

**Project-Oriented Dissertation**

On

**“An Econometric Analysis of the Impact of Exchange  
Rate Fluctuations on the Indian Equity Market”**

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Under The Guidance of:

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## **DECLARATION**

I, **Jaishree Joshita**, a student of Master of Arts in Economics course, Roll No. **19439ECO010**, certify that the work entitled “**An Econometric Analysis of the Impact of Exchange Rate Fluctuations on the Indian Equity Market**” is a record of original work done by me in partial fulfillment of the requirement for the award of the **Degree** of “**Master of Arts**” in “**Economics**” under the supervision of Assistant Prof **Dr. Preeti Singh** at **Banaras Hindu University, Varanasi**.

I declare that I have faithfully acknowledged, given due credit to and referred to the research workers whenever their work have been cited in the text and in the body of dissertation. I further certify that I have not wilfully lifted up some other’s work, para, text, etc. or available at websites & included them in this project-oriented dissertation and cited as my own work. Moreover, this work has not been submitted to any other university or institute for the award of any respective degree or diploma.

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### **CERTIFICATE OF APPROVAL**

This is to certify that the dissertation titled “**An Econometric Analysis of the impact of exchange rate fluctuations on the Indian Equity Market**” submitted to the **Banaras Hindu University**, Varanasi in partial fulfillment for the degree of “**Masters of Arts**” in “**Economics**” is a bonafide research work carried out by **Jaishree Joshita**, Roll No. **19439ECO010**, under the guidance of Assistant Prof. **Dr. Preeti Singh**, during the academic year 2019-2021.

All help received have been duly acknowledged. No part of this dissertation have been submitted anywhere for the award of any degree or diploma.

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## **Abstract**

*Indian Economy has witnessed both good and bad days while undergoing slow but steady process of economic reforms since the period of economic liberalization. The reforms in Indian Capital Market is also in tandem with the macro-economic reforms over the period. In this process, it has transited from an administered exchange rate pricing system to one that is determined by market forces. As the Indian Capital market has opened for global investors, it has considerable influence from the global markets and global capital flows. The equity market and exchange rate market has both increased their efficiency over the years. In this context, the study on “**An Econometric Analysis of the Impact of Exchange Rate Fluctuations on the Indian Equity Market**” is an attempt to understand the interrelationship between exchange rate fluctuation and share price movement and to establish an empirical relationship between these two variables. The study is in-depth as it covers the period from January 1991 to February 2021 divided into four phases – Economic Liberalization and its aftermaths, Global Financial Crisis, Consistent Equity Market Growth, Coronavirus Pandemic. This bifurcation is performed in order to account the nature of economic periods (growth and stress), major economic reforms and shift in the level of considered variables.*

**Keywords:** *Indian Economy, Capital Market, Equity Market, Exchange Rate, Linear Relationship, Share Prices*

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# **Chapter 1:**

## **Introduction**

- ❖ **Relevance of the Study**
- ❖ **The Scope of the Study**
- ❖ **Objectives**
- ❖ **Chapter Schemes**

## 1 Introduction

The impact of macro-economic factors movement on the capital markets is well known and Indian capital market is not an exception. The individual share price in a capital market is influenced not only by the company specific factors (i.e. revenue, profit, competitor, sector etc.) but also with the overall capital market. In Indian equity market, the overall capital market is represented by SENSEX and NIFTY indices. The SENSEX index belongs to Bombay Stock Exchange (BSE) and NIFTY index belongs to National Stock Exchange (NSE). The indices comprise a pool of companies that are chosen based on the liquidity, market capitalization, revenue, diversification of the company etc. A particular index represents overall health of the capital market and which is affected by the macro-economic environment in the economy.

The share price movements are reasonably judged with respect to both technical and fundamental analysis. There are many macro-economic factors taken into account to judge the price movement such as Inflation, Credit Policy, Monetary Policy, Interest Rate, Exchange Rate etc. However, the impact of these factors has not been quantified to any reasonable extent. A little literature is available on that assess the impact of macro-economic factors into share price movement especially for Indian capital market. In a perfect market situation where the information is readily available and there is no cost of transactions, the investor is expected to react rationally in tandem with the changes in macro-economic factors. However, the market realities have been different. In an ideal case, the direction of macro-economic factors on share price movement might be predictable but the strength of this relationship can be assessed empirically.

### 1.1 Relevance of the Study

The major economic reforms in India have started in 1991 – the period of economic liberalization. Following this reform, Indian capital market has witnessed the periods of Global Financial crisis, a decade long continuous growth and period of Coronavirus stress till now. In the last three decades (1991 – 2020), Indian economy has gone through both uprise and downfall stages of an economic cycle. The long period of economic downfall and upswing has assisted in the efficient price discovery of interest rates, exchange rates and securities, the overall functioning of the financial markets. While stock markets are subject to market forces for the price determination, the convertibility of the rupee should enable the

rupee also to discover its price based on more on market forces. Indian capital market is not isolated from global happenings nor are the completely isolated from exogenous shocks. Over the years, the investment of foreign institutions in the Indian capital market has increased significantly. It not only affects the share price movements but also the exchange rate market. As a result, a great degree of financial integration has evolved over the past one decade which is expected to strengthen the interrelationship between the different variables of the financial matrix of the country.

The share price volatility in the Indian equity market has seen large swings in the last three decades as the economy has gone through both positive and negative growth stages. The volatility is more pronounced since economic reforms that kick started the liberalization process in 1993. Similarly, the value of Indian rupees with respect to US dollars has also witnessed wide fluctuations. From a pre-liberalisation rate of around Rs 21/US dollar it declined to Rs 77/US dollar in the year 2021. The variation in daily INR/USD exchange rate is more pronounced when it is subjected to market forces and after being made convertible in 1995.

The progress and stability helped India and her stock market to become one of the preferred destinations for investment. Capital flows from both domestic and international investors to the Indian equity market have become significant post 2000. India now attracts a chunky portion of the global portfolio flows to emerging markets. Mobility of Capital especially invested through portfolio investment seems to traffic between economies all over the Globe, based on competitiveness of prices and returns. Stock prices/indices have also now become an important parameter in defining the financial matrix of any country along with conventional measures of interest rates, exchange rates, GDP growth rates etc. Some of these factors are mutually dependent also.

Evidence of stock market reaction to some of the factors like interest rate, inflation, and money supply has been reported at length. At the time of conceiving the topic for study no conclusive evidence was available on the response of share prices in relation to the exchange rate fluctuations covering the data after 2006. There is some research covering the data till 2006 by [1]. This research gap motivated to take up a detailed study on the topic of impact of exchange rate fluctuations on the share prices in the Indian Capital Market.

## 1.2 The Scope of the Study

The scope of the study is limited to the exchange rate of Indian Rupees against the US dollar (INR/USD exchange rate) and Equity prices (SENSEX) in the secondary market exchanges of BSE. The period of coverage is from January 1991 to February 2021 which covers major economic events – Economic Liberalization, Global Financial Crisis, Growth Period and Coronavirus Crisis.

## 1.3 Objectives

The primary objective of this study is to establish any empirical relationship between the INR/USD exchange rate fluctuation and share price fluctuations in the Indian capital market. As the period of coverage consists of both stress and growth period, the study has been performed by dividing the data into multiple periods of stress and growth. This involved –

- Examining the behaviour of INR/USD exchange rate and Indian capital market during the study period.
- Examining the volatility of INR/USD exchange rate and share price (SENSEX) of the Indian capital market.
- Establishing an empirical relationship, if any, between the exchange rate fluctuation and share price fluctuations.
- Differentiating the relationship, if any, during the period of capital market growth and capital market stress.

## 1.4 Chapter Scheme

The Project-oriented dissertation is organized under five chapters. The first chapter provides an introduction to the study. This chapter discussed the motivation that led to undertake this topic of study and further defines objectives of the study. The second chapter gives an overview of literature study as part of the dissertation. The literature study highlights the literature gaps that this study aims to cover. The third chapter on Research Methodology provides a detail overview of the research methodology used to establish empirical relationship between exchange rate fluctuations and share price movement. This chapter provides details on the dataset, data sources, tools and techniques used for the study. The

fourth chapter provides the details on empirical analysis and discuss results. Finally, the chapter five provides conclusion of the study.

# **Chapter 2:**

## **Literature Reviews**

❖ **Summary of the Literatures**

## 2 Literature Review

This section presents the overview of literature review performed for the current study. There are various qualitative studies on the relationship between stock price and exchange rate has been performed but there is limited literature on the empirical relationship between the two variables. One of the empirical studies has been performed in [1] covering the period till 2006. However, Indian economy has progressed significantly after 2006. It has witnessed Global Financial Crisis, period of growth and recently Coronavirus Crisis period. Hence, the current study is performed covering the data till 2021 so the time period covers both stages of an economic cycle – growth and stress. The summary of literature review is as follows:

### 2.1 Summary of Literature Reviews

- The earliest of the studies was done by Frank and Young in 1972 who investigated the relationship between exchange rate and stock prices using six different exchange rates and found no relationship between the two financial variables.
- Aggarwal (1981) [2] studied the contemporaneous relationship between changes in the US stock prices and the changes in the trade weighted exchange rate of the US Dollar during the period 1974-1978 and found that the stock prices and the value of the US Dollar were positively correlated and the relationship was stronger in the short term than in the long term.
- Ajay A and Mougoue (1996) [3] studied the inter-temporal relation between stock indices and exchange rates for a sample of eight developed countries. By employing causality test and co-integration on daily closing stock market indices for the period 1984-1991 it was found that
  - I. An increase in aggregate domestic stock price has a negative short run effect on currency values.
  - II. Sustained increase in domestic stock prices will induce domestic currency appreciations in the long run.
  - III. Currency depreciation has negative short run and long run effects on stock markets.

