

An Event Study on the Effect of PNB Scam on Banking Stock Prices

Dr. Nirmala Sawan, Asst. Professor, IIPS - DAVV, Indore

Dr. Navneet Kaur Bhatia, Asst. Professor, IIPS - DAVV, Indore

Ms Poonam Mangwani, Asst. Professor, IIPS - DAVV, Indore

Mr Himanshu Shrivastava, Student, IIPS – DAVV, Indore

Abstract

The stock market has become a crucial aspect of banks' earnings and growth, with any changes in a bank's operations having an impact on its stock price. This sensitivity is due to investors making rational decisions based on trends and public information. This study aims to examine the effect of the PNB Scam, a significant fraud case, on banking stock prices in both the short and long run. Using secondary data from 41 banks listed on the BSE Sensex, the study analyzes the stock prices in the aftermath of the scam. The data is filtered and processed using MS Office Excel to calculate returns and average returns. Additionally, Z-scores are computed based on cumulative average abnormal returns to determine if there is a direct impact of the scam on stock prices. The findings indicate that, in the short run, there was no significant and continuous impact of the PNB Scam on bank stock prices. However, certain days during this period did show abnormal returns, suggesting a potential for unusual stock performance. Moreover, in the long run, the study found no impact of the scam on bank stock prices.

Keywords: PNB Scam/fraud, Banking stock Prices, Banking Industry, Short Term Returns and Long Term Returns, Abnormal Returns.

Introduction

The objective of this study is to examine the effects of the Nirav Modi and Punjab National Bank (PNB) scam on the stock prices of the banking industry in both the short run and long run timeframes. The banking industry plays a vital role in the financial system by accepting and safeguarding money from individuals and entities, as well as providing various financial

services. The roots of banking can be traced back to ancient times, where practices such as keeping money safe and savings in temples were prevalent. The modern banking system emerged with the establishment of the Bank of Venice in 1157 and the rise of modern banking in England with the Lombard bankers. In India, the Bank of Hindustan became the first bank to be established in 1770, followed by the Bank of Bengal in 1806. During the pre-nationalization era, banking in India was primarily conducted by agencies of the East India Company. The Bank of Bengal, Bank of Bombay, and Bank of Madras, collectively known as Presidency Banks, were established during this period. In 1921, the Imperial Bank of India was set up to act as a central bank and regulator for other banks. The Reserve Bank of India (RBI) was then established in 1935 as the country's central bank. The nationalization phase of Indian banking began with the establishment of the State Bank of India (SBI) in 1955, which took over the functions of the Imperial Bank of India. As a result, several state-associated banks became subsidiaries of SBI. In 1969, the government nationalized 14 major scheduled commercial banks, followed by the nationalization of six more banks in 1980. To expand banking facilities in rural and semi-urban areas, the lead bank scheme and regional rural banks were introduced. The post-liberalization era brought about significant reforms in the banking sector. The Narasimham Committee recommended measures to enhance the viability and efficiency of banks, including self-regulation, flexibility, transparency, and improved technology. The focus shifted towards prudential banking, customer care, and customer services. Bank fraud, a criminal act, occurs when individuals or entities employ illegal means to acquire money or assets from banks or financial institutions. The Nirav Modi and PNB scam, which was uncovered in 2018, involved fraudulent transactions worth \$1.77 billion at a single PNB branch in Mumbai. The scam had a substantial impact on PNB, which was already grappling with significant bad loans. The case revolved around the issuance of fake letters of undertaking (LOUs) by PNB officials, which were utilized to obtain loans from other banks. The impact of such scams on the banking industry and stock prices can be profound. In the case under examination, the scam had adverse effects on PNB's stock price and raised concerns about the overall health of the banking sector. The main purpose of the study is to understand the impact of the PNB Scam event on the stock prices of the banking industry registered in BSE Sensex and represented by the Bankex Index.

