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Impact of Macro-Economic factors on the Indian Stock Market

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ABSTRACT

This paper, based on the average monthly data (January 2006 to November 2016) of 11 macro-economic variables, uses the data reduction technique-factor analysis to derive the factors which determine the performance of stock market in India. The Principal Component Technique after using Varimax rotation extracted three factors labelled intuitively as Macro Economic Environment variables, Policy Rates and Crude and Industrial Performance. It was concluded that markets rely more on the macro-economic factors, industrial performance and how US exchange reacts to the events in the economy.

JEL Code: E44, F62, F65.

Keywords: Stock Market, Macro Environment.

1. INTRODUCTION

A Multi-factor model is a financial model that employs multiple factors in its computations to explain the market phenomenon and equilibrium asset prices. The multi-factor model can be used to explain either an individual security or a portfolio of security. Factor models are thus based on one of the fundamental tenets of financial theory: no reward without risk. The Capital Asset Pricing Model (CAPM) first presented by Sharpe (1964), Linter (1965) and Mossin (1996) is a single factor model and remains one of the most popular empirical models of the return generation process. This model uses stock beta as the only relevant risk measure. But empirical studies could not confirm this restrictive statement. Ross (1976) posited a more general multiple factor structure for the returns generating process, known as the Arbitrage Pricing Theory (APT). However, he was unable to explain the nature or specify the number of factors. Further work carried out in this field by Chen et. al., (1986) attempts to explain some of these factors. Fama and French (1992) find that the main prediction of the CAPM is violated for the US stock market. Exposures

to two other factors, a size-based factor and a book-to-market-based factor, often called a "value" factor, explain a significant part of the cross-sectional dispersion in mean returns. Their paper was the foundation for a number of empirical studies in this direction.

Multi-factor models can be divided into three categories: macroeconomic models, fundamental models and statistical models. Macroeconomic models compare a security's return to such factors as employment, Inflation and interest. Fundamental models analyze the relationship between a security's return and its underlying financials, such as earnings and its relation to various assets. Statistical models are used to compare the returns of different securities based on the statistical performance of each security in and of itself.

The beta of a security measures the systemic risk of the security in relation to the overall market. A beta of 1 indicates that the security theoretically experiences the same degree of volatility as the market and moves in tandem with the market. A beta greater than 1 indicates the security is theoretically more volatile than the market. Conversely, a beta less than 1 indicates the security is theoretically less volatile than the market.

A multiple factor model for I = 1, ..., *n* securities of a market can be represented in the form of an equation

$$R_i = \alpha_i + \beta_{i1}F_1 + ..., B_{ik}F_k + \varepsilon_i \quad (1)$$

where,

R_i = returns to security *i*

α_i, β_{ij} = sensitivity of security *i* to factor *j*

F_1, ..., F_k = the *k* factors

ε_i = specific return to security *i*

There are three broad assumptions behind the model. The first is that the specific returns are not correlated with each other. This implies that the correlation between the returns on two different securities is solely determined by their common dependence on the factors F_1, F_2, ..., F_n. The second is that the expected specific return is zero. The third is that the specific returns are independent of the factors.

2. LITERATURE REVIEW

It is well established in the financial economics literature that the macroeconomic variables affect the behaviour of stock market (Chen, Roll and Ross, 1986). Apart from the fundamentals of the firm, macro environment plays an important role in determining the stock market volatility. The behaviour of macroeconomic variables, both internal and external, has positive as well as the negative effect on the stock market performance depending on the nature of the variables. In the past two and half decades, researchers have endeavoured to identify such relationship by applying the techniques like Factor Analysis, Co-integration, and Vector Autoregressive Approach (VAR) and ARCH/GARCH models.