- Qiao, YU (1997)[4] found bi-directional causal relationship between stock prices and exchange rates for Tokyo market. While in Hong Kong market exchange rates changes caused changes in stock prices, no such interaction was seen in Singapore market as evidenced by Granger causality test on daily data covering the period 1983-1994. While using the VAR (Vector Auto Regression Model) a long run stable relationship was evidenced in the three Asian markets.
- Li Lian Ong and Izan H Y (1999), using non- linear least square method found that US share price returns fully reflect information conveyed by movements in both Japanese Yen and French Franc with a lag of four weeks. They concluded that depreciation in a country's currency would cause its share market returns to rise while an appreciation would have an opposite effect.
- The study by Katephylaktis and Fahiala Ravazzolo(2000) [5] suggested that
  - There is no long run relationship between the real exchange rate and the local stock market of Pacific basin countries via; Indonesia, Singapore, Thailand, and the Philippines over the period1980-1988.
  - During the 1990s for all six countries including Hong Kong the real exchange rate and the US stock prices were positively related to domestic stock prices.
  - Foreign exchange restrictions have not been an important determinant of the link between the domestic stock and forex markets on the one hand and between the domestic capital and world capital market on the other hand.
- Pathe and Karnik (2000) [6] made an attempt to investigate the interaction of Indian stock market and macro-economic variables and found there is no long-run stable relationship between stock prices and exchange rate. Other monetary variables considered were PLR, Money supply and index for industrial production.
- Karmakar et al (2001) by employing the coefficient of determination and regression analysis on weekly closing values of exchange rates Rupee/US dollar and five composites as well as five sectoral indices of stock market over the period 2000



concluded that the depreciation of rupee with respect to US dollar leads to an appreciation of stock prices and vice versa.

- Apte (2001) [7] endeavored to research the relationship between volatility of the nominal exchange rate of India by utilizing the EGARCH specification on the daily closing US/INR exchange rate, BSE Sensex, and NIFTY over the period 1991 to 2000. The investigation shows an appearance of the overflow from the exchange rate market to the stock market but not vice-versa.
- Battacharya et al. (2002) [8] examined the nature of the causal connection between securities exchange, exchange rate, foreign exchange reserves, and trade balance concerning India from April 1990 to March 2001 by applying the cointegration and long-run Granger causality test. The outcomes recommended that there are no causal linkages between stock prices and the three variables under consideration. viz., exchange rate, foreign exchange reserves and value of trade balance.
- Nath and Samantha (2003)[9] utilized Granger causality test on daily data during the period March 1993 to December 2002. The empirical finding recommended that the two markets didn't have any causal relationship. Besides, the extended analysis of the study didn't track down any critical causal relationship between exchange rate and stock price developments with the exception of the year 1993, 2001, and 2002. Unidirectional causal influences from stock to foreign exchange market was recognized in these years and mild reverse causal influence during 1997 and 2002.
- Scaria, P Filomina (2007) studied the impact of exchange rate fluctuations on the share prices in the Indian capital market for the period till 2006. The empirical findings suggest a long term and short-term relationship between the exchange rate fluctuations and share price movements. The analysis was performed for various episode of dataset based on structural breaks in the dataset.

The above literature study shows that interrelationship between Stock Prices and Exchange Rate have so far used many methods and tests from correlations and regression to causality and co-integration tests. The literature covers various studies in different countries solely and

collectively yielded results which are not conclusive. Additionally, these studies have been performed using the data before the global financial crisis. The studies on Indian market are also very minimal.

Post liberalization, the capital flows from foreign investors into Indian capital market has increased multi-fold. Free trading in foreign exchange is still lagging in terms of a full-fledged currency market and on the issue of full convertibility of capital account and a matured market is still evolving in the Indian scenario. As both markets are getting much closer and integrated it is important to consciously recognize the influence of the prices/rates in one market on the other. In the light of these literature gaps, the current empirical study expands the analysis till 2021 that covers both the growth periods and stress periods.

# **Chapter 3:**

# **Research**

# **Methodology**

- ❖ **Research Design**
- ❖ **Data used**
- ❖ **Exchange Rate Data**
- ❖ **Share Price data**
- ❖ **Sources of data Collection**
- ❖ **Research Hypothesis**
- ❖ **Tools, Techniques and Tests**
- ❖ **Time Series: At a Glance**

### 3 Research Methodology

This section presents the detailed overview of research methodology used in the current empirical study in the following subsections:

#### 3.1 Research Design

The empirical study was performed to find out the impact of exchange rate fluctuations on the share prices on Indian capital market over various macro-economic conditions. For this objective, two important economic variables i.e. share prices and exchange rate were identified as the subject of study. The exchange rate is taken as daily spot rate INR/USD exchange rate i.e. rupee per US dollar for the study period of January 1991 to February 2021. The exchange rate daily data is taken from FRED (Federal Reserve Economic Data) which is free and authentic data. The share price of Indian capital market is considered as BSE SENSEX index data for the study period. The SENSEX is BSE 30 index that represents the weighted average share price of 30 well established companies listed on Bombay Stock Exchange. This represents overall market movement as the list of 30 companies is regularly updated to present clear picture of Indian economy.

#### 3.2 Data Used

The period of study is chosen from 1<sup>st</sup> January 1991 to 28<sup>th</sup> February 2021. This period covers the last three decades which is further divided into four phases based on the observed shift in the dataset. The multiple phases are also created in tandem with the major macro-economic conditions covering both the growth and stress periods of an economic cycle. Further details on the data used as follows:

##### 3.2.1 Exchange Rate Data

The exchange rate data is taken as daily spot rate i.e. daily exchange rate of Rupee per dollar (INR/USD daily exchange rate) for the period covering from 1<sup>st</sup> January 1991 to 28<sup>th</sup> February 2021. The data is taken from Federal Reserve Economic Data (FRED).

### 3.2.2 Share Price Data

The share price data is taken as daily close value of Indian Stock Market indicator, SENSEX from 1<sup>st</sup> January 1991 to 28<sup>th</sup> February 2021. The data is sourced from Quandl database which is a free and reliable API based data source for many indices across the globe. The SENSEX index represents the weighted stock market index of 30 well-established and financially sound companies listed on Bombay Stock Exchange.

### 3.3 Sources of Data Collection

The various data for this study are collected from various secondary sources: Publication of RBI, SEBI, BSE, data from organization such as FRED (Federal Reserve Economic Data) and databases such as Quandl, etc. Following websites have been used to source the data –

- INR/USD exchange rate data (FRED) - <https://fred.stlouisfed.org/>
- BSE SENSEX daily price data (Quandl) - <https://www.quandl.com/>

### 3.4 Research Hypothesis

To achieve the objectives described in the above section, the following hypothesis have been formulated:

H<sub>0</sub>: There is no significant impact of exchange rate fluctuations on the share price movement

H<sub>1</sub>: The fluctuations in the exchange rate have impact on the share price movement

### 3.5 Tools, Techniques and Tests

For the current study, various statistical and econometrics tools have been used to analyze the data and find out the empirical relationship between the exchange rate fluctuations and SENSEX price movement.

#### 3.5.1 Graphical and Visual Exploration

The graphical and visual exploration is the first stage to identify any patterns, graphical relationship or to identify whether any major shift in the data level that can ear-mark sub periods for the further analysis. This exploration analysis was carried out by plotting the daily

spot rate of exchange rate and daily close value of SENSEX. As the study covers a wide range of analysis period starting from January 1991 to February 2021, the dataset has periods of growth and period of stress. Graphical analysis was helpful in subdividing the dataset into various periods as per the objective. The graphical and visual exploration between the two variables is also helpful in understanding whether any functional relationship between the two variables.

### 3.5.2 Descriptive Statistics

The descriptive statistical analysis measures the statistics like mean, median, maximum, minimum and standard deviation etc. These are also helpful in understanding the level of data and intensity of fluctuations in the dataset over the study period. The analysis of descriptive statistics in the sub-periods further support the reasonableness of assuming the sub-period instead of taking a complete study period. As the sub-periods are divided based on major economic event or change in the economic conditions, the descriptive statistics of the two sub-periods will be significantly different.

### 3.5.3 An Episodic Analysis

The current study period covers a long time series of last three decades. Hence, the complete study period has been divided into four episodes of major economic environment prevailed in the country – Economic Liberalization, Global Financial Crisis, Continued Growth and Corona Virus Crisis. The empirical study has been performed in each period separately by dividing the data into four parts.

### 3.5.4 Correlation and Regression

To establish the relationship between exchange rate fluctuations and Share price movement, Ordinary Least Square linear regression analysis has been performed between the two variables. The coefficient of correlation between the two variables tells the strength of linear relationship between the two variables which is exactly similar to adjusted r-squared value in two variables OLS linear regression model as discussed in [2]. Moreover, the slope coefficient in the regression analysis measures the impact on share price movement for unit fluctuation in the exchange rate. Hence, the OLS regression analysis has been chosen for

understanding the empirical relationship between the two variables of study. The detailed overview of OLS regression analysis between two variables can be found in [2].

