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CATASTROPHIC SHOCKS IN THE STOCK MARKET: EVIDENCE FROM NEPAL EARTHQUAKE

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Abstract: Many factors affect stock market price behaviors; they bring out over-or under-reaction in the market. This study intends to find the impact of major catastrophic event on stock returns. For this purpose, it uses daily data of stock prices with total 210 observations and the impact of catastrophic event (Nepal Earthquake 2015) is tested for different event windows using the event analysis methodology. The catastrophic event doesn't seem to have significant impact on stock returns and is resilient to shocks caused by earthquake. The study shows that Nepalese stock market is inefficient at a semi-strong level. Results also demonstrate the higher abnormal returns in the event window of (+2, +10).

Key words: Catastrophic event, earthquake, stock market

1. Introduction and Study Objectives

The importance of stock markets as financial channels for saving and investment is gaining significant role in Nepalese economy. In general, volatility in the Nepal Stock Market is less than the average volatility of other developing countries (K.C, 2009). The reason is mainly low volume of trading equities due to low demand. However, in recent years volatility has increased due to the increase in the volume of trading triggered by the speculative motives of investors. Not only the macroeconomic and fundamental factors are the signals of stock volatility, there are more other pieces of information, which can make investors react to market immediately after the new public information. Some of the events are unpredictable by the financial market, such as political risks (Beaulieu, Cosset, & Essaddam, 2006) and earthquake (Papadakis, 2006). Papadakis (2006) has concluded that the earthquake generated abnormal returns. This study examines whether this piece of findings also valid to our stock market. So, the occurrence of devastating earthquake Nepal-2015 is the considerable catastrophic event of the study.

Description of Event: On 25 April 2015, a 7.6 magnitude earthquake (as recorded by National Seismological Centre, Nepal) hit Barpak of Gorkha District, about 76 km northwest of Kathmandu followed by several aftershocks including one measuring 6.8 magnitude that struck back on 12th May with the epicentre near Mount Everest (NRA, 2016). The catastrophic earthquake has resulted in the huge loss of human, physical, infrastructure and natural resources. So far, 8,891 people have been killed and 22,302 injured. 608,155 residential buildings were completely broken down whereas 298,998 were partially damaged. Similarly, 2,687 government buildings were completely collapsed and 3,776 were partially damaged. Furthermore, 743 historical and archaeologically invaluable heritage sites/monuments were hit by the earthquake causing 133 fully collapsed, 95 partially collapsed and 515 partly damaged. It has been estimated to have damaged/destroyed properties equivalent to Rs. 706.5 billion (PDNA, 2015).

Generally, in the semi-strong form of market efficiency, announcement of new information immediately

influences the investors' psychology. Thus, the stock market immediately reacts to the announcement of any new event including mergers and acquisitions, announcement of dividend and earning, major changes in policies, unanticipated political announcement, business expansion, macro-economic changes, and natural calamities and pandemic. The investors perceive the different unanticipated events in different ways, viz., as good news, bad news and no effect-news. One of the major characteristics of a perfectly efficient market is that all available information is reflected in prices. However, empirical studies show that this extreme version of the market efficiency hypothesis is not valid. This study also tests the degree of market efficiency evaluated by the speed of adjustment of stock prices to new information.

Problem Statement

Economic liberalization and financial sector reforms in Nepal have guided in a change in the financial architecture of the economy. This leads towards widening the scope for a re-examination of the relationship between the stock market performance and the non-economic variables in Nepal. Knowing which force leads the other can help in reducing the shock factor because the public will be somewhat aware of what might happen in the economy or the financial market and thus will be able to take protective measures. This study is an endeavour in this direction. Nepalese stock market has passed through different stages. Major political changes occurred during this recent decade and the market has jumped to all time high 1881.45 points on July 31, 2016 from all-time low of 292.31 points on June 15, 2011. What factors are responsible for these changes in volatility? Every individual specially related with stock market in this or that way, tries to get answer to these questions. Graham (1973) pointed out that stocks do well or poorly in the future because the businesses behind them do well or poorly-nothing more, and nothing less. Indeed in some markets, prices exhibit common movements that are hard to explain by movements in fundamentals (Watanabe, 2008). If fundamentals are not influential, then what else is responsible for changing stock prices over time? Though there are many studies, the majorities of existing literature underlying theoretical constructs establish a link between macroeconomic volatility and stock market prices.

