

Influence of the Climate Change On The Stock Market



N. Deepika, M. Nirupama Bhat, P. Victor Paul

Abstract: *The parameters of the natural climate are rainfall, humidity, maximum temperature, minimum temperature in a day, carbon dioxide emissions, solar radiation intensity etc, if there is an abrupt changes in the parameters it will cause natural calamities. The risk of business not only effected with right decisions at right times and also effected with climate changes; as the action of purchasing the goods by the people are influenced by the climate. Bankers are at high risk, they face difficulties in collecting the loans. Climate physical changes may damage properties of the governments and individual people. People get financial losses so they change their purchasing behavior. Both the weather and climate have a great influence on the behavior of tourist; better the climate more the tourism business. While the floods caused to downfall the finances of people living in the state, they could also have an impact on the portfolios of thousands of others in the form of stocks of companies with links to that particular state. Here we considered the real time scenario: remarkable heavy rainfall during the monsoon season causes the severe floods which was happened from 9th August 2018, affected the India's south state Kerala. Due to the intense flooding the red alert was announced by the Kerala State Disaster Management Authority. Because of this, a major damage was happened to various sectors like tourism, transportation, business, finance etc. All the operations of Cochin International Airport, Kerala which was India's fourth busiest international traffic were suspended for more than 15 days in August, for the reason runway flooding .In this paper, it is aimed to examine the effect of rain fall at flood time in Kerala on related stocks and gold rates of Kerala.*

Keywords: *Climate change, purchasing power, rainfall, banker's risk, customer behavior, severe floods.*

I. INTRODUCTION

A common place, where people can trade their company shares and derivatives through economic transactions, at an agreed price is known as stock market. The decisions made by government can also affect the energy related enterprise's stock. Furthermore, people's dread will also affect securities exchanges. After the catastrophic events, panic buying and panic selling can occur.

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This sort of activities can cause a shock to a securities exchange .In today's increasingly interconnected economy, there are many fluctuations due to several macro factors. Floods, natural disaster s, typhoons, and hurricanes are the Natural disasters which cause serious smash up and so causes to drop the economy. Natural calamities destroys the physical assets of firms such as buildings and equipment, as well as human capital and caused to their production capacity get worse; as the result that company share prices fall down . The economic dropdown from a cataclysmic event isn't just downgrade the geographic zone it hits, even natural disasters that happen thousands of miles away can shakeup your portfolio here at home. These undesirable impacts may sometimes be incurable to the small firms and result in being forced to close forever, as they couldn't afford the cost to renovate. Large firms are also affected, that effect passed on to consumers in terms of hike in product& service rates to recover from damage. As an example we can consider the scenario U.S. oil refineries were hit hard by Hurricane Harvey, the costliest disaster in U.S. One more impacted thing by the natural disasters is the commodity prices and Commodity Scarcity. As natural disaster in Chile, blocked copper production and drive up copper prices in worldwide copper market. These price jumps are also extended to non market-traded staple and regular commodities. The scarcity rules, during the time of natural disaster strikes, as a result regular needs like food, merchandise and even housing are gets commoditized. The investors are always need to predict their gains and losses with respect to all the world wide occurring real time events like financial crises, news, political issues. And they also in need for react and incorporating environmental issues into the process of stock valuation to make right investment decisions which returns good derivatives. Whatever may be the reasons for climate changes as consequences we all are going to get effected severely in terms of economy. Natural disasters prompt to the shut-down of the manufacturing units and destruction of transportation systems- harbors, roads and rail ways, resulting in delivery delay or cancellation of the products, as the material or parts of the product cannot be delivered on time to finish the assembling process. Or, end products stored in stock rooms are destroyed by disasters. For instance, Japan trades cars to everywhere throughout the world. If any of the circumstances above occurred, it will cause the overseas partners to adjust their strategies and there is the effect on the stock price of these overseas partners and on their own domestic securities exchange. These days, many corporations list their stocks on overseas markets because of the process named economic globalization.