Correlation and regression analysis on time series data are not free from depicting spurious relationships. Empirical work from the beginning phase was centred around the linkage between the returns in the stock and foreign exchange markets and didn't utilize the levels of the data series. Such a limit was because of econometric suppositions about inadequate stationarity of financial data series. Stationarity is stringently needed in regression analysis to keep away from misleading inferences. By differencing the variables some information regarding a possible linear combination between the levels of the variables may be lost. In the current study, the correlation and regression analysis were performed between the daily price volatility (percent change) of SENSEX and daily volatility of the exchange rate movement. Both of these variables are tested on stationarity before performing regression analysis. The level values of these variables are not stationary but taking the volatility (percent change) makes both of the time series stationary. The details on time series and stationarity are provided in the below section –

### 3.6 Time Series Econometrics: At a Glance

A time series is a stochastic process which is a collection of random variables sequenced in the order of time. A type of stochastic process that has received a great deal of attention and scrutiny by time series analysis is the so called stationary stochastic process. Statistically, a stationary process is a stochastic process whose probability distribution at any fixed time or position is the same, i.e. it has a constant unconditional mean and variance over time. Stationarity is an essential property for standard econometric analysis, without which we cannot obtain consistent estimates. Most macroeconomic and financial time series are non-stationary, which means that such variables have no clear tendency to return to a constant value or a linear trend.

Using non-stationary macroeconomic variables in time series analysis causes spuriousness problems in regression. Stationarity is used as a characteristic tool in time series analysis where the raw data are often transformed to become stationary. It is therefore, considered important that the time series properties of the data series are identified before proceeding with further analysis.

### 3.6.1 Stationary Stochastic Processes

If a time series is stationary, its mean, variance and auto covariance (at various lags) remain the same no matter at what point we measure them; i.e. they are time non-variant.

If  $Y_t$  represents a stochastic time series it is said to be stationary, if the following conditions are satisfied for all values of  $t$  and  $k$  such that,

$$\text{Mean: } E(Y_t) = E(Y_{t+k}) = \mu$$

$$\text{Variance: } V(Y_t) = E(Y_t - \mu)^2 = E(Y_{t+k} - \mu)^2 = \sigma_y^2$$

$$\text{Covariance: } \gamma_k = E(Y_t - \mu)(Y_{t+k} - \mu)$$

are constant and time-invariant.

### 3.6.2 Non-Stationary Stochastic Processes

If a time series is not stationary it will have time varying mean or a time varying variance or both and the findings cannot be generalized over various time periods and cannot be of much use for policy makers. The classical example of non-stationary time series is expressed in the Random Walk Model (RWM), which can take either of the following two forms:

- A random walk without drift
- A random walk with drift

Asset prices, stock prices and exchange rates are believed to follow a random walk model, which is a non-stationary stochastic process. However, the first difference of a random walk time series is stationary and is represented by an AR(1) model. Proponents of Efficient Market Hypothesis (EMH) believe that stock prices are essentially random.

### 3.6.3 Stationarity Test

A quick way of telling if a process is stationary is to plot the series against time. If the graph crosses the mean of the sample many times, chances are that the variable is stationary; otherwise that is an indication of persistent trends away from the mean of the series. Several methods are available which describe the stationary or non-stationary nature of the time series and the one which has gained popularity and has become synonymous with non-stationarity and random walk is the Unit Root Process. A unit root process will only cross the mean of the sample very infrequently, and the process will experience long positive and



negative strays away from the sample mean whereas the Random Walk Model is a specific case of stochastic process a more general class of stochastic process is the integrated process. A process that has a unit root is also called integrated of order 1  $I(1)$ . Similarly, if a time series has to be differenced twice to make it stationary, such a series is integrated to the order two and is denoted as  $I(2)$ . A time series which is stationary is a process integrated to order zero and is denoted as  $I(0)$ . Most economic time series are generally  $I(1)$  and become stationary only after taking the first difference.

### 3.6.4 Unit Root Test

For a time series analysis to be meaningful any spurious correlation in the data should be isolated. This is done by establishing the degree of integration of each variable by checking for stationarity of the series.

The unit root test of stationarity is based on the following set up.

$$Y_t = \alpha + \rho Y_{t-1} + u_t \text{ where } u_t \sim I(0) \text{ and } -1 \leq \rho \leq 1$$

If  $\rho = 1$ , the model becomes a random walk model and  $Y_t$  is non-stationary –

$$Y_t - Y_{t-1} = \alpha + (\rho - 1)Y_{t-1} + u_t$$

$$\Delta Y_t = \alpha + \delta Y_{t-1} + u_t$$

If we test the null hypothesis that  $\delta = 0$  and  $\rho = 1$  there is a unit root and the time series under consideration is non-stationary.

Several methods are already developed for carrying out unit root test, of which the most widely used ones in literature are the Dickey Fuller (DF) and the Augmented Dickey Fuller (ADF) tests Phillips–Perron (PP) test and the Kwiatkosky, Phillips, Schmidt, and Shintest (KPSS) tests. For the current study, ADF test has been used for checking the stationarity of time series.

### 3.6.5 The Dickey Fuller and the Augmented Dickey-Fuller Tests

The Dickey Fuller Unit Root Test has three alternative specifications as follows depending on whether the random walk process may have no drift or it may have drift or it may have drift and deterministic and stochastic trends.

1. Without Constant or Trend  $\Delta Y_t = \delta Y_{t-1} + u_t$
2. With Constant  $\Delta Y_t = \alpha + \delta Y_{t-1} + u_t$
3. With Constant and Trend  $\Delta Y_t = \alpha + \beta t + \delta Y_{t-1} + u_t$

The first is a pure random walk model, the second adds an intercept or drift term, and the third includes both a drift and linear time trend. The parameter of interest is  $\delta = (\rho - 1)$ . The hypothesis tested is –

$$\begin{aligned} H_0: \delta = 0 \text{ or } \rho = 1 & \text{ (i.e. } Y_t \text{ has a unit root therefore non-stationary)} \\ H_1: \rho < 1 & \text{ (i.e. } Y_t \text{ has no unit root therefore stationary)} \end{aligned}$$

The Augmented Dickey-Fuller (ADF) test makes a parametric correction in Dickey-Fuller (DF) test for higher-order correlation by assuming that the series follows an AR(p) process. The ADF approach controls for higher-order correlation by adding lagged difference terms of the dependent variable to the right-hand side of the regression.

$$\Delta Y_t = \alpha + \beta t + \delta Y_{t-1} + \theta_i \sum_{i=1}^p \Delta Y_{t-i} + u_t$$

The  $t$  value of the estimated coefficient of  $Y_{t-1}$  follows  $\tau$  statistic.

### 3.6.6 Granger Causality Test

The Granger Causality test is employed to argue established causality between two variables where past values of one variable affect the present value of other. In a regression of Y on other variable X, if we include past or lagged values of X and it significantly improves the prediction of Y then it can be said that X Granger causes Y. A similar argument can be given for regression of X on Y. The Granger Causality for regression of Y on X can be represented as follows:

$$Y_t = \sum_{j=1}^n \alpha_j X_{t-j} + \sum_{j=1}^n \beta_j Y_{t-j} + u_{1t}$$

The Granger Causality has two statements:

1. The cause occurs before the effect; and
2. The cause contains information about the effect that is unique and is now in the other variable

If there is a Granger Causality between X and Y then as a result it can be said that the causal variable help forecast the effect of the variable after other data has first been used.

# Chapter 4:

# Econometric Analysis

- ❖ **Graphical & visual Exploration**
- ❖ **An Episodic Analysis: Structural Breaks & Four Phases**
- ❖ **Phase 1: Economic Liberalization and its after effect (Jan' 1991 – Dec' 2006)**
- ❖ **Phase 2: Global Financial Crisis (Jan' 2007 – Dec'2010)**
- ❖ **Phase 3: Consistent Equity Market Growth (Jan' 2011 to Dec' 2019)**
- ❖ **Phase 4: Coronavirus Pandemic (Jan' 2020 to Feb'2021)**

## 4 Econometric Analysis

### 4.1 Graphical and Visual Exploration

This section presents the graphical exploration of the two variables of study - Share Price (SENSEX) and Exchange Rate (INRUSD) for the whole period - January 1991 to February 2021. The graphical exploration is helpful in identifying any relationship between the two variables by visual inspection. Graphical exploration is performed by looking at the variables individually and jointly. In addition, the movement of the two variables is tracked in different time frames to perform episodic analysis.

#### 4.1.1 Graphical and Visual Exploration of Exchange Rate

A plot of daily exchange rate, measured in terms of Rupee per US dollar is presented for the period of January 1991 to February 2021 in Figure 1. This figure is useful for identifying any variation or patterns in the variation of exchange rate over the study period. Overall, a steady decline in the value of rupee with respect of dollar can be seen in the Figure 1. From the graphical representation, a steady increase in dollar can be seen in the time period 1991 to 2001 and 2012 to 2021 while the period of 2001 to 2006 appeared to be calm which indicate no momentous changes in the market forces.

In addition to level change in the exchange rate, volatility of the exchange rate is presented in the Figure 2. The volatility is calculated as daily percent change in the INR/USD exchange rate. The graphical representation of exchange-rate volatility depicts several spikes and volatility clustering at various time periods.

#### 4.1.2 Graphical and Visual Exploration of SENSEX

This section presents the graphical and visual exploration of Indian equity price represented by SENSEX. For this study, daily “Close” value of SENSEX is plotted in Figure 3. An increasing trend can be observed in the SESEX value except for 2008-10 periods and 2020 period which can be attributed to Global Financial Crisis and Corona Virus Stress respectively.

Additionally, a graphical representation of volatility (daily percent change) in Figure 4 shows the various spikes in the volatility in different time period and phenomenon of volatility clustering can also be observed.