Literature Review

Pooja Antil et al. (2017): The study highlights the significant changes in the Indian banking and finance sector during the 1990s, with increased reliance on information technology and the internet. It mentions that the banking system in India is dominated by nationalized banks. S. Gsyathri and T. Mangaiyarkarasi (2018): This study focuses on the internal operations and auditing processes of banks involved in the PNB scam. It suggests that identifying and addressing loopholes in internal operations and auditing is crucial. The impact of the scam on various banks and the overall economy is also discussed. Dawar G. and Goyal S. (2013): This study examines the impact of corporate scams on stock returns using event study methodology. The study concludes that the market is efficient and absorbs all information related to the events, as the abnormal returns and cumulative abnormal returns are found to be insignificant. Dr Pallavi(2000): The paper categorizes the Indian banking system into government-owned, private, and specialized banks. It mentions that all Indian banks operate under the Reserve Bank of India (RBI). The establishment of public sector banks since 1969 is attributed to customer demand and base. V.N. Limbore and S.B. Mane (2014): This study analyzes the performance of Indian banks and the impact of economic slowdown and global developments. The findings indicate that the banking sector's performance has been affected, leading to moderate business growth. Banks have been forced to consolidate operations, readjust focus, and strengthen balance sheets. S. Narayan (2018): The study focuses on the PNB scandal, where a large fraud case was revealed. It emphasizes the failure of institutional controls and oversight mechanisms, calling for stronger enforcement of ethical standards in institutional behavior. A. Yakkaldevi and A.R. Burla: This excerpt highlights the importance of the banking sector as the backbone of modern businesses, trade, commerce, and industry. It mentions that while the banking sector in India is mature in terms of supply, product range, and reach, there are challenges in reaching rural India. It emphasizes the need for a well-functioning domestic capital market and suitable capital adequacy ratios for banks to support growth.

Objectives of the study:

1. To understand the effect of a PNB scam over the banking stocks prices
2. To analyze the effect in long term and short term both the time frames

Research Methodology

The research design employed in this study is exploratory and descriptive in nature. It involves the study of secondary data derived from observation and analysis to address the research objectives and answer the research question. The data collection method used in this study is

secondary data collection. Historical daily stock price data of 41 banks registered in the BSE Sensex, as well as the market index Bankex, have been collected from the official website of BSE, specifically from the historical price section. Regarding the sampling design, the data collected consists of daily historical prices of 41 banks and the BANKEX index, which represents the entire banking sector registered in the BSE Sensex. Each bank's data, in cumulative form, serves as the sample for the study. By analyzing the collected data for individual banks and the index, it becomes possible to assess the overall performance of the banking industry in the BSE Sensex. The nature of the universe under study is the banking industry from the stock market, and the sample size consists of 41 banks. For data analysis, Microsoft Office Excel is utilized as the primary tool. The gathered data is filtered and adjusted to suit the specific tools and techniques required for the study. Various techniques and formulae are applied within Excel to analyze the data and derive meaningful insights. These analytical techniques assist in examining the impact of the Nirav Modi and PNB scam on the stock prices of the banking industry in both the short run and long run timeframes.

Average Return:

Share prices are volatile and varies between the peak and low value for each day. Following G.Dawar and S. Goyal (2013), to get a single price for each day average return is used by averaging the high/peak price and low price for the particular day.

$$\text{Average return} = (\text{H.P.} + \text{L. P.})/2$$

Where

H.P. = High price for the day

L.P. = Low Price for the day

AR (Abnormal Return):

To conduct an event study, the measurement needs to be done on the security's performance by comparing it with a standard benchmark. The benchmark represents the estimate of return generation of security if the event would have not taken place.

Following Brown and Warner (1980) and (1985), the difference between the benchmark and the actual return is the abnormal return for the security which is calculated as follows:

$$AR_{jt} = R_{jt} - R_{jP}$$

Where,

AR_{jt} is the abnormal return on the security of firm j in time period t ,

R_{jt} is the return of security j at a particular time t

R_{jP} is the mean return for security of a firm j over time t .

AAR (Average Abnormal Return):

Once the abnormal return has been calculated, the cross section average abnormal returns are then calculated as follows:

$$AAR = \sum_{j=1}^n AR_{jt} / n$$

Where AAR is the average abnormal return for time period t , and n is the number of firms under the study.

CAAR (Cumulative Average Abnormal Return):

It is calculated by summing up all the average abnormal return.

Z-score: Following G. Dawar and S. Goyal (2013)

- Calculation for Degree of freedom has been done by square root of $(n-1)$.
- The Degree of freedom is multiplied to AAR and CAAR to calculate Z-values.