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From 1995 Japan, as one of the most progressive economy in the world including New York, London and Frankfurt has just had 121 Japanese corporations listing their stocks on overseas stock trades. This number is growing rapidly since the fast development of economic globalization. The formation of the world wide industrial chain will connects the world's economy more intently. One product will be made in an overseas factory and parts of this product will come from anywhere in the world. If one or some of the connections has an issue, at that point the entire chain will be affected. Under this condition, this cataclysmic catastrophic event may affect worldwide securities exchanges, instead of just one single country's stock market, such as Japan's.

In our work, we considered the stock market perspective, during Kerala flood time, investors will be worried about the some companies having momentous exposure to the Kerala namely South Indian Bank, Federal Bank, Geojit Financial Services, Manappuram Finance, Mutooth Finance, Cochin minerals & retiles, Kerala Ayurveda, Kitex Garments Industries. The South Indian Bank and Federal Bank are the two leading Kerala based banks and are headquartered in Kerala. Almost 50% of these banks branches are expanded in Kerala state. On the other hand and construction and material industries. This sort of stocks exhibits a positive impact as there is a requirement for reconstruction after the disaster. As an example we can consider the cement industry, gives the short term pain but long term gains from reconstruction after disaster. The major cement industries are Kerala-based Malabar Cements, Chennai-based Cements. Here in this paper, we considered how the recent major damage by floods in Kerala affected the stock market with most representative stocks.

II. LITERATURE SURVEY

Sveltana Vlady et.al^[1], analyzed Australian capital market, whether it includes climate change information for stock assessment after introducing reduction policies of greenhouse gas. The author given descriptive statistics for the data considered the Oil and Gas index, S&P/ASX 200 index, All Ordinaries index for Caltex Limited refining factory in Australia. The regressor model namely AR(p)-GARCH(1,1) has been applied to study the market's response to climate change. Author concluded that the investors are rational and in the process of stock valuation they incorporate climate information for weather/climate-sensitive refining company.

TU Danni et.al^[2], investigated climate change risks and their consequent impact on stock market performance, then tried to figure out the association. For their study, they considered 5 sectors namely aviation and cement/construction, automobiles, electricity, gas production and oil returns. And also they focused on other sectors like chemicals, mining, pharmaceuticals, raw materials, paper, packaging etc..

Mark Allen et.al^[3] studied the influence of the climate change on markets and gave important remarks. In March 2015 the CO₂ level is 402 ppm, by the year 2100 it can reach 450 ppm. Economic and population growth increasing CO₂ levels. The temperature changes have to be kept below 2⁰ C. to decrease the carbon emissions decarbonization of electricity generation has to be done. The energy sector units

are getting negative reputation in markets due to their high carbon emissions. Some companies are getting legal problems of the greenhouse gas emissions. Re-insurance and insurance Industry greatly affected by climate change. Bank of England gave noticeable instructions for risk of climate changes, saying fossil fuel based assets may be useless may become uneconomic if strict environment regulations are followed.

Timothy K.M. Beatty et.al^[4] felt that the climatic changes may be critical corporate strategy in future. The green markets may emerge as profiting making businesses. There exists a strong relation between the climate and business.

Eoin Campbell^[5] noticed that the climate change influences physical capital rather than the human capital. Population will decreased the extreme climatic conditions, high risk cities faces the problems of investments. Climatic changes will make changes in property demands, the hot climate will demand the refrigeration's etc. the cost of living will increase. Urban life styles will be influenced by the available water facilities.

Deb Clarke^[6] concluded that all the investors had greatly influenced by the global political and physical climates. The investor has to face long term risk based on the climate changes. Global warming to CO₂ is a dangerous indication of climate change. Deb Clarke gave clear instructions to reduce the use of fossil fuel by 40%, carbon emissions by generation of electricity should be reduced by 90% so that humans are safe by 2050.

Paolo Venturi et.al^[7] felt that the investors should invest by keeping the point of social responsibility for better and cleaner environment. The development of the forest areas by constructing houses and industries will raise the CO₂ levels. The energy sectors should be restricted to green methods like solar energy.

Michael P. Vandenberg et.al^[8] gave remarks as there exists a great disconnect between people and environment. The energy needs of the population will greatly pollute the environment. More CO₂ emissions takes place by using more energy. There exists a clear gap between the government rules and practices of private power producing agencies. The power producing companies faces a risk always from government regulations.