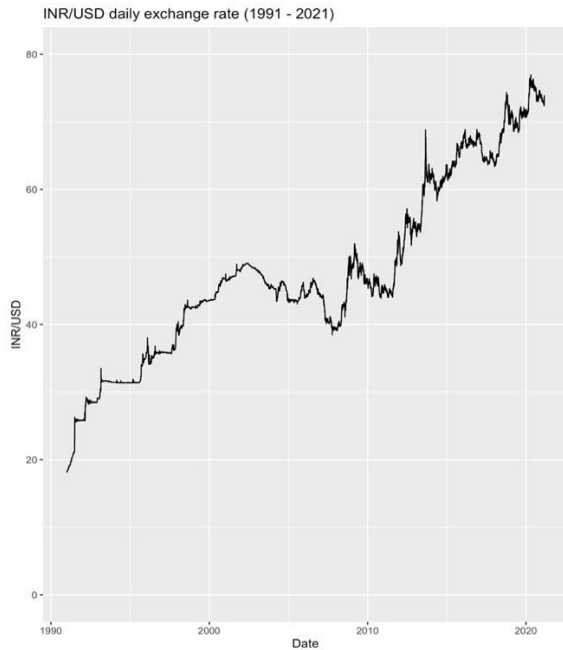


Figure 1: INR/USD daily exchange rate

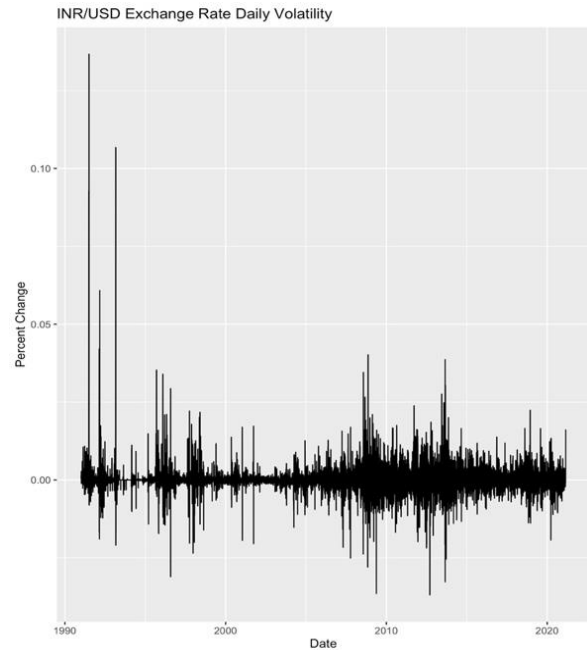


Figure 2: INR/USD daily exchange rate volatility

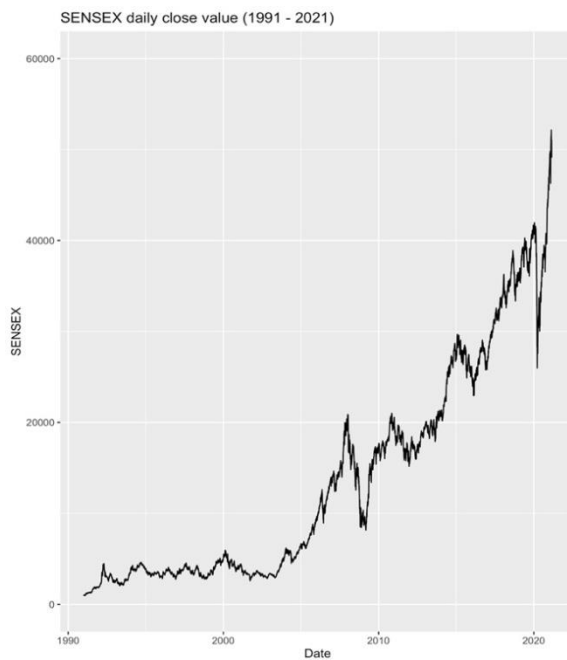


Figure 3: SENSEX daily close value

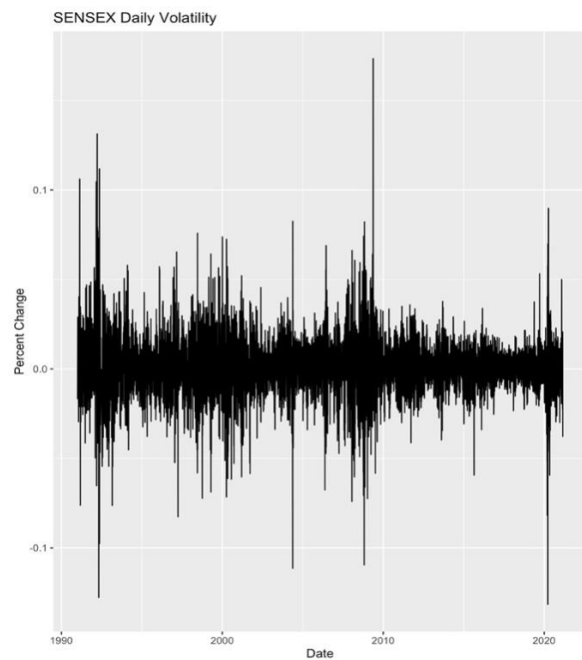


Figure 4: SENSEX daily volatility

### 4.1.3 Comparative representation of volatility

A comparative representation of the volatility (daily percent change) of SENSEX and INR/USD ex-rate is presented in Figure 5. It can be seen from the figure that the daily volatility of SENSEX is much higher than that of INR/USD exchange rate.

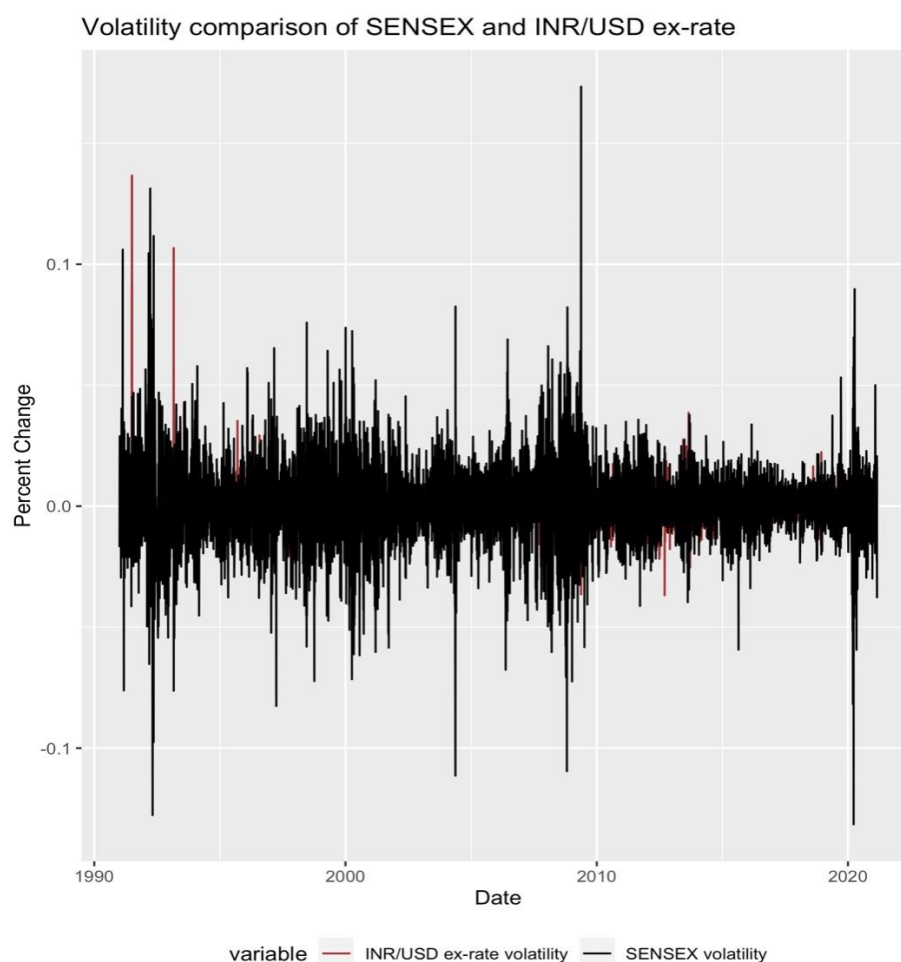


Figure 5: Relative volatility of SENSEX and INR/USD ex-rate (Jan'1991 - Feb'

## 4.2 An Episodic Analysis: Structural Breaks and Four Phases

In the complete dataset covering January 1991 to February 2021, four phases have been considered. Each phase represents major macro-economic environment in India which covers major economic reforms, normal conditions and stressed conditions. The empirical analysis has been performed separately as the correlation between exchange rate fluctuations and equity price fluctuations may differ based on prevailing macro-economic environment. The following four phases have been considered –

- I. Phase 1: period covering January 1991 to December 2006
- II. Phase 2: period covering January 2007 to December 2010
- III. Phase 3: period covering January 2011 to December 2019
- IV. Phase 4: period covering January 2020 to February 2021

A graphical comparison of INR/USD exchange rate and SENSEX price for Phase 1 to Phase 4 has been shown in Figure 6 to Figure 9 respectively. The time interval in Phase 1 represents the period of Economic Liberalization and its after-impact on the share price and exchange rate. Phase 2 represents the period of Global Financial Crisis where a steep decline in the SENSEX is clearly visible. Phase 3 represents the period of continuous growth in equity prices. However, continuous decline in INR value with respect to dollar can be observed here. Finally, Phase 4 covers the period of recent Coronavirus pandemic. In addition to the graphical comparison, a comparison of descriptive statistics has been performed in Table 4-1 to Table 4-4 for INR/USD Ex-rate, Ex-rate daily volatility, SENSEX value, SENSEX daily volatility respectively. The standard deviation in each phase shows the distinctiveness of each phase from each other.