Some of these studies have considered only the real economic variables (Fama, 1981); and others have used financial variables to emphasize the affect on stock market volatility (Connor & Korajczyk, 1986). There are more comprehensive studies that have used the combination of real and financial variables (Van

Rensburg, 2000; Solnik 1987). In the developed countries, it has been established that, on average, the number of factors explaining returns remain approximately the same across the various samples of same size and across various time intervals, except the numbers of significant factors increase with the group size (Kryzanowski & To, 1983; Dhrymes et. al., 1984). It has been proved in the literature that exploratory factor analysis technique is better than the confirmatory factor analysis technique (Garret & Priestley, 1997).

Besides, more selective studies have been done to explain the volatility of stock market. As money supply and oil prices are more important variables in the crude producing countries. These two factors were able to explain considerably the variation in the stock market in the Iranian economy (Mohseni, 2007). Since the less developed countries of South Asia including India are relatively less integrated to the world, hence international macro economic variables have insignificant though positive role in explain the shakiness of stock markets. Moreover, these economies did not depict any long run relationship between stock market and the exchange rate (Smyth & Nandha, 2003). However, some studies have found a significant positive relationship between stock market and exchange rates (Smith,1992; Solnik, 1987; Aggarwal, 1981) while others have reported a significant negative relationship between the two (Soenen & Hennigar, 1988).

In accordance with the basic division of factor models of stock returns on economic and fundamental, the literature on factor models can also be regarded in this way. The well-known paper of Fama and French (1992), for example, analyzes firm-specific microeconomic variables such as market beta, firm size, earnings-price ratio, leverage ratio and book-to-market equity in explaining stock returns, thus representing the fundamental factor model. On the other hand, Chen, Roll and Ross (1986) analyse macroeconomic and financial market variables in an economic factor model. Given that this paper investigates macroeconomic factors and stock returns, we present a brief overview of similar studies.

Variables used by Chen, Roll and Ross (1986) in their notable study on U.S. stock returns include industrial production, inflation, risk premium, term structure, market index, consumption and oil prices. The authors found that the industrial production, unanticipated change in the risk premium, unanticipated inflation, and, a slightly weaker, the unanticipated change in term structure, are the most important factors affecting expected stock returns.

In order to eliminate some economic and econometric difficulties associated with factor analysis techniques, McElroy and Burmeister (1988) modified the APT as a multivariate non-linear regression model. They used four macroeconomic variables, namely, the risk premium, term structure, unexpected deflation and unexpected growth in sales, as well as the residual market factor. Within the multivariate non-linear regression model all five factors showed as significant in explaining stock returns.

3. SCOPE & OBJECTIVE

Money Supply has significant effect on the macro-economic variables which is represented by broad money supply (M3). Consumer Price Index reflects the inflation in the economy and its high level will threaten the macro-economic stability and thus stock market becomes more volatile. In trading economics, exchange rate has substantial impact on the investment portfolio. A stronger dollar dampens thedemand for commodities that are priced in dollar. India is dependent on other nations for more than three fourth of their crude oil need. Any movement in the international crude prices considerably affects the national economy and ultimately reflected in the stock market of the country. Gold is a safe asset class and has significant relation

with the stock market prices. The strength and stability of the host country's currency is measured by the level and the volatility of the call money rates. The Business Confidence Indexis based on the enterprise's assessment of production, orders and stocks and it shows confidence in the economy hence faith in the stock market. IIP shows the status of industrial activity and help predict the market movement. Average Price to Earnings Ratio depicts if the stock market is cheap or expense. When the Index rises at a faster pace than earnings, PE expands. Inversely, when the Index falls at a faster rate than the earnings contraction, it leads to a lower PE. Nikkei 225 and S&P 500 are introduced as global market cues – whereas Nikkei 225 of Japan opens before the Nifty of India there is some common trading hours but S&P 500 in the US opens after the Indian stock market closes. Therefore, same day indices are compared for Nikkei 225 and Nifty but previous day's index value of S&P 500 is compared to next day value of Nifty. We have also used S&P 500 and Nikkei 225 in this paper to provide evidence that India's stock market returns are highly dependent on the how US market responses to the macro-economic and bubble bursts around the globe.