Keith Wade^[9] stated that the global economic is depends on the climate to a great extent, proper care has to be taken for saving economy by following the environmental procedures for clean environments. A government has to take plies to save environment.

Erik Thedéen^[10] mentioned that, final system has a risk from environment, as global temperature increases the sea levels increases, increases extreme weather conditions, such changes has negative implications, the rise in 2 – 3⁰ C could decrease the global GDP by 3%.

III. ARCHITECTURE

The Architecture for analyzing the floods impact on securities can be depicted using the following architecture:



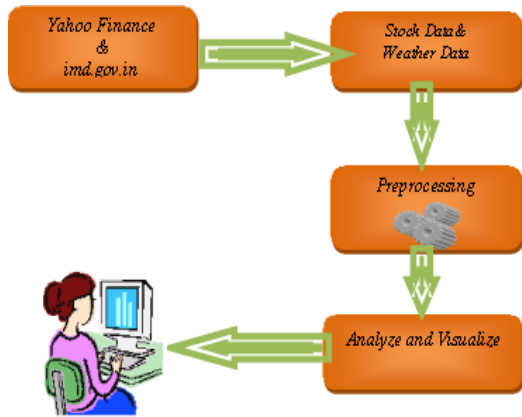


Figure 1: Proposed Architecture

Data collection: From India Metrological Department website the rain fall information and from yahoo finance some Kerala related company stocks data are retrieved for the monsoon period i.e. from June to September.

IV. METHODOLOGY

As the next step after gathering data we adopted the exploratory analysis, where we analyze the variables with plots and descriptive statistics. To do this make a scatter plot to view the overall pattern of our data. Correlation is a statistical measure which determines co-relationship or association strength of two variables.

We can find various relationships in data as Monotonic Relationships, Linear Relationships, and Non Linear Relationships.

- **Monotonic Direct Relationships(positive correlation)** are the relationships when One variable raises and the other raises. Or One variable drop off and the other decreases.
- **Monotonic inverse relationships (negative correlation)** are the relationships where *increase* in the one variable causes a *decrease* in the one variable (image b), this is called a Linear Relationships are the monotonic relationships, where the increasing or decreasing rate is constant. but not all monotonic relationships are linear.
- Monotonic variables raise (or drop off) in the same direction, but not always at the fixed rate.
- Linear variables raise (or drop off) in the same direction at the fixed rate.

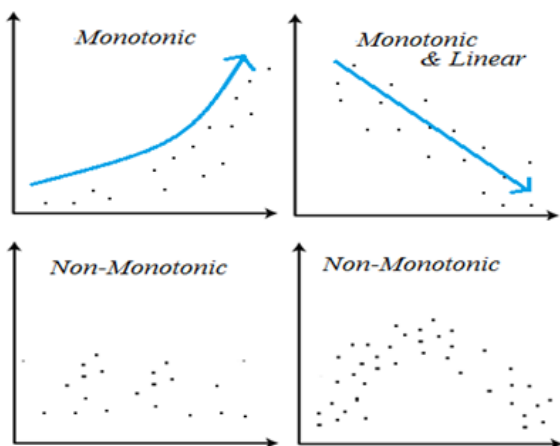


Figure 2: Types of Relationships

Correlation:

The extent to which two factors will in general change together measured by a correlation coefficient, by describing the direction and strength of the association.

Two correlation analyses:

- i) Pearson product moment correlation
- ii) Spearman rank-order correlation

Pearson product moment correlation

When a change in one variable is connected with a proportional change in the other variable that relationship is known as linear. To estimate the linear relationship between two continuous variables the Pearson correlation can be used.

Ex: to assess whether increasing years of experience are associated with hike the amount in terms of salary.

Spearman rank-order correlation

Rank-Order Spearman Correlation can be exercised to measure the strength and direction of a monotonic association of connecting two variables .When the variables tend to change collectively, but not essentially at a steady rate that relationship is known as monotonic .To assess monotonic relationship of connected two continuous or ordinal variables the correlation by Spearman can be used. This coefficient calculation utilizes the each variable ranked value rather than the actual or raw data.

$$\rho = 1 - \frac{6 \sum d_i^2}{n(n^2 - 1)} \quad \text{-----} \quad (1)$$

Ex: to identify or judge the students in which order they complete a test exercise, with the quantity of hours they have been practiced that exercise.