Where,

n = number of days

The impact of event news on bank's share price can be tested if the Z-score lies in between -1.96 and +1.96 then the event has a significant impact on the bank stock prices for that particular day.

If the Z-score do not lie in between -1.96 and +1.96 then that the event does not have any impact on the stock prices of the banks for the particular day after the event.

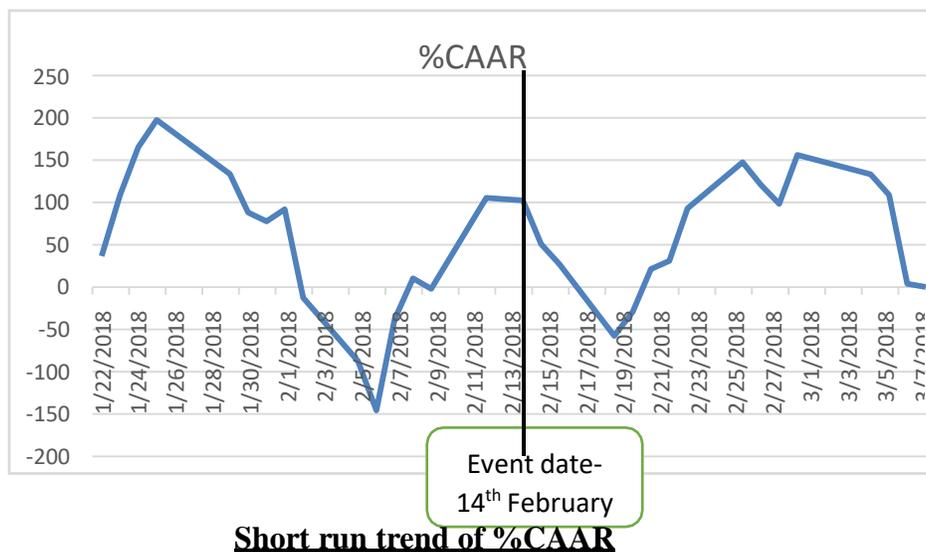
Pre and post event

Below are the charts representing the trend of %CAAR pre and post the event for the long run and short run, These charts are used for analysis purpose of price trend of whole market comprising all the 41 banks for long run and 40 banks for short run.

Note: Bandhan bank has started its operation from the last week of March 2018 and the data after the date is added into Long run studies.

Short Run:

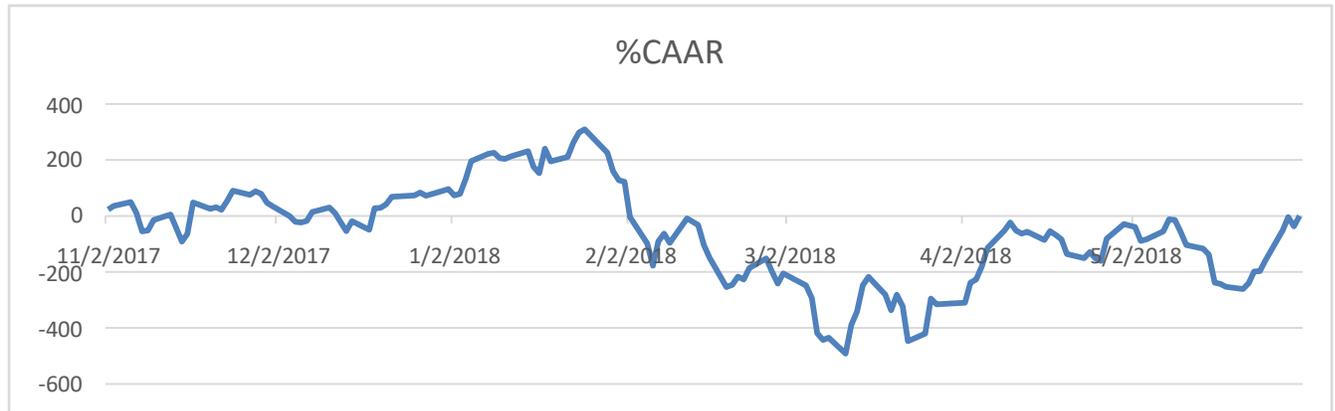
The data for short run is collected 15 days pre and post of the event date which is 14 February 2018, starting from 22 January 2018 - 8 March 2018.