The aim of this paper is to study the evidence of a multi factor model for explaining the stock price returns in Indian Stock Market. Factor models observe the sensitivity of an asset return as a function of one or more factors. This paper analyzes returns of stocks of various sectors for a span of 11 years using factors like Money Supply, Inflation, Share Price, 10-year Bond Yield, Gold, Crude Oil Prices, USDINR rate, Business Confidence Index(BCI), Index of Industrial Production, S&P 500 and Nikkei 225 index returns.

4. HYPOTHESIS STUDY

Ho: The extracted factors, S&P 500 and Nikkei 225 impact returns on BSE Sensex

H1: The extracted factors, S&P 500 and Nikkei 225 doesnot impact returns on BSE Sensex

We have taken the confidence level at 95%.

If the significance level is greater than 5% then we will reject the null hypothesis and accept alternative Hypothesis and vice versa.

5. DATA DESCRIPTION AND SAMPLE PERIOD

The study covers the period from January 2006 to November 2016. This period has witnessed the phases of boom and recession, hence may better reflect the performance of the macroeconomic variables on stock market indices. We have chosen BSE Sensex and monthly average data has been culled from the bseindia website. The monthly average data for other macroeconomic variables has been taken from various websites and presented in following table.

Table 1
Macro Economic Variables used in the analysis

Variable	*Symbol*	*Data Source*	*Unit*
Money Supply	M3	https://data.oecd.org	INR Billion
Consumer Price Index	CPI	https://data.oecd.org	Index
Gold Prices	GP	http://www.indexmundi.com/commodities/	INR per 10 gm

(*Contd...*)

Variable	*Symbol*	*Data Source*	*Unit*
Crude Oil Price	COP	http://www.indexmundi.com/commodities/	INR per barrel
Call Money Rate	CMR	https://dbie.rbi.org.in	% per annum
Index of Industrial Production	IIP	https://data.oecd.org	Index
Business Confidence Index	BCI	https://data.oecd.org	Index
USDINR rate	USDINR	https://dbie.rbi.org.in	INR per dollar
10-Yr Government Bond Yield	BY	https://dbie.rbi.org.in	% per annum
Share Price	SP	https://data.oecd.org	INR
Average PE	PE	https://dbie.rbi.org.in	Ratio

The above table depicts that variables from all segments of the economy are used which have potential to influence the movement of the stock market such as circulation of money supply in the economy, external economy, performance of the real economy, prices and policy rates.

6. METHODOLOGY

Since this study is related to impact of various macroeconomic variables on the stock market in India, variables identified to include as macroeconomic variables in the analysis are expected to be correlated among themselves. The bold values in the Table 2 show that several variables are significantly correlated and if direct regression has been applied by using these macroeconomic variables as explanatory variables, we may encounter severe multi co-linearity problem in the fitting of the model. Hence, to overcome this problem and have effective results, factor analysis approach of data reduction has been applied by using the software SPSS.

Table 2
The Correlation Matrix of the Macro Economic Variables
Correlation Matrix

		M3	*CPI*	*10-Yr Bond Yield*	*Gold*	*Crude*	*USDINR*	*BCI*	*IIP*	*Call Money Rate*	*Average Price/ Earning Ratio*	*Share Price*
Correlation	M3	1.0	.996	.091	.862	.279	.935	–.62	.903	.247	–.145	.893
	CPI		1.00	.136	.881	.332	.933	–.60	.908	.269	–.154	.887
	10-Yr Bond Yield			1.000	.272	.729	.005	.303	.230	.546	.032	.148
	Gold				1.00	.566	.752	–.57	.901	.352	–.305	.673
	Crude					1.000	.193	–.15	.442	.507	–.288	.193
	USDINR						1.000	–.68	.731	.247	–.274	.768
	BCI							1.00	–.53	-.009	.652	-.323
	IIP								1.00	.255	–.110	.827
	Call Money Rate									1.000	–.231	.194
	Average Price/ Earning Ratio										1.000	.243
	Share Price											1.000

Before applying the technique of factor analysis, The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy test and Bartlett Test of Sphericity are applied to find the applicability of factor analysis. KMO test is an index for comparing the magnitude of the observed correlation coefficients to the magnitude of the partial correlation coefficient. Its value. 5 or more is considered as a sizeable sampling adequacy. Bartlett Test of Sphericity is used to test the correlation matrix is an identity matrix. If the value of the test statistic for sphericity is large and the associated significance level is small, it is unlikely that the correlation matrix is an identity, hence, the factor analysis is recommended.