The stock price can also be affected by the events and unanticipated information. Kramer and Hyclak (2002) examined the impact of strikes on capital market and found statistically significant negative effects of the announcement of a strike on the cumulative average stock market returns of struck firms. Concurrently, the announcement of a strike had significant positive effects on the cumulative abnormal returns (CAR) of non - struck competitors in the same industries. The previous studies (Barrett et al., 1987; Bittlingmayer, 1998; Beaulieu et al., 2006) revealed that the stock market reacted immediately for a short or long period after the announcement of new unanticipated information. This paper basically deals with following research issues:

- Does Nepalese Stock market react immediately to any catastrophic events?
- How long is the market reaction to new catastrophic events?

Objectives of the Study

The major objective of this study is to examine the stock market efficiency. However, the specific objectives are as follows.

- To evaluate the impact of catastrophic events on stock returns.
- To assess the time duration of market reaction to the unanticipated events in the Nepalese stock market

Research Hypotheses

H_{01}: There is no significant relationship between catastrophic event and the stock prices.

H_{02}: The stock market is efficient and follows the efficient market hypothesis (EMH).

2. Review of Literature

The efficient market hypothesis (EMH) led by Fama (1970), generally believed that securities markets were extremely efficient in reflecting information about

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individual stocks and about the stock market as a whole. The accepted view was that when information arises, the news spreads very quickly and is incorporated into the prices of securities without delay. Thus, neither technical analysis nor even fundamental analysis help investors select "undervalued" stocks to achieve returns greater than those that could be obtained by holding a randomly selected portfolio of individual stocks with comparable risk. The three major forms of efficiency are "weak", "semi-strong", and "strong". There is evidence for and against the weak and semi-strong EMHs, while there is powerful evidence against strong EMH. The market is efficient in a semi-strong form if the security prices reflect not only the information that contains the past time series of stock prices but also all publicly available information. Studies of the semi-strong form of the efficient markets hypothesis can be categorized as tests of the speed of adjustment of prices to new information. The principal research tool in this area is the event study. Different form of disasters were studied in the past using event study methods.

Hill and Schneeweis (1983) examined the effect on the stock return of public utility firms of Three Mile Island nuclear accident. Their study indicates that the impact of the accident on non-nuclear firms was less than that on nuclear based utilities. Barrett *et al.* (1987) examined stock market reaction on total 78 fatal commercial aircraft crashes from January 1962 to December 1985. Using market model, the study found a significant decline in stock price on only one full trading day after the event. The market appears to assimilate the new information rapidly, even if the crash occurs in a remote geographic location. The study by Shelor, Anderson, and Cross (1990) examined the effect of California earthquake on the stock value of firms in the real estate industry. The findings showed that the earthquake transmits important new information to the market that was reflected in statistically significant negative stock returns among those firms operating in the area hit by the earthquake. Real estate-related firms operating in other areas were generally unaffected by the earthquake. Kalra, Henderson, and Raines (1993) investigated the market reaction in U.S. to the Chernobyl nuclear accident. According to this study, utility investors correctly interpreted that Chernobyl marked the start of a new era for nuclear power in U.S. and the stock market quickly recognized the consequences for utility stocks.