The %CAAR has shown a high volatility which represents that the market was already showing the volatility in its trend because the news was not official but investors and researchers were getting insights regarding the event that CBI was investigating a scam related to PNB.

Long Run:

The data for Long run is collected 72 days pre and post of the event date which is 14 February 2018, starting from 02 November 2018 - 31 May 2018.



Long run trend of %CAAR

When we have a look at the long run trend of CAAR for the 144 days, we can see in the above chart that market was not showing much fluctuation in the month November, December and starting days of January and then from mid of January Market started showing positive return but when the insights of PNB scam started coming out from the start of February 2018, the market changed the trend and started falling down and reached at a negative peak of -500% which was a huge fluctuation. For short run it has shown the effect then again the market started repairing the trend and till the end of March 2018 it reached to the average growth then again started working as per the previous general trends and the volatility magnitude also reduced. The reason behind the trend can be the theory that “Market Averages Everything”.

Z-score Analysis

The table below represents the Z-scores of AAR and CAAR on the particular event day after the event.

Here there are two tables showing the results

1. Short Run
2. Long Run

Return depending on security mean

The calculation of AAR and CAAR is done on the base of average of security return

1. Short Run:

The event has impacted those days where the Z-values for AAR and CAAR in the significance column shows Yes and has no impact on the days where the values are No. In short run the event has impacted the share prices of banking stocks which results the volatility of market that the stock market reflect the change in price immediately when the event was reported in the stock market by Punjab National Bank.

Date	AAR	Z-Scores	Significance	CAAR	Z-Scores	Significance
15-02-2018	-0.446562354	-1.6708833	Yes	-0.44656	-1.67088333	Yes
16-02-2018	-0.172058285	-0.6437832	Yes	-0.61862	-2.31466649	No
19-02-2018	-0.77665957	-2.905994	No	-1.39528	-5.2206605	No
20-02-2018	0.353968559	1.3244291	Yes	-1.04131	-3.89623143	No
21-02-2018	0.572603226	2.1424851	No	-0.46871	-1.75374634	Yes
22-02-2018	0.163498742	0.6117563	Yes	-0.30521	-1.14199006	Yes
23-02-2018	0.687965887	2.5741326	No	0.382756	1.43214258	Yes
26-02-2018	0.613388397	2.2950892	No	0.996145	3.72723181	No
27-02-2018	-0.199507319	-0.746488	Yes	0.796637	2.98074377	No
28-02-2018	-0.154594442	-0.5784394	Yes	0.642043	2.40230434	No
01-03-2018	0.644001565	2.4096332	No	1.286044	4.81193755	No
05-03-2018	-0.158202998	-0.5919414	Yes	1.127841	4.21999613	No
06-03-2018	-0.179238376	-0.6706486	Yes	0.948603	3.54934754	No
07-03-2018	-0.979096226	-3.6634426	No	-0.03049	-0.11409509	Yes
08-03-2018	0.030493195	0.1140951	Yes	-4.5E-16	-1.7006E-15	Yes

2. Long Run:

The event not impacted the share price for any day, where the Z-values for AAR and CAAR has no impact on the days where the values are No.

In Long run the event has not shown any impacted on the share prices of banking stocks which results that a particular event has its impact only for short run. Market averages all the impact and does not let a particular event of a particular security effect the prices of the industry.