Statistics	Phase 1	Phase 2	Phase 3	Phase 4
Min.	18.12	38.48	44.00	70.69
1 <sup>st</sup> Quartile	31.70	40.88	55.57	73.08
Median	43.16	45.05	63.71	73.86
Mean	39.55	44.58	61.58	73.96
3 <sup>rd</sup> Quartile	45.80	47.05	67.01	75.11
Max.	49.07	51.96	74.33	76.95

Statistics	Phase 1	Phase 2	Phase 3	Phase 4
Std. Deviation	11.37	4.73	10.39	2.08

Table 4-1: INR/USD Ex-rate comparison for the four phases

Statistics	Phase 1	Phase 2	Phase 3	Phase 4
Min.	-0.0312	-0.0365	-0.0369	-0.0192
1 <sup>st</sup> Quartile	-0.0006	-0.0029	-0.0022	-0.0018
Median	0.0000	0.0000	0.0000	0.0001
Mean	0.0003	0.0002	0.0003	0.0001
3 <sup>rd</sup> Quartile	0.0007	0.0031	0.0026	0.0021
Max.	0.1367	0.0402	0.0386	0.0162
Std. Deviation	0.0597	0.0243	0.0239	0.0113

Table 4-2: INR/USD Ex-rate daily volatility comparison for the four phases

Statistics	Phase 1	Phase 2	Phase 3	Phase 4
Min.	956.11	8160.40	15175.08	25981.24
1 <sup>st</sup> Quartile	3177.28	14041.24	19411.62	34914.68
Median	3659.40	15760.52	26481.25	38937.25
Mean	4372.88	15496.48	26433.04	39333.83
3 <sup>rd</sup> Quartile	4716.53	17578.23	32273.14	41947.19
Max.	13972.03	21004.96	41681.54	52104.17
Std. Deviation	4523.76	4255.26	9394.75	8562.67

Table 4-3: SENSEX value comparison for the four phases

Statistics	Phase 1	Phase 2	Phase 3	Phase 4
Min.	-0.1277	-0.1096	-0.0594	-0.1315
1 <sup>st</sup> Quartile	-0.0089	-0.0089	-0.0049	-0.0050
Median	0.0010	0.0010	0.0003	0.0023
Mean	0.0007	0.0006	0.0003	0.0008
3 <sup>rd</sup> Quartile	0.0103	0.0102	0.0058	0.0091
Max.	0.1313	0.1734	0.0532	0.0897
Std. Deviation	0.0821	0.0911	0.0358	0.0711

Table 4-4: SENSEX daily volatility comparison for the four phases



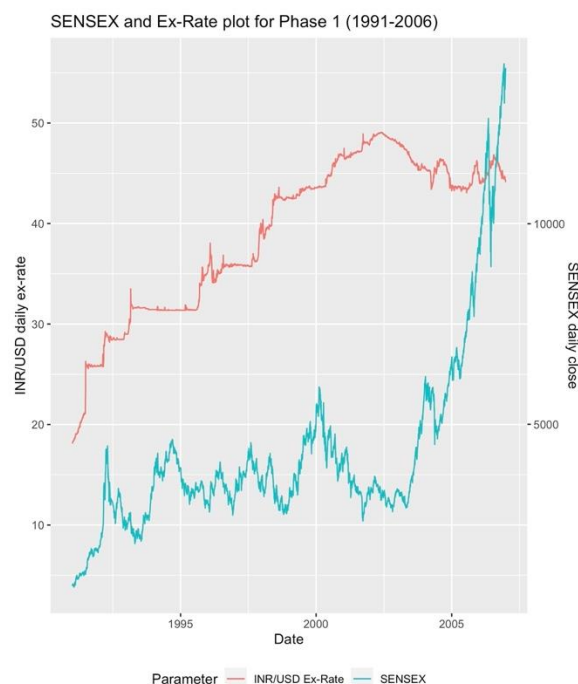


Figure 6: Ex-rate and Sensex movement in Phase 1

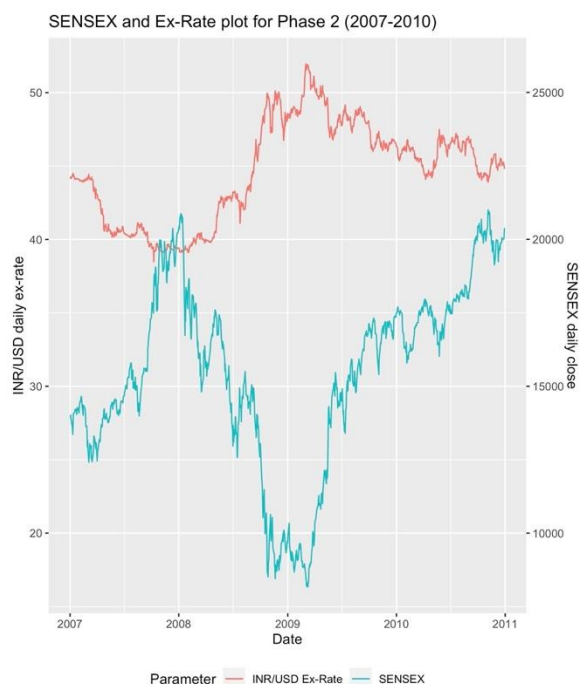


Figure 7: Ex-rate and Sensex movement in Phase 2

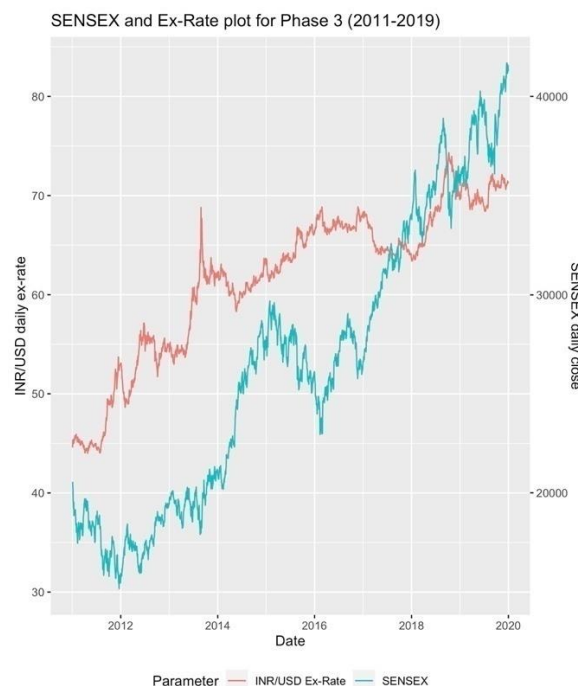


Figure 8: Ex-rate and Sensex movement in Phase 3

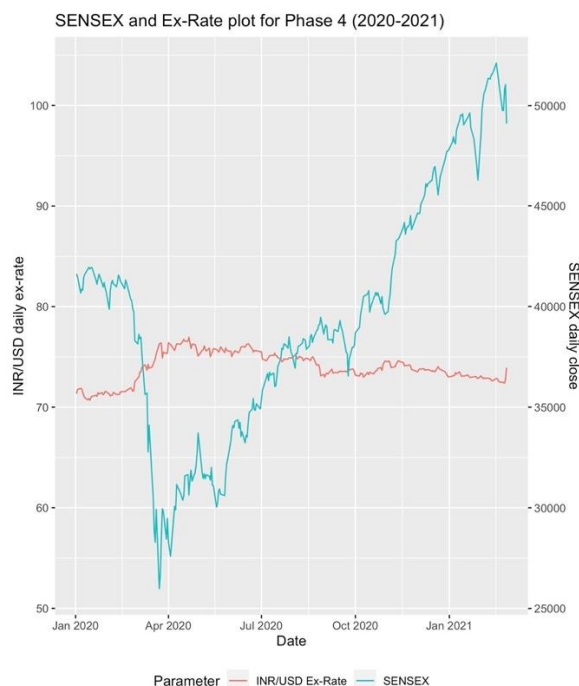


Figure 9: Ex-rate and Sensex movement in Phase 4

### 4.3 Phase1: Economic Liberalization and its aftermath (Jan'1991 – Dec'2006)

The first phase covers the period of Economic Liberalization in India and its after impact on the equity market from January 1991 to December 2006. 1991 will consistently be recognized as a red-letter year in India's financial history. Paving the way for much needed reforms in the form of liberalization, privatization and globalization, the Indian economy geared up for groundbreaking change. A shift in the balance in economy from state to private sector bestowed on the stock market the burden of pooling sufficient resources from domestic, regional and international sources and allocating efficiently for productive uses. Table 4-5 shows the pattern of change in the Indian stock market with gradual deregulation of Indian economy. It can be seen from the table that equity market witnessed a large positive shift in each aspect (i.e. no. of stock exchanges, no. of listed companies, P/E ratio, capital raised by private sector, net investment of Foreign Institutional Investors) from 1990-91 and the growth continued thereafter the post-liberalization growth in Table 4-5 is consistent with the equity price (SENSEX) movement observed in Figure 6.

Indicators	1961- 80	1980- 81	1990- 91	1991- 92	1992- 93	1994- 95	1999- 2000
No. of stock exchanges	7	9	19	20	21	22	23
No. of listed companies	120	2265	5968	6229	6480	7811	NA
P/E ratio	NA	NA	NA	19.82	55.17	48.96	21.81
No. of sharing owing individuals (lakhs)	6.25	24.00	NA	60.00	200.00	NA	NA
Average turnover	NA	NA	36012	71777	45695	67740	68500
Capital raised by private sector (crores)	99	196	11190	14400	29000	49200	51533
Net investment of FIIs (crores)	NA	NA	NA	NA	2595	6791	6697

Table 4-5: Indian stock market growth pattern in pre- and post-liberalization period

The objective of the current study is the empirical assessment of correlation between SENSEX price daily volatility and INR/USD exchange rate daily volatility. For this

assessment, a single factor regression between SENSEX price daily volatility and INR/USD exchange rate daily volatility has been performed the regression equation if as follows:

$$SENSEX\ volatility_{p1}(t) = \alpha + \beta_1 * Exchange\ rate\ volatility_{p1}(t) + u(t)$$

The regression dataset covers time period from January 1991 to December 2006 as per the phase 1. The dependent variable is SENSEX daily volatility and independent variable is INR/USD exchange rate daily volatility. As discussed before, the daily volatility is calculated as percentage change from the last day. The estimated regression coefficient and the relevant regression results are mentioned in Table 4-6 and the corresponding regression plot can be seen in Figure 10.