The study by Blose et al. (1996) conducted on the Challenger crash showed that on the day of explosion, there was a significant negative abnormal return on the stocks of NASA contractors, and any contagion effect was limited to narrow set of NASA contractors. Angbazo and Ranga (1996) examined the impact of Hurricane and a subsequent change in the regulatory environment on the stock prices of 48 publicly-traded property-liability insurers. Angbazo found that Hurricane and the related regulations had industry-wide contagion effect since they significantly affected most insurers, regardless of whether these firms had any loss exposure in the hurricane affected places. The results of the study by Bosch, Eckard, and Singal (1998) showed the clear evidence that the stock market imposes value losses on firms upon the release of negative product safety information, including airlines involved in crashes. However, air crash studies to date have produced little or no evidence of impacts on other airlines, and the source of the crash airline's stock reaction remains in dispute. Lamb (1998) examined the market efficiency around hurricanes. The observation indicate that the stock market showed an ability to discriminate by the magnitude of hurricane and by Property and Casualty firms based on their degree of loss exposure. The evidence on the speed and accuracy of price discovery was provided by Maloney and Mulherein (2003) by studying stock return and trading volume surrounding the crash of the space shuttle Challenger. They showed that price discovery occurred without large trading profits and much of price discovery occurred during a trading halt of the firm responsible for faulty component. Carter and Simkins (2004) investigated the reaction of airline stock prices after the September 11 attacks. Their study supports the hypothesis of rational pricing and

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suggests that the stock market differentiated among various airline firms.

Earthquake is an unanticipated and unpredictable event. Papadakis (2006) performed event analysis concerns the performance of the four stocks (*i.e.* PC producers- Dell computer, Gateway, Compaq and IBM) after Taiwan earthquake on September 21, 1999. The study found lower profitability after abrupt component price increases and decreased in share prices. It has indicated that stock market reacts immediately after the event. Dangol (2008) studied the reaction of Nepalese stock market to announcements of unanticipated political events and adjustment of stock prices using the event analysis methodology. His analysis covered the period from 2001 to 2006. He found that good-news (bad news) political events generate positive (negative) abnormal returns in the post-event period.

To sum up, the researchers have come to common findings that the new unanticipated informations and the disasters affect the stock prices.

3. Research Methods

The event analysis is more rigorously used in finance to test semi-strong form of market efficiency. The conceptual framework of the study is presented as following:

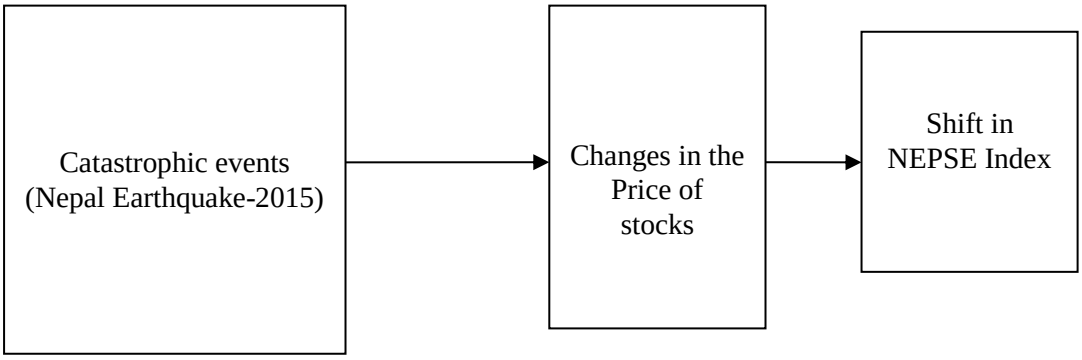

Figure 1: *Conceptual Framework of the Study*

Research Design

This study uses descriptive and causal comparative research designs to deal with the catastrophic event influencing stock prices in the context of Nepal. This study follows positivism research paradigm. From an ontological stand point, this paradigm assumes that there is universal single truth and reality is out there (Jennings, 2001). It studies of the nature of existence.

Nature and Sources of Data

Secondary data of daily stock prices are collected from Nepal Stock Exchange Ltd. (NEPSE). Data period covers from 15th June 2014 to 7th June, 2015 with total 210 days data. The data was classified in to pre event and post event period. Pre-event consisted the 200 days data from beginning period to the just one day ahead of event occurrence (*i.e.*, 25th of April, 2015). Dummy variable (D) was used to represent the event that takes value 1 for devastating event day, 0 otherwise

Methods of Data Analysis

Event Analysis

A measure of the event's economic impact can be assessed using security prices observed over a relative short time period (MacKinlay, 1997). The study determines whether there is an "abnormal" stock returns associated with an unanticipated event. From this determination, it can infer the significance of the event. However, the inference of significance relies on the

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following assumptions as suggested by McWilliams and Siegel (1997):

(1) The markets are efficient,

(2) The event is unanticipated, and

(3) There are no confounding effects during the event windows.