Date	AAR	Z-Score	Significance	CAAR	Z-Score	Significance
15-02-2018	-0.724695683	-6.106829182	No	-0.724695683	-6.106829182	No
16-02-2018	-0.450191614	-3.793652084	No	-1.174887297	-9.900481266	No
19-02-2018	-1.054792899	-8.888475821	No	-2.229680196	-18.78895709	No
20-02-2018	0.07583523	0.639044508	No	-2.153844966	-18.14991258	No
21-02-2018	0.294469897	2.481424138	No	-1.859375069	-15.66848844	No
22-02-2018	-0.114634587	-0.965996983	No	-1.974009656	-16.63448543	No
23-02-2018	0.409832558	3.453556413	No	-1.564177099	-13.18092901	No
26-02-2018	0.335255069	2.825110573	No	-1.22892203	-10.35581844	No
27-02-2018	-0.477640647	-4.024958218	No	-1.706562678	-14.38077666	No
28-02-2018	-0.432727771	-3.646488649	No	-2.139290449	-18.02726531	No
01-03-2018	0.365868236	3.083080074	No	-1.773422213	-14.94418523	No
05-03-2018	-0.436336327	-3.676897042	No	-2.20975854	-18.62108227	No
06-03-2018	-0.457371705	-3.854156913	No	-2.667130245	-22.47523919	No
07-03-2018	-1.257229555	-10.59435886	No	-3.9243598	-33.06959805	No
08-03-2018	-0.247640134	-2.086801445	No	-4.171999934	-35.1563995	No
09-03-2018	0.074480052	0.627624765	No	-4.097519881	-34.52877473	No
12-03-2018	-0.567099172	-4.778802823	No	-4.664619054	-39.30757755	No
13-03-2018	1.020835035	8.602321399	No	-3.643784019	-30.70525615	No
14-03-2018	0.466343972	3.929763957	No	-3.177440047	-26.7754922	No
15-03-2018	0.939095018	7.913518731	No	-2.238345029	-18.86197347	No
16-03-2018	0.295553387	2.490554433	No	-1.942791643	-16.37141903	No
19-03-2018	-0.63975326	-5.391040638	No	-2.582544903	-21.76245967	No
20-03-2018	-0.563899369	-4.75183888	No	-3.146444272	-26.51429855	No
21-03-2018	0.546427379	4.604606796	No	-2.600016892	-21.90969176	No
22-03-2018	-0.410209569	-3.456733395	No	-3.010226461	-25.36642515	No
23-03-2018	-1.25719604	-10.59407644	No	-4.267422501	-35.96050159	No
26-03-2018	0.274866493	2.316231156	No	-3.992556008	-33.64427044	No
27-03-2018	1.247851045	10.51532851	No	-2.744704963	-23.12894193	No
28-03-2018	-0.220001784	-1.853899987	No	-2.964706748	-24.98284191	No
02-04-2018	0.056873375	0.479257701	No	-2.907833373	-24.50358421	No

03-04-2018	0.715150767	6.026396563	No	-2.192682606	-18.47718765	No
04-04-2018	0.107435334	0.905330679	No	-2.085247271	-17.57185697	No
05-04-2018	0.456214335	3.844404044	No	-1.629032937	-13.72745293	No
06-04-2018	0.659289587	5.555668375	No	-0.96974335	-8.171784553	No
09-04-2018	0.621653655	5.238519797	No	-0.348089695	-2.933264756	No
10-04-2018	0.270626785	2.280504199	No	-0.07746291	-0.652760556	No
11-04-2018	-0.280495028	-2.363661411	No	-0.357957937	-3.016421968	No
12-04-2018	-0.123647982	-1.041950601	No	-0.481605919	-4.058372568	No
13-04-2018	0.060611453	0.510757549	No	-0.420994466	-3.54761502	No
16-04-2018	-0.297538211	-2.50728005	No	-0.718532677	-6.05489507	No
17-04-2018	0.316738125	2.669072926	No	-0.401794551	-3.385822144	No
18-04-2018	-0.136853436	-1.153229661	No	-0.538647987	-4.539051805	No
19-04-2018	-0.164773138	-1.388502001	No	-0.703421125	-5.927553806	No
20-04-2018	-0.530398228	-4.469533151	No	-1.233819353	-10.39708696	No
23-04-2018	-0.153542704	-1.293865947	No	-1.387362058	-11.6909529	No
24-04-2018	0.217660388	1.834169629	No	-1.169701669	-9.856783275	No
25-04-2018	-0.232284956	-1.957407201	No	-1.401986625	-11.81419048	No
26-04-2018	-0.103390378	-0.871244841	No	-1.505377003	-12.68543532	No
27-04-2018	0.798751537	6.730879334	No	-0.706625466	-5.954555984	No
30-04-2018	0.512164479	4.315881908	No	-0.194460987	-1.638674076	No
02-05-2018	-0.103594624	-0.872965975	No	-0.298055611	-2.51164005	No
03-05-2018	-0.507067739	-4.272932953	No	-0.80512335	-6.784573003	No
04-05-2018	0.05024622	0.423412323	No	-0.75487713	-6.361160681	No
07-05-2018	0.283113246	2.385724484	No	-0.471763883	-3.975436197	No
08-05-2018	0.420532958	3.543726011	No	-0.051230925	-0.431710185	No
09-05-2018	-0.022970812	-0.193569286	No	-0.074201737	-0.625279472	No
10-05-2018	-0.425055799	-3.581838858	No	-0.499257536	-4.20711833	No
11-05-2018	-0.479254908	-4.03856119	No	-0.978512445	-8.24567952	No
14-05-2018	-0.132069797	-1.112919136	No	-1.110582242	-9.358598656	No
15-05-2018	-0.215492183	-1.815898707	No	-1.326074425	-11.17449736	No
16-05-2018	-1.011230131	-8.521383279	No	-2.337304557	-19.69588064	No