Factor analysis is a statistical method used to reduce the number of variables and to detect structure in relationships between variables that is to classify variables. We have used Principal Components analysis is used to reduce the dimensionality of the data set consisting of a large number of interrelated variables. Factor weights are computed in order to extract the maximum possible variance, with successive factoring continuing until there is no further meaningful variance left. The number of factors extracted is determined by the Kaiser Criterion and Scree Plot. The Kaiser rule is to drop all components with Eigen value less than 1.0. In this paper, Varimax rotation, an orthogonal rotation of the factor axes to maximize the variance of the squared loadings of a factor on all the variables in a factor matrix, which has the effect of differentiating the original variables by extracted factor. Each factor will tend to have either large or small loadings of any particular variable. A varimax solution yields results which make it as easy as possible to identify each variable with a single factor. This is the most common rotation option. After extracting the factors, factor score series are derived from the SPSS and the CNX nifty series has been regressed on the factor score series as:

$$S_t = \alpha + \lambda_1 F_{1t} + \lambda_2 F_{2t} + \cdots + \lambda_k F_{kt} + \varepsilon \quad (2)$$

where, S_t is the average index value of BSE Sensex in month t.

F_{1t}, F_{2t}, ⋯, F_{kt} are the average factor scores in month t for respective factors in month

λ_1, λ_2, ⋯, λ_k are factor coefficients measuring the strength of factors on the volatility of Sensex.

7. RESULTS AND DISCUSSION

Given the nature of the literature review included in the study, the problem of the correlation cannot be ruled out. The correlation matrix in Table 2 shows a strong correlation among the variables. So, we used the KMO and Barlett's Test to affirm the multi co-linearity among the variables. The KMO value in Table-3 is 0.773 which exceeds 0.5, hence KMO test confirms the correlation among the macroeconomic variables and the factor analysis of the variables is feasible. According to the Bartlett's test of sphericity the Chi-Square value is quite large and associated significance is. 00 which means that the correlation matrix is not an identity matrix.

Table 3
KMO and Barlett's test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.773
Bartlett's Test of Sphericity	Approx. Chi-Square	2522.183
	df	55
	Sig.	.000

Therefore it points out that the data reduction technique of factor analysis is plausible. The PCA method has been used to derive the factors. The results are presented in Table 4. The table shows that out of the 11 variables used only 3 factors are capable in explaining 88.56% variance, of which 54.8% is explained by Factor-1, 19.2% is explained by Factor-2 and rest by Factor-3.

Table 4
Factors derived by Principal Component Analysis using Kaiser Criterion
Total Variance Explained

Component	*Initial Eigenvalues*			*Extraction Sums of Squared Loadings*			*Rotation Sums of Squared Loadings*		
	Total	*% of Variance*	*Cumulative %*	*Total*	*% of Variance*	*Cumulative %*	*Total*	*% of Variance*	*Cumulative %*
1	6.034	54.852	54.852	6.034	54.852	54.852	5.442	49.477	49.477
2	2.118	19.250	74.102	2.118	19.250	74.102	2.423	22.031	71.508
3	1.591	14.463	88.565	1.591	14.463	88.565	1.876	17.057	88.565
4	.600	5.455	94.020						
5	.253	2.301	96.321						
6	.173	1.573	97.894						
7	.130	1.179	99.073						
8	.066	.597	99.670						
9	.026	.239	99.909						
10	.008	.073	99.982						
11	.002	.018	100.000						

Extraction Method: Principal Component Analysis.