The study also tests the market efficiency using the catastrophic event (earthquake) happening in the country and its impact on stock prices. For this purpose, the estimated period starts 200 days before the announcement date and ends of 21 days before the announcement date (or day t = - 200 to day t = -21). The length of the estimation period use in this study is consistent with prior studies of capital market responses (Bosch & Hirchey, 1989; Hovav & John, 2003). The study confined to six separate events periods for a 21 days around the event announcement (*i.e.* –10 days to +10 days) for event analysis (Cheng & Leung, 2006, as cited in Dangol, 2008)**.** These six event periods, also shown in figure 2, are as under:

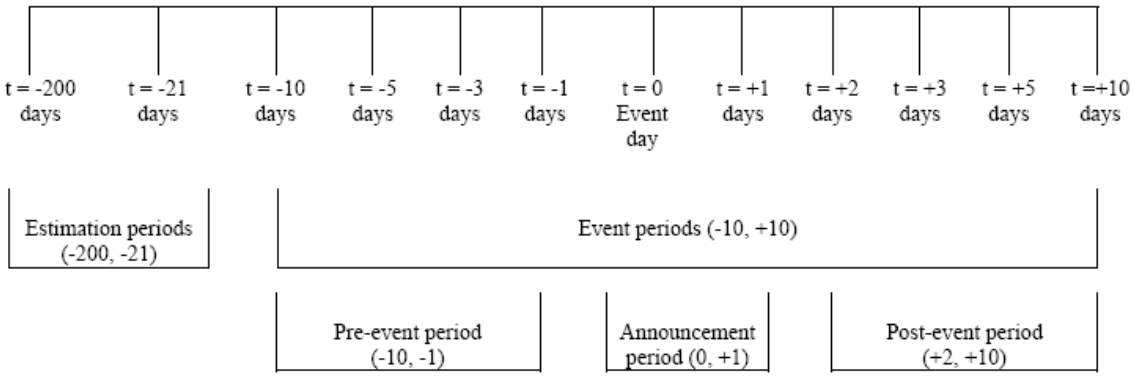

Figure 2: *The Parameter Estimation and Event Period*

Note: The figure shows the estimation periods, event periods as pre-event period, announcement period and post-event period.

(1) Ten trading days prior to the information announcement, $t - 10$, to one day prior to the date of announcement day (*i.e.* day $t = -10$ to $t = -1$);

(2) Announcement day, $t = 0$, to ten trading days after the announcement, $t + 10$; (*i.e.* day $t = 0$ to $t = +10$),

(3) Two trading days after the announcement, $t + 2$, to ten trading days after the announcement, $t + 10$; (*i.e.* day $t = +2$ to $t = +10$),

(4) Ten trading days prior to the information announcement, $t - 10$, to ten days after the date of announcement day $t + 10$ (*i.e.* day t = -10 to t = +10);

(5) Five trading days prior to the information announcement, $t - 5$, to five days after the date of announcement day $t + 5$ (*i.e.* day $t = -5$ to $t = +5$); and

(6) Three days prior to the information announcement, $t - 3$, to three days after the date of announcement day $t + 3$ (*i.e.* day $t = -3$ to $t = +3$). Event day $t = 0$, is the date when government makes the announcement of new information.

i) Test of Homogeneity of Variance: The catastrophic event; Nepal earthquake-2015, is measured by dummy variable. The event period (25th April, 2015) is denoted by value "1" otherwise "0". This study used stock returns as the dependent variable as it tries to check whether stock returns are affected by the event or not.