17-05-2018	-0.041198205	-0.347166961	No	-2.378502761	-20.0430476	No
18-05-2018	-0.115337836	-0.971923087	No	-2.493840598	-21.01497069	No
21-05-2018	-0.079928407	-0.673536689	No	-2.573769005	-21.68850738	No
22-05-2018	0.200528396	1.689802618	No	-2.373240609	-19.99870476	No
23-05-2018	0.411616759	3.468591433	No	-1.961623849	-16.53011333	No
24-05-2018	0.006478378	0.054591674	No	-1.955145471	-16.47552165	No
25-05-2018	0.3981957	3.355495522	No	-1.556949771	-13.12002613	No
28-05-2018	1.061073025	8.941396875	No	-0.495876746	-4.178629255	No
29-05-2018	0.455889082	3.841663219	No	-0.039987664	-0.336966036	No
30-05-2018	-0.323874018	-2.729205304	No	-0.363861681	-3.06617134	No
31-05-2018	0.363861681	3.06617134	No	-1.66533E-15	-1.40334E-14	No

The above results for short run and long run represents that after PNB reported the Scam in the stock market the event effected the banking industry's stock prices immediately for the short run but when in long run it could not affect the industry because the market has its characteristic that any event of a particular security could not make a permanent change in the industries stock prices because there were only few banks involved in the scam, other banks were not involved in the scam so it mitigated the short run effect over Long run.

Return by considering market mean

This is also another method to analyze the impact of an Event over the stock prices of the Banking stocks for the same period but the difference here is that here the Expected return is considered to be the Average return of Market. In the previous method we have used the Expected return of Average return of security.

1. Short Run:

The table below shows the calculated values for Z-score for AAR and CAAR the short run period -15 days post the event.

Date	AAR	Z-Scores	Significance	CAAR	Z-Scores	Significance
15-02-2018	-0.650501918	-2.433955307	No	-0.650501918	-2.433955307	No
16-02-2018	-0.37599785	-1.406855131	Yes	-1.026499768	-3.840810438	No
19-02-2018	-0.980599134	-3.669065993	No	-2.007098902	-7.509876432	No

20-02-2018	0.150028995	0.561357097	Yes	-1.857069907	-6.948519335	No
21-02-2018	0.368663662	1.379413113	Yes	-1.488406245	-5.569106221	No
22-02-2018	-0.040440823	-0.151315703	Yes	-1.528847068	-5.720421924	No
23-02-2018	0.484026323	1.811060665	Yes	-1.044820745	-3.909361259	No
26-02-2018	0.409448833	1.532017252	Yes	-0.635371912	-2.377344007	No
27-02-2018	-0.403446883	-1.509560009	Yes	-1.038818794	-3.886904016	No
28-02-2018	-0.358534007	-1.341511414	Yes	-1.397352801	-5.22841543	No
01-03-2018	0.440062001	1.646561236	Yes	-0.9572908	-3.581854194	No
05-03-2018	-0.362142562	-1.355013392	Yes	-1.319433362	-4.936867586	No
06-03-2018	-0.38317794	-1.433720571	Yes	-1.702611302	-6.370588157	No
07-03-2018	-1.18303579	-4.426514602	No	-2.885647092	-10.79710276	No
08-03-2018	-0.173446369	-0.648976889	Yes	-3.059093462	-11.44607965	No

1. Long run

The table below shows the calculated values for Z-score for AAR and CAAR by taking the market return as the mean for the long run period - 72 days post the event.

