifying the stocks that are riskier for investments.

The process proposed through this study can be used for classifying any stock by estimating the tail index value and recording the times it will be less than 3. This will add value to the existing process of deciding on investing in a given stock.

Frequency of Crisis Periods

The following table gives the frequency of crisis periods that have impacted the stocks. It will help the decision-makers to identify the sensitive periods and perform in-depth analysis for each of the stocks before taking any decision on them. This process also helps one to note the number of times the crisis periods have affected the behaviour of the stock prices. The frequency is calculated based on the times the period has a tail index value less than 3 and the total of this was taken to calculate the number of times the period has recurred.

Table-15

Frequency of the periods

Year	2007-09	2010	2011-14	2015-16	2017-19	2020
BajajAuto	1	0	1	0	0	0
Eicher Motors	1	1	1	0	1	0
Hero MotoCorp Ltd	0	0	1	0	1	0
Mahindra & Mahindra	1	1	1	0	1	1
Maruthi Suzuki	1	0	1	0	0	0
Tata Motors	1	0	1	1	1	1
Axis	1	0	1	0	0	1
HDFC Bank	1	0	1	0	1	0
ICICI Bank	1	0	1	1	0	1
Indus Bank	1	1	1	0	1	1
Kotak Mahindra Bank	1	1	1	1	1	1
SBI	1	0	1	1	0	1
Yes Bank	1	0	1	1	1	1
Grasim Industries	1	0	0	1	1	0
Ultratech cement	1	0	1	0	0	0
Asian Paints	1	0	1	0	1	0
Britannia Industries	0	1	1	1	1	0
Hindustan Unilever	0	0	1	0	1	0
ITC Limited	0	1	1	0	0	1
Nestlé India	1	0	1	0	1	0
Titan Company	1	1	1	0	1	0
Bharat Petroleum	1	0	1	1	1	0
GAIL	1	0	0	0	1	1

Indian Oil Corporation	1	0	1	1	1	0
ONGC	1	0	0	0	1	1
Reliance Industries	1	0	0	0	1	1
NTPC	1	0	0	0	0	1
Power Grid Corp of India	1	0	0	0	0	0
HDFC	1	1	0	0	1	1
Bajaj Finance	1	0	1	1	1	0
Bajaj Finserv	1	0	1	1	1	0
HCL Technologies	1	0	1	0	1	0
Infosys	1	0	1	0	1	1
TCS	1	0	1	0	0	0
Tech Mahindra	1	0	1	1	1	0
Wipro	1	1	0	0	0	1
Hindalco Industries	1	0	1	1	0	1
JSW Steel	1	0	1	1	1	1
Tata Steel	1	0	1	1	1	1
Cipla	0	0	0	0	0	0
Dr Reddy's	1	0	1	0	0	0
Sun Pharma	0	1	1	0	0	0
Adani Ports	1	0	1	1	0	0
Bharati Airtel	1	0	0	0	0	0
Infratel	1	1	1	0	1	1
L & T	1	0	1	1	0	1
UPL	1	1	1	1	1	1
Vedl	1	1	1	1	1	1
Zeel	1	1	1	0	1	1
Coal India	1	0	0	0	1	0
	44	14	39	19	32	24

From the above table, one can note that 2007-09 has affected the stocks more times as compared to other periods. 2011-14 has affected 39 times followed by 2017-19 (32 times). 2020 is a special year that has uniquely affected the world and has recurred 24 times. 2010 has recurred fewer times (14 times), followed by 2015-16 (19 times). This can be used to identify the sensitive periods, affecting the stocks (leading to an index value less than 3). One

can also take the crisis events that have occurred during these periods and measure the level of impact they have on each of the stocks.