A scatter plot is good way of analysis to examine the association of connecting variables. Only linear or monotonic relationships are measured by Correlation coefficients. Both the correlation coefficients can range in value from -1 to +1.

Comparison of Pearson and Spearman coefficients

Case 1: when one variable raises, the other variable also raises with the steady quantity; it forms a positive slope perfect line. Then both the correlation coefficients can be taken as +1.

Case 2: When one variable raises, the other raises, but the quantity is not steady, then use correlation coefficient calculation by Spearman.

Case 3: When a there is no relationship i.e random existence between variables, then two correlation coefficients are nearly zero.

Case 4: when one variable drop offs, the other variable also reduces with the steady quantity; it forms a perfect line with negative slope. Then both the correlation coefficients can be taken as -1.

Case 5: When one variable drop offs, the other variable also decreases, but the change quantity is not steady, and then use correlation coefficient calculation by Spearman.

When the data is normally distributed, and if there exists monotonic linearity and homoscedasticity relationships in it we need to use Pearson correlation.



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A straight line relationship between each of the two variables is known as Linearity and equally distributed data about the regression line is known as homoscedasticity. When the data with highly skewed, has high kurtosis, or is heteroscedastic data is ordinal data and there exists monotonical relationship between variables then Spearman correlation need to be used.

The least squares model is the best option for finding the amount of one changeable factor will change in response to a change in some other factor. As an extension to it, there is a need to forecast and analyze the size of the errors of the model. And here the standard tools ARCH/GARCH models came into existence. The fundamental assumption of the least squares model is ,homoskedasticity of data i.e., the expected value for summation of squared error terms is same at any given point. Where, in the case of heteroskedastic data i.e. , Data in which the variances of the error terms are not equal and expected to be larger at some points, the ordinary least squares regression gives the unbiased regression coefficients, but the too narrow estimated confidence intervals and standard errors, giving a false sense of accuracy. When the variable quantity is regressed against one or more lagged values of itself the model is termed autoregressive. A data can be a stationary or non stationary ,if it is stationary it is easy to predict the future statistical properties as they are same or proportional to current statistical properties i.e., the mean, variance and covariance of the series should not be the function of time. ARCH (p) can also be referred as AR (p), is a functional model on the time series data variance i.e., at time t, the variance of time series is conditional on the past observations of different periods.

$$\sigma_t^2 = c + \alpha_1 x_{t-1}^2 + \alpha_2 x_{t-2}^2 + \dots + \alpha_m x_{t-m}^2$$

$$= c + \alpha(L) x_t^2 \text{ ----- (2)}$$

Since σ_t^2 cannot be negative, it follows that $c > 0$ and $\alpha_i \geq 0$ for $i=1,2,\dots,m$.

In order to reflect the degree of autocorrelation displayed by the data as in eq(2), it may be necessary for m to become relatively large .

The ARMA model with the time series variance, is known as GARCH model i.e., it consists both autoregressive and a moving average terms. The residuals variance given by squared errors or simply squared time series is modeled by AR(p) models. The variance of the process modeled by MA(q) portion models.

$$\sigma_t^2 = c + \alpha_1 x_{t-1}^2 + \alpha_2 x_{t-2}^2 + \dots + \alpha_m x_{t-m}^2 + \beta_1 \sigma_{t-1}^2 + \beta_2 \sigma_{t-2}^2 + \dots + \beta_m \sigma_{t-r}^2$$

$$= c + \sum_{i=1}^m \alpha_i x_{t-i}^2 + \sum_{i=1}^m \beta_i \sigma_{t-i}^2$$

----- (3)

The GARCH (1,1) represents the most popular model expressed as:

$$\sigma_t^2 = c + \alpha_1 x_t^2 + \beta_1 \sigma_{t-1}^2 = c + \alpha_1 (x_t^2 - \sigma_{t-1}^2) + (\alpha_1 + \beta_1) \sigma_{t-1}^2$$

----- (4)

V. RESULTS

In Kerala, the monsoon time rainfall caused severe floods and majorly affected all the Kerala related stocks. Figure 1 shows the multi collinear relationship among the rainfall and various stocks. As per total monsoon period

analysis south Indian bank, Nifty, Manappuram, Federal bank stock values are majorly affected. Kerala Ayurveda also majorly affected stock in the particular 2 weeks of floods. Mutooth finance gained after flood period in terms of gold finance as getting the gold finance is the fastest and easy way of renovating money.