Coefficients	Estimate	Std. Error	t-value	p-value
$\alpha$	0.0007455	0.0002881	2.588	0.00969
$\beta_1$	-0.1785756	0.0618409	-2.888	0.00390
Adjusted R-squared			0.20%	

Table 4-6: Regression estimation results for phase 1

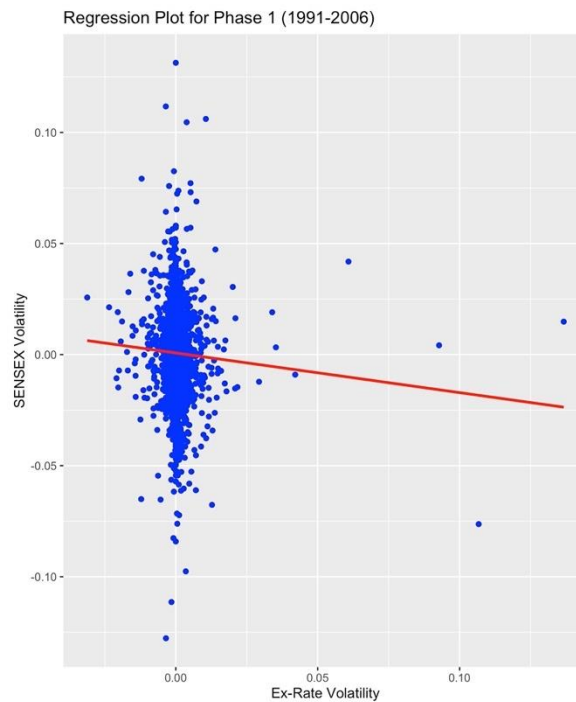


Figure 10: Regression plot for Phase 1

It can be seen from the regression estimate that the relationship is negative between the SENSEX price daily volatility and INR/USD ex-change rate volatility as the  $\beta$  coefficient is negative. As the volatility represents daily percentage change, the negative relationship tells that positive change in INR/USD ex-change rate results in the negative movement in the SENSEX price. However the regression adjusted r-squared value is 0.20% which shows that the strength of relationship very less. In the single factor regression, the regression r-squared value also equals to the coefficient of correlation. Hence the strength of linear relationship is very less. The regression results are also consistent with the pictorial representation in Figure 10. It can be seen from the figure that the dataset is clustered around one value of exchange rate volatility which represents very minimal variation in the exchange rate volatility in the considered period.

Based on these regression results, it can be concluded that there is a negative relationship between SENSEX price daily volatility and INR/USD exchange rate volatility but the strength of the relationship is negligible for the Phase 1.

#### 4.4 Phase 2: Global Financial Crisis (Jan'2007 – Dec'2010)

The Phase 2 covers the time-frame of Worldwide Financial Emergency that influenced numerous equity market all throughout the world. Following the ejection of financial emergency when the Wall Street of the US and securities exchanges of European nations smashed, its influence gushed out over to India and India's securities exchange was hit worsely. To meet the liquidity prerequisites or liabilities of their parent organizations, Foreign Institutional Investors (FII) began selling the portions of the Indian organizations held by them. The selling pressure by FIIs brought a crash in SENSEX.

In the first few years FIIs (2000-06) had invested on a massive scale in the equity shares of several Indian companies operating in various industries from consumer goods to infrastructure industries. As a result of buying spree of Indian companies by FIIs, share prices rose to new heights. The SENSEX which was around 6,000 in 2004 rose to 8,000 in Aug-Sep 2005 and went on rising further crossing 10,000 mark in 2006, 13,000 mark in 2007 and reached to peak of around 21,000 mark in January 2008.

At around this time, share prices in the US and European financial markets began to fall rapidly and the issues of liquidity and credit crunch rose to grave extents. This drove FII to sell shares held by them in the Indian securities exchange to pull out capital from India. This was done to satisfy the requirements of recovery pressures on their parent organizations

who were confronting liquidity issue. As a result of this selling pressure, SENSEX started tumbling; it fell from around 21,000 in January 2008 to 11,000 in September 2008 and in its downward march it fell below 10,000 in October 2008 and 9,000 mark in November 2008, that is, 60 per cent fall since January 2008. This caused enormous misfortunes the Indian organizations and investors, whose immense wealth was cleared out a few months in 2008. Foreign Institutional Investors sold more than \$13 billion worth of portions of Indian organizations up to November 2008 and localized them to their countries. Likewise, this prompted the decrease in foreign exchange reserves held by the RBI to \$250 billion by the end of 2008.

#### Depreciation of Indian Rupee:

Yet, the impact of capital outflow by FIIs was not bound to a steep decline in share prices however was more profound and divesting. At the point when Foreign Institutional Investors (FIIs) sold their shares in India they got rupees. They needed to change their rupees into dollars over to send them to foreign countries. This prompted the increase in demand for dollars. The rupee-dollar exchange rate being dictated by the demand for and supply of currencies, the increment sought after for dollars caused appreciation of the US dollar in terms of rupees, i.e., the rupee devalued against the US dollar.

The Indian importers likewise requested dollars to pay for the imports of goods. The Indian banks doing foreign exchange activities also brought US dollars at home to keep their foreign exchange tasks afloat since in the credit crunch nobody in foreign nations was able to loan dollars to any Indian bank. This further raised the demand for dollars causing quick deterioration of the rupee in the long stretches of September, October, and November 2008. The Indian rupee whose worth had appreciated to 39.4 for a dollar in December 2007 depreciated to Rs. 49.3 for a dollar in end-October 2008 and further to surpassed low of Rs. 50.6 for a dollar in mid-November 2008. This depreciation of Indian rupee though made our exports cheaper, made our imports costlier. In October and November 2008, crude oil price depreciated from surpassed high of \$147 per barrel to around \$50 in November 2008 and to \$40 per barrel in February 2009.

#### Empirical Study:

From the above discussion, it is clear that the time period covered in Phase 2 represents the Financial Crisis scenario. Hence, the current empirical study in Phase 2 is important to understand the nature and strength of relationship between the equity price volatility and

exchange rate volatility for the crisis period. Similar to Phase 1, a single factor regression model with SENSEX daily volatility as dependent variable and INR/USD ex-change rate daily volatility as independent variable is developed for the period January 2007 to December 2010. The regression equation is as follows:

$$SENSEX\ volatility_{p2}(t) = \alpha + \beta_2 * Exchange\ rate\ volatility_{p2}(t) + u(t)$$

The estimated regression coefficients and regression results are described in Table 4-7 and corresponding regression plot is shown in Figure 11.

Coefficients	Estimate	Std. Error	t-value	p-value
$\alpha$	0.0008786	0.0005864	1.498	0.134
$\beta_2$	-1.4417268	0.0979164	-14.724	2E-16
Adjusted R-squared			18.42%	

Table 4-7: Regression Estimation results for Phase 2

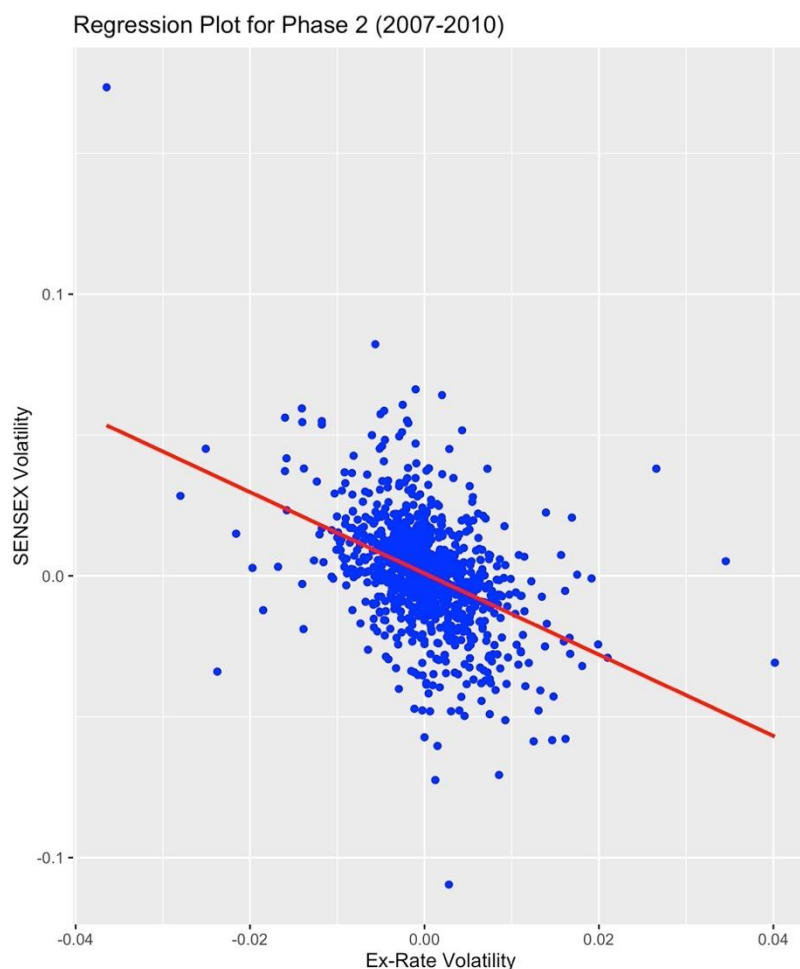


Figure 11: Regression Plot for Phase 2

The regression estimation results shows negative slope coefficient (-1.44) and r-squared value of 18.42%. Both the slope coefficients and r-squared value is significantly higher than Phase 1 which shows strong negative correlation between the SENSEX price volatility and INR/USD exchange rate volatility. The regression results are consistent with the intuition and nature of economic crisis period. As discussed in the starting of this section, the impact of global financial crisis majorly felt in the Indian equity market due to Foreign Institutional Investors (FIIs) pulling out their money from the Indian equity which led to both sharp dip in SENSEX price and further devalues the rupee with respect to USD (INR/USD ex-change rate).