Conclusion

We estimate the tail index value for each of the stocks considered and based on the thickness of the tail we conclude on the behaviour of the stock prices during the crisis periods. The value of the tail index decides the thickness of the tail and the behaviour of the stock price random variable during that period. From the analysis, we found that most of the stocks have got affected due to the financial crisis 2007-2009 but have been out of the situation to regain back their positions. The next period that has affected the stocks was 2011-14, followed by 2017-19. Table-15 gives the frequency or recurrence of crisis periods that have affected the stocks. During other periods few stocks have lost drastically while others didn't lose much. Table-14 gives the details of the stocks that have lost drastically during the crisis periods and stocks that haven't lost much. We conclude that stocks with an index value of less than 3, have turbulences during the crisis periods and have heavy tails, indicating that these stocks have got affected by the crisis events. Stocks with an index value of more than 3 have performed better during the market crash periods. Note that, a stock can have an index value that can fluctuate with levels less than 3 and levels more than 3, as the crisis period change. Based on the frequency of change, one can conclude on the sensitivity of the stock to the market crashes. Also, such stocks will have high volatility and collapse during crisis periods. Whereas few stocks whose index value do not change frequently will sustain during the crisis periods. But one has to consider other factors related to the market or the stock-specific or any other external factors while drawing complete conclusions. The inferences drawn based on the index values give one an idea of the behaviour of the stock and taking this as the starting point one can investigate other aspects. From our analysis, we have found the stocks that have got highly affected by the market crashes and those that have not got affected much.

We finally conclude that studying the tail behaviour of the stock prices is very important to know the sustenance of the stock to the crisis events. When none of the probability models best fit the stock prices, studying the tail thickness will help one in understanding the behaviour. From the study, we propose to study the tail behaviour of the stock prices, before making any decision or using any other methods for further analysis. Taking decisions without this may sometimes lead to wrong conclusions or other methods may not perform

well. Another important point that we would like to highlight is, studying the change in the index value with change in the events of the periods will help one to decide the sensitivity of the stock to the crisis events, before making an investment decision. For example, one may avoid stock if the stock's index fluctuates or change frequently at different time points.

The current research was taken up to study the behaviour of the stocks by estimating the tail index during each of the crisis periods, which was not considered in the previous studies. This fills the gap and contributes to the existing research. Also, this gives a process to the decision-makers, to study each of the stocks in association with the major events and take decisions appropriately. Also, motivates to study each of the stocks by associating their behaviour to stock-specific events. Academicians can consider this process before adopting any advanced methods for analysing the stocks.

Limitation and Scope for Future Work

The current study hasn't considered specific events related to individual stocks, and considering the events specific to each of the stocks and performing in-depth analysis, will give one a better understanding of the stock. Along with descriptive research, one can consider other research designs that answer the question "why the changes are happening?". After identifying the best probability model, one can build a predictive model for predicting the prices. One can also extend the current study by measuring the level of impact each of the crisis events has caused on the stocks.

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Conflicts of interest

No conflict of interest

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Appendix-1

List of Stocks Considered

Symbol	Date of Inclusion in NSE	Symbol	Date of Inclusion in NSE
ADANIPTS	27.Nov.2007	IOC	24.Jul.1996
ASIANPAINT	31.May.1995	ITC	23.Aug.1995
AXISBANK	16.Nov.1998	JSWSTEEL	23.Mar.2005
BAJAJ-AUTO	26.May.2008	KOTAKBANK	20.Dec.1995
BAJAJFINSV	26.May.2008	LT	23.June.2004
BAJFINANCE	01.Apr.2003	M&M	03.Jan.1996
BHARTIARTL	15.Feb.2002	MARUTI	09.Jul.2003
BPCL	13.Sep.1995	NESTLEIND	08.Jan.2010
BRITANNIA	05.Nov.1998	NTPC	05.Nov.2004
CIPLA	08.Feb.1995	ONGC	19.Jul.1995
COALINDIA	04.Nov.2010	POWERGRID	05.Oct.2007
Dr REDDY	09.Jul.2003	RELIANCE	29.Nov.1995
EICHERMOT	07.Sep.2004	SBIN	01.Mar.1995
GAIL	02.Apr.1997	SUNPHARMA	08.Feb.1995
GRASIM	10.May.1995	TATAMOTORS	22.Jul.1998
HCLTECH	06.Jan.2000	TATASTEEL	18.Nov.1998
HDFC	23.Oct.1996	TCS	25.Aug.2004
HDFCBANK	08.Nov.1995	TECHM	28.Aug.2006
HEROMOTOCO	11.Apr.2003	TITAN	24.Sep.2004
HINDALCO	08.Jan.1997	ULTRACEMCO	24.Aug.2004
HINDUNILVR	06.Jul.1995	UPL	23.Jan.2004
ICICIBANK	17.Sep.1997	VEDL	13.May.1998
INDUSINDBK	28.Jan.1998	WIPRO	08.Nov.1995
INFRADEL	28.Dec.2012	YESBANK	12.Jul.2005
INFY	14.June.1993	ZEEL	09.Sep.1998