Table-1: descriptive statistics

DATA	83
MEAN	0.000221
SKEWNESS	-0.284
KURTOSIS	2.743
JARQUE-BERA	1.344
R-squared:	0.945
Adj. R-squared:	0.939

R-Square values range from 0 to 1, a better fit indicated by higher value. Constant coefficient or Y-intercept is the expected output (i.e., the Y), if all the independent coefficients are zero. The level of accuracy of the coefficients is reflected by std.err. The lower value it is, the level of accuracy is high. $P > |t|$ is your p-value, is considered statistically significant is less than 0.05. The range in which our coefficients are likely to fall is mentioned as Confidence Interval.

Table-2: ARCH Model Results

COEFFICIENT	VALUE	STANDARD ERROR	P-VALUE
Omega	1.1082e+04	5724.915	5.289e-02
alpha[1]	0.8843	8.383e-02	5.181e-26

Table-3: GARCH Model Results

COEFFICIENT	VALUE	STANDARD ERROR	P-VALUE
ω	2217.71	3892.057	0.569
α	0.9570	0.195	8.929e-07
β	0.0294	0.248	0.906
$\alpha + \beta$	0.9864	-	-

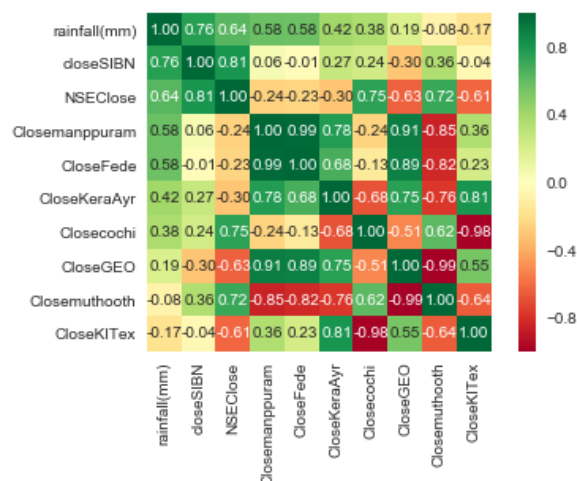


Figure 3: correlation matrix



VI. CONCLUSION

The impact of natural calamities has a drastic effect either positively or negatively on the stock market. The systematic risk by these abnormal effects increases uncertainty on their macro and microeconomic impacts. By considering the collective abnormal return of each stock in the business sectors, the effect was felt contrastingly crosswise companies and industries. For the natural disaster, some companies demonstrated a positive effect and some other had negative effect, or else the natural disaster had no significant impact on the rest of the companies. This can be viewed as the motivation behind why generally speaking the catastrophic event had no critical effect on worldwide financial exchanges. Besides, extraordinary cataclysmic events have different properties so the impacts will fluctuate by enterprises and organizations. So our forecast is that it is hard to make sure what effect a catastrophic event will have on a particular securities exchange or worldwide markets in general. Everyone who lives in areas susceptible to flooding and effected by natural disasters must need to prepare their Finances for a Natural Disaster by taking Insurance, Flood insurance. And you must know what you own and requires ownership proofs of damaged items .For this, save receipts for high-ticket items and remember to have insurance for the valuables which may not cover under homeowner's policy like expensive ornaments.

The outcomes discovered that prices of various stocks affected differently, even though the financial centre is located in Kerala, the uncertain changes in climate in Kerala are going to affect the share holders and traders around that state. This work can be further extended by including grouping of location wise stocks as an indicator, to analyze the stock market trend.

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