#### 4.5 Phase 3: Consistent Equity Market Growth (Jan'2011 to Dec'2019)

As discussed in Phase 2, the period of Global Financial Crisis the global market in a state of flux. After 2009, the global economy was just emerging from the financial crisis which had

pushed most of the investment bank into the brink. However, an amalgam of liquidity infusion and fiscal policy led the market to bull run from afterwards. The stock market witnessed consistent growth for the next decade. The consistent growth in Phase 3 can also be seen in Figure 8 which shows continuous growth of SENSEX from January 2011 to Dec 2019.

Particulars	BSE SENSEX	BSE 500	BSE ALLCAPS
10-year returns	137.40%	128.86%	126.16%
CAGR returns	9.05%	8.63%	8.52%

Table 4-8: Performance of Indian equity market in Phase3

Table 4-8 presents the absolute and CAGR market returns in Phase 3 for various BSE indices. BSE SENSEX can be taken as proxy for the large cap universe. Additionally, BSE 500 and BSE ALLCAPS represents the return of overall a broader Indian equity market. Over Phase 3, the narrow based and broad based indices on the BSE have more than doubled. For the Sensex as a portfolio, the CAGR returns has been 9.05% annualized while for the other two broad-based indices it has been nearer to 8.5%. Unmistakably, the real issue of the stage 3 has been the large-cap stocks. The steady progression of liquidity into the Indian business sectors, both homegrown and worldwide, has plainly floated towards the large-caps, empowering them to outperform over the long term time frame. Automobiles, banks, FMCG, and IT were the significant sectors that drove the rally in the markets. Obviously, FMCG and banks have been incredibly reliable but IT was a lot more erratic in the middle years before picking up. These four sectors account for over 70% of the Sensex weightage and their buoyancy has largely explained the positive sentiments in the Sensex.

Particulars	BSE AUTO	BSE BANKEX	BSE FMCG	BSE IT
10-year returns	145.54%	266.84%	309.83%	201.07%
CAGR returns	9.41%	13.88%	15.15%	11.65%

Table 4-9: Big 4 gainers in Indian equity market over Phase 3



### Empirical Study:

As discussed above, the Indian equity market witnessed continued growth in Phase 3 (January 2011 to December 2019). Hence, it is important to study the nature and strength of relationship between SENSEX price daily volatility and INR/USD exchange rate daily volatility in the growth period. A single factor regression model has been developed where the independent variable is INR/USD daily exchange rate volatility and dependent variable is SENSEX price daily volatility for the complete time period of Phase 3. The regression equation is as follows:

$$SENSEX\ volatility_{p3}(t) = \alpha + \beta_3 * Exchange\ rate\ volatility_{p3}(t) + u(t)$$

The estimated regression coefficient and other regression results are mentioned in Table 4-10 and corresponding regression plot is shown in Figure 12.

Coefficients	Estimate	Std. Error	t-value	p-value
$\alpha$	0.0005100	0.0001897	2.688	0.00724
$\beta_3$	-0.7672937	0.0383070	-20.030	2E-16
Adjusted R-squared			15.82%	

Table 4-10: Regression estimation results for Phase 3

The regression estimation results show the slope coefficient as -0.77 and regression r-squared value is 15.82%. These regression results depict negative relationship between SENSEX price daily volatility and INR/USD exchange rate daily volatility. The negative relationship is intuitive as devaluation of rupee will result in the downward movement in the equity prices. The strength of the relationship (regression r-squared) is also significant however, it is less than the observed relationship strength in Phase 2. This empirical results are also consistent with the regression plot in Figure 12.

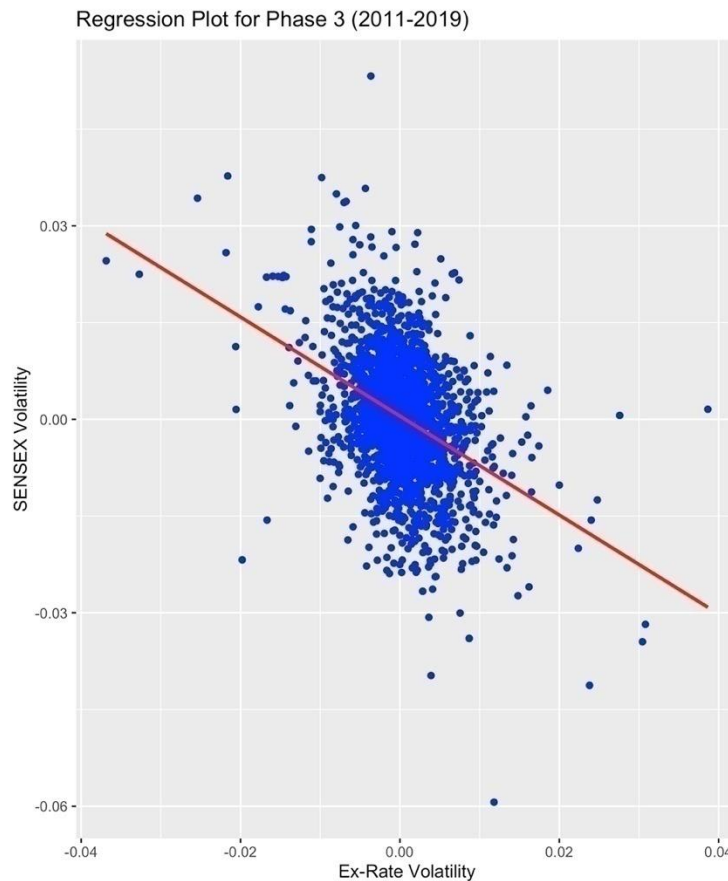


Figure 12: Regression plot for Phase 3

#### 4.6 Phase 4: Corona Virus Pandemic (Jan'2020 to Feb'2021)

The Phase 4 of the dataset (January 2020 to February 2021) covers the coronavirus pandemic period when the equity market throughout the world hit severely and major economies around the world collapsed. The outbreak of Covid-19 (Coronavirus) has influenced the entire global financial market in an unprecedented way. Because of disturbances that arose in the global market, the financial market of India also reacted to the pandemic and witnessed sharp volatility. The return on Indian stock market reached to bottom line during the first lockdown period, which is from 24<sup>th</sup> March to 6<sup>th</sup> April.

The pandemic is not only a global health emergency but is a significant global economic downturn too. As many countries adopted strict lockdown policies to fight with the unseen pandemic, their economic activities were suddenly shut down. Most importantly, consumers and firms have forestalled their usual consumption patterns due to the creation of panic among them and made market abnormality. Uncertainty and risk occur because of this pandemic, causing huge effect everywhere on the globe influencing both advanced and

arising economies like US, Spain, Italy, Brazil, and India. The government of India announced Janata Curfew on 22<sup>nd</sup> March 2020 and lockdown policy to maintain social distancing practice to slow down the COVID-19 outbreak from 24<sup>th</sup> March 2020. As the government announced such a strict lockdown policy, major economic activities stopped almost immediately. As a result, the Indian stock market witnessed sharp volatility and adverse impact. It has also borne the brunt of COVID-19 pandemic. The SENSEX dropped 13.2% on 23<sup>rd</sup> March 2020 which was the highest single day fall since 1991. A few economists have considered the effect of Coronavirus on the Indian securities exchange as a 'Black Swan Event' i.e. the event of an exceptionally unforeseen situation with an extremely terrible effect. Because of the lockdown strategy implemented by the public authority, the manufacturing plants have diminished the size of their workforce as well as production level which disturbed the supply chain. Again on account of the uncertainty prevailing among mankind, individuals decrease their consumption propensities prompting the demand-side shock. Moreover, Studies have tracked down that the whole past pandemic had influenced only the demand chain. But this COVID-19 pandemic has affected both the demand chain and supply chain. Table 4-11 shows the comparative analysis of SENSEX return in the pre-COVID and during COVID periods. It can be seen from the table that mean return became negative and standard deviation of the returns has increased significantly. Hence, the adverse impact and high volatility can be observed during the Phase 4.

Parameter	Pre COVID-19 period	During COVID-19 period
Mean	8.84E-05	-0.000239
Median	-0.000306	0.000217
Maximum	0.020004	0.039111
Minimum	-0.015436	-0.043645
Std. Deviation	0.006570	0.014427

*Table 4-11: SENSEX return comparison for pre-COVID and during COVID period*

### **Empirical Analysis:**

As discussed above, the Phase 4 comprised of coronavirus stress period when Indian stock market affected adversely and volatility also increased significantly. Although stress period for equity market has been covered in Phase 2 however, this crisis period is different as severity of market shock was substantially higher in Phase 4 crisis. Hence, it is important to understand the nature and strength of relationship between SENSEX volatility and INR/USD

exchange rate volatility. A single factor regression model has been developed where the independent variable is INR/USD exchange rate daily volatility and dependent variable is SENSEX price daily volatility covering the time period of Phase 4. The regression equation is as follows:

$$SENSEX\ volatility_{p4}(t) = \alpha + \beta_4 * Exchange\ rate\ volatility_{p4}(t) + u(t)$$

The estimated regression coefficient and regression result is summarized in Table 4-12 and corresponding regression plot is shown in Figure 13.