Date	AAR	Z-Score	Significance	CAAR	Z-Score	Significance
15-02-2018	-0.811379478	-6.837291833	No	0.811379478	-6.837291833	No
16-02-2018	-0.536875409	4.524114734	No	1.348254887	-11.36140657	No
19-02-2018	-1.141476694	9.618938471	No	2.489731581	-20.98034504	No
20-02-2018	-0.010848565	0.091418143	No	2.500580146	-21.07176318	No
21-02-2018	0.207786102	1.750961487	No	2.292794044	-19.32080169	No
22-02-2018	-0.201318382	1.696459634	No	2.494112427	-21.01726133	No
23-02-2018	0.323148763	2.723093763	No	2.170963664	-18.29416757	No
26-02-2018	0.248571273	2.094647922	No	1.922392391	-16.19951964	No
27-02-2018	-0.564324443	4.755420868	No	2.486716833	-20.95494051	No
28-02-2018	-0.519411566	4.376951299	No	-3.0061284	-25.33189181	No

01-03-2018	0.279184441	2.352617424	No	-	2.726943959	-22.97927439	No
05-03-2018	-0.523020122	4.407359693	No	-	3.249964081	-27.38663408	No
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28-05-2018	0.97438923	8.210934225	No	- 6.477058606	-54.58055214	No
29-05-2018	0.369205287	3.111200569	No	- 6.107853319	-51.46935157	No
30-05-2018	-0.410557813	- 3.459667955	No	- 6.518411132	-54.92901952	No
31-05-2018	0.277177886	2.33570869	No	- 6.241233245	-52.59331084	No

Findings

Based on the analysis of abnormal returns in both the short run and long run, several findings can be observed regarding the impact of the disclosed scam on the stock prices of the banking sector: In the long run, the negative abnormal returns are found to be less significant compared to the positive abnormal returns. This suggests that over time, the event's impact on stock prices diminished. The stock market tends to exhibit a characteristic of not allowing trends to persist for a long time. While the initial disclosure of the scam had a negative effect on both the Punjab National Bank (PNB) and the overall stock market prices, the market eventually reversed the trend due to other factors such as the good performance of other securities and industry-wide factors that supported price recovery. However in the short run, the event news was considered negative for the banking sector. Most of the return values were negative, indicating that the

market quickly reflected the available public information. This led to changing trends and high volatility in stock prices. Short-term price volatility is often driven by immediate reactions from investors seeking to mitigate potential losses or gain profits. Consequently, the affected industry experienced a decline in stock prices. The %CAAR charts in the short run showed significant negative fluctuations throughout the study period, indicating that the event had an impact on the stock prices of the banking sector. Speculators in the market eagerly anticipate such events and information as opportunities to generate profits by taking advantage of the news. This can lead to sudden changes in trends until another event or news emerges to generate further profit opportunities. The significance of abnormal returns, as measured by Z-values, varied based on the estimation of security means. In the short run, for both AAR and CAAR, there were cases of both significant ("Yes") and nonsignificant ("No") abnormal returns. This can be attributed to the event's impact being specific to certain securities rather than the entire sector. Securities unaffected by negative news performed smoothly in the market, reducing the overall magnitude of the impact. In the long run, all abnormal returns were nonsignificant ("No") for the entire study period. This suggests that the market was not significantly impacted over time. Other market factors played a role in stabilizing the trend at a standardized level. In summary, the disclosed scam had a negative impact on the stock prices of the banking sector in the short run, with significant fluctuations and negative abnormal returns. However, in the long run, the market recovered, and the impact diminished, with positive abnormal returns outweighing the negatives. Other market factors and the tendency for trends to revert to a standardized level played a role in this recovery.

Conclusion

In conclusion, the PNB scam involving Nirav Modi had a significant short-term impact on the stock prices of the banking sector, leading to a decline in prices. However, the market's tendency to average out trends and incorporate all available information resulted in a stabilization of prices in the long run. While there were certain days with abnormal returns during the scam period, overall, the event did not have a continuous and significant effect on the stock prices of banks. This analysis aligns with the efficient market hypothesis, highlighting the market's ability to efficiently reflect and adjust to new information.

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