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NEPSE Index stock returns before and after the occurrences of events were investigated. This study uses percentage stock returns to solve the problem of unit root making data stationary.

$$SR_t = \frac{NI_t - NI_{t-1}}{NI_{t-1}} \text{ ---------- (1)}$$

Where; SR_t is the stock returns, NI_t is the current day returns and NIt_{-1} is the previous day returns

Fama (1991) titled studies which investigate the impact of publically available information on stock returns as an Event Study. This method compares the mean stock returns before and after the happening of an event or any publically available information. For this purpose Independent t-test has been used because it consists of two independent data groups i.e. before events data and after events data.

This study used Levene's test to find whether the data would consider t-value for equal variances assumed or equal variances not assumed. The data is homoscedastic when there are equal variances and heteroscedastic when equal variances are not there. The events are considered to have significant impact on stock returns if there is no equal variance between the groups.

ii) Dummy Variable Regression Model: The regression analysis (OLS) is the basic technique employed for fitting models of normal stock return as a function of general market performance during the event period. The method used to compute the abnormal return is based on dummy variable regression model, the most widely used method to assess the impact of events on market performance (Gujarati et al., 2012):

$$SR_{it} = \alpha_i + \beta_i D_{it} + e_{it} \text{ ..... (i)}$$

Where,

SR_{it} = the stock return on event *i* on day *t*.

$$= \frac{Price_{it} - Price_{it-1}}{Price_{it-1}}$$

D_{it} = the Catastrophic event dummy (takes value 1 if event happens, 0 otherwise)

α_i and β_i = independent coefficients to be estimated.

e_{it} = a random error term for stock return on event i on period *t*.

The model is estimated for each event windows considered in the study.

iii) Estimation of Abnormal Returns: The abnormal returns in the event periods are computed in comparison to the normal stock returns in the estimated period. This study uses running average method to calculate the expected returns [$E(R_{it})$] and actual returns (R_{it}). The abnormal return will be calculated by the formula:

$$AB_{it} = R_{it} - E(R_{it})$$

Where, AB_{it} = Abnormal return on event window (W_i)

To sum up, the event analysis has been made in a sequential order. First, it attempts to identify whether there is a significant impact on stock returns for the given event or not. For this purpose, Levene's test is performed. Second, the study intends to find which event window is statistically significant to influence the stock returns within a given event. For this purpose, dummy variable regression method is executed. Finally, in the third method, the study desires to know what is the level of abnormal returns in the given event and event windows. For this purpose, estimation of abnormal returns is carried out by using running average method.

4. Data Analysis and Discussion

The major objective of this study is to test the impact of catastrophic events on stock prices in Nepal. The results from the data analysis obtained by applying the tests defined above are presented below.

i) Test of Homogeneity of Variance

Levene's test was conducted to find whether the data would consider t-value for equal variances assumed or equal variances not assumed. It is an inferential statistic used to assess the equality of variances for a variable calculated for two or more groups. The statistical procedures assume that variances

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of the populations from which different samples are drawn are equal. The data is homoscedastic when there are equal variances and heteroscedastic when equal variances are not there. A value less than .05 means that the variability in two conditions is not the same. That the scores in one condition vary much more than the scores in other second condition. Scientifically, when $p < 0.05$ then it means that the event that we considered for testing has significant impact on stock returns. The catastrophic event, Nepal earthquake-2015, is assumed to have negative impacts on stock returns as bad news for market performance.

Description of the Catastrophic Event

Date of Events	Events Details
2072 Baisakh 12 (2015 April 25)	A 7.8-magnitude earthquake strikes Kathmandu and its surrounding areas killing more than 8,000 people, causing mass devastation and leaving millions homeless.

The impact of this event was estimated on six event windows. For this purpose, the equal variances (test of homogeneity) on two groups are tested using Levene's test. Table 1 summarizes the impact of catastrophic events on stock returns.