Coefficients	Estimate	Std. Error	t-value	p-value
$\alpha$	0.001048	0.001099	0.954	0.341
$\beta_3$	-2.052988	0.288114	-7.126	9.81E-12
Adjusted R-squared			15.33%	

Table 4-12: Regression estimation result for Phase 4

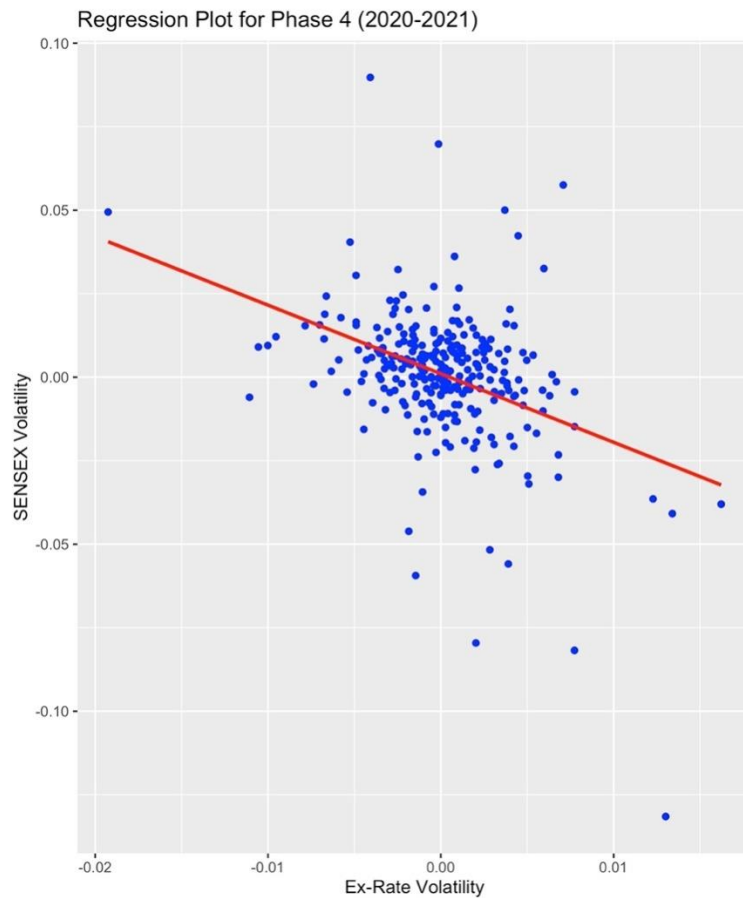


Figure 13: Regression plot for Phase 4

The regression estimation results the slope coefficient as -2.053 and regression r-squared value of 15.33%. The slope coefficient shows negative relationship between SENSEX daily volatility and INR/USD exchange rate daily volatility as expected. It should be noted that the absolute value of slope coefficient is the highest among all phases which shows the exchange rate volatility has the highest impact on SENSEX daily volatility. Additionally, regression r-squared value is also significant as compared to Phase 1 which shows significant correlation between exchange rate volatility and SENSEX volatility. The empirical results are also consistent with the regression plot in Figure 13.

#### 4.7 Granger Causality Test

This section presents the result of Granger Causality Test to argue whether the causal variable can help forecast the other variable. For this analysis, the two variables of study i.e. INR/USD exchange rate daily volatility and SESEX daily volatility have been used. As discussed in Section 3.6.6, the causality can be established in either way – INR/USD exchange rate daily volatility to SENSEX daily volatility or SENSEX daily volatility to INR/USD exchange rate daily volatility. Hence, the test has been performed for both of the cases. The Granger Causality test has been performed on the complete time series and on each of the four phases separately. The null hypothesis of this test is that there is no causal relationship between the variable. Therefore, the p-value of less than 0.05 represents null hypothesis can be rejected and there is a causal relationship between the variable of studies. The test results are shown in the below tables where X is INR/USD exchange rate daily volatility and Y is SENSEX daily volatility.

Direction of Causality	F-Statistic value	P-value	Result
Complete Dataset (January 1991 – February 2021)			
$X \rightarrow Y$	0.3845	0.5352	No Causality
$Y \rightarrow X$	0.6509	0.4198	No Causality
Phase 1 (January 1991 – December 2006)			
$X \rightarrow Y$	1.6237	0.2027	No Causality
$Y \rightarrow X$	0.6172	0.4321	No Causality
Phase 2 (January 2007 – December 2010)			
$X \rightarrow Y$	2.672	0.1025	No Causality

$Y \rightarrow X$	3.0302	0.0821	No Causality
Phase 3 (January 2011 – December 2019)			
$X \rightarrow Y$	3.1020	0.0783	No Causality
$Y \rightarrow X$	2.0421	0.1531	No Causality
Phase 4 (January 2020 – February 2021)			
$X \rightarrow Y$	5.8008	0.01668	Causality
$Y \rightarrow X$	0.0038	0.9505	No Causality

Table 4-13: Grange Causality Test results

The above table represents the results for Granger Causality test for all of the phases and the complete calibration period. It can be seen from the table that Causality is present in only Phase 4 from INR/USD daily exchange rate volatility to SENSEX daily volatility. For other time periods, causality is not present in any direction. It should be noted that the presence of causality means that the one variable can be helpful in forecasting the other variable as discussed in section 3.6.6. Hence, it should not be compared with the linear relation between the two variables as established in Section 4.4 to Section 4.5 where considerable linear relationship has been established between the two variables in different phases. Although, there is significant linear relationship between the two variables in Phase 2, Phase 3 and Phase 4. The INR/USD exchange rate variable is not helpful in forecasting the SENSEX daily price volatility except in Phase 4.

# Chapter 5: Conclusion

❖ **Recommendations**

## 5 Conclusions

The study presents the impact of exchange rate fluctuation on the share price movement through an empirical linear relationship between the two variables. The complete study period is divided into four phases to account for the shift in economic conditions, capital market levels and crisis period i.e. Economic Liberalization and its After Effect, Global Financial Crisis, Consistent Equity Market Growth, Corona Virus Pandemic. The study analyze each of the phases independently and determine empirical relationship between exchange rate fluctuations and share price movement. The Ordinary Least Square linear regression analysis has been used for the empirical relationship. Based on the results, it can be concluded that there is a negative relationship between SENSEX price movement and INR/USD exchange rate volatility (percent change) as the value of rupee decreases (INR/USD index increase), the SENSEX index decreases. However, the strength and impact of the movement in exchange rate varies in different phases.

In the Phase 1 of Economic Liberalization and its After effect, the relationship between the two variables if negligible. This can be explained as the foreign investors were just starting to invest in the Indian Capital Market so the exchange rate market was not very efficient. Hence, there was no significant impact of exchange rate fluctuations on the share price movement in Phase 1.

Phase 2 of Global Financial Crisis has the greatest strength of linear relationship in all of the four phases. In this period, there were significant contribution of foreign investors in the Indian capital market and exchange rate market were also liquid and efficient. Since this financial crisis was primarily in US, the stress on Indian capital market was due to foreign investors pulling their money from the market. Hence, this is completely driven by foreign investors. Hence, the relationship is significant and the impact of INR/USD exchange rate fluctuations on the SENSEX price movement was also considerable.

Phase 3 of Consistent Equity Market Growth has the high strength of linear relationship between the exchange rate fluctuations and share price movements. However, the impact of exchange rate fluctuations on share price movement was negligible. This can be explained as the growth in equity market was consistent with the economic growth in India. Hence, both the foreign investors and domestic investors has presence in the equity market. The growth was driven by economic expansion in the country itself that drove the share



price. Hence, the impact of exchange rate fluctuation is negligible in the period of consistent growth.

Phase 4 of Corona Virus Pandemic has high strength of linear relationship between the exchange rate fluctuations and share price movements. The impact of exchange rate fluctuation on share price movement was also significant. As this crisis affected both domestic and global economy in contrast to the global financial crisis which was primarily in US, the stress was felt on both SENSEX and INR/USD exchange rate. Hence, there is a strong relationship between SENSEX movement and INR/USD exchange rate fluctuations.

Additionally, the Granger Causality test shows that the causality is present only in Phase 4 from INR/USD exchange rate volatility to SENSEX price volatility. For other phases, there is no causal relationship in either directions.

Overall, it can be concluded that there is a negative relationship between SENSEX price movement and INR/USD exchange rate fluctuations. However, the strength of the relationship depends on nature of stress or growth period.

## 5.1 Recommendations

This study is an attempt to understand the relationship between Indian equity market (SENSEX) movement and INR/USD exchange rate fluctuations. The relationship between the two variables is established in different economic conditions – stress, normal and growth period by dividing the dataset (January'91 – February'21) into four phases. As shown in this study, the strength of the linear relationship varies in different economic conditions. Although, there is not very strong causal relationship between the two variables, the empirical relationship is certainly helpful in hedging a portfolio which includes both equity market and exchange market instruments. Since the relationship changes with the economic conditions, it would be helpful for an investor to change the quantity of hedging. As this study provides a relationship between the equity market and exchange market, it can also be used government financial institutions to change their positions in the two market based on the established relationship.

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