Table 1: ***Empirical Results for Catastrophic Event***

Test	Levene's test value	P-value
Window 1 (-10, -1)	0.671	0.413
Window 2 (0, +10)	1.519	0.218
Window 3 (+2, +10)	0.072	0.788
Window 4 (-10, +10)	0.112	0.738
Window 5 (-5, +5)	1.195	0.274
Window 6 (-3, +3)	3.205*	0.074

Note: Test of Homogeneity of Variance on stock returns at catastrophic event and different event windows

The catastrophic event doesn't seem to have significant impact on stock returns. Only event window 6 shows the weak influence on market returns at 10% level of significance. This means the impact is very short and is adjusted with in maximum 3 days of the event happening. Levene's values for rest of all five event windows are insignificant i.e greater than 5%. This means that the data considered is homoscedastic. Thus P- values for "equal variances assumed" would be interpreted.

ii) Dummy Variable Regression Results

Here, the impact of catastrophic event i.e., Nepal earthquake-2015, on stock returns has been analysed using dummy variables for the different event windows. Table 2 summarizes the results of regressing using dummy variables for each event.

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Table 2: ***Impact of Catastrophic Event, Nepal Earthquake-2015 on Stock Market***

	Coefficient	*Std. Error*	*t-ratio*	*p-value*
const	0.016	0.085	0.183	0.855
W1 (-10, -1)	0.147	0.531	0.278	0.782
W2 (0, +10)	-2.834	1.195	-2.372	0.0187**
W3 (+2, +10)	0.706	1.173	0.602	0.548
W5 (-5, +5)	-0.424	0.981	-0.432	0.666
W6 (-3, +3)	0.020	1.070	0.019	0.985

Mean dep. var	-0.044	S.D. dep. var	1.227
Sum sq. resid	272.240	S.E. of regression	1.173
R-squared	0.110	Adj. R-squared	0.087
F(5, 198)	4.877	P-value(F)	0.0003
Log-likelihood	-318.897	Akaike criterion	649.794
Schwarz criterion	669.702	Hannan-Quinn	657.847
rho	0.109	Durbin-Watson	1.755

Model: OLS, using observations 2014/06/15-2015/05/27 (T = 204)
Dependent variable: Stock Returns (SR)

The results show the significant impact of catastrophic event only in the event window (0, +10). It implies that the effects of the event starts form the happening date and last up to 10 days, which is the total length of the event considered for the study. Further the negative coefficient implies that the stock prices were negatively hit by the devastating event. As it being a natural calamities, no signalling effect has been documented.

iii) Estimation of Abnormal Returns in Event Windows

The primary hypothesis addressed in this section is whether or not, the unanticipated catastrophic events on stock market received any abnormal returns. The abnormal returns of stocks over the 6 event window are given in Table 3.

Table 3: ***Averages of Daily Abnormal Stock Returns***

Estimated period	Event Windows: Abnormal Returns in Percent					
(-200, -21)	(-10, -1)	(0, +10)	(+2, +10)	(-10, +10)	(-5, +5)	(-3, +3)
0.0235	-0.0430	-0.0946	0.6004	-0.0700	-0.7995	-1.7429

The cumulative running averages of stock returns on each event windows have been estimated. The results show that the positive and highest abnormal return (0.6004) was observed for the post-event period (+2, +10) compared to the normal average expected return (0.0235). This suggests that the buying stocks starting from 3rd days of event happening turns out to be profitable. The excess return to this window (+2, +10) is found to be 24.5% compared to the normal average return. At that time general mass sentiment was supposed to be weak and people go on discounting the price of stocks longer. It further, reflects the existence of semi-strong form of market efficiency in Nepali stock market.

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Conclusion and Implications

The results of Levene's test found the weak impact of catastrophic event; Nepal earthquake-2015, on stock returns. Only event window (-3, +3) shows the weak effects at 10 percent level of significance. However, in regression analysis, the results documented the significant impact of the event on stock returns for the event window (0, +10). People were going for discounting the stock prices in the market comparatively for longer periods. It is one of the behavioural aspect of overreaction to bad information. The abnormal returns for the investors was positive and higher for the window period (+2, +10). This further supports our claim that market adjusts the effects within this frame. It is noteworthy that investing in the stocks at the time of low market confidence will turn to be much profitable for the investors. For natural calamities, like earthquake, no signalling effects have been observed. In general, the market attempts to adjust the influences of unanticipated events in as many as 3 to 10 days from the happening date. Thus, it shows that Nepalese stock market is inefficient at a semi-strong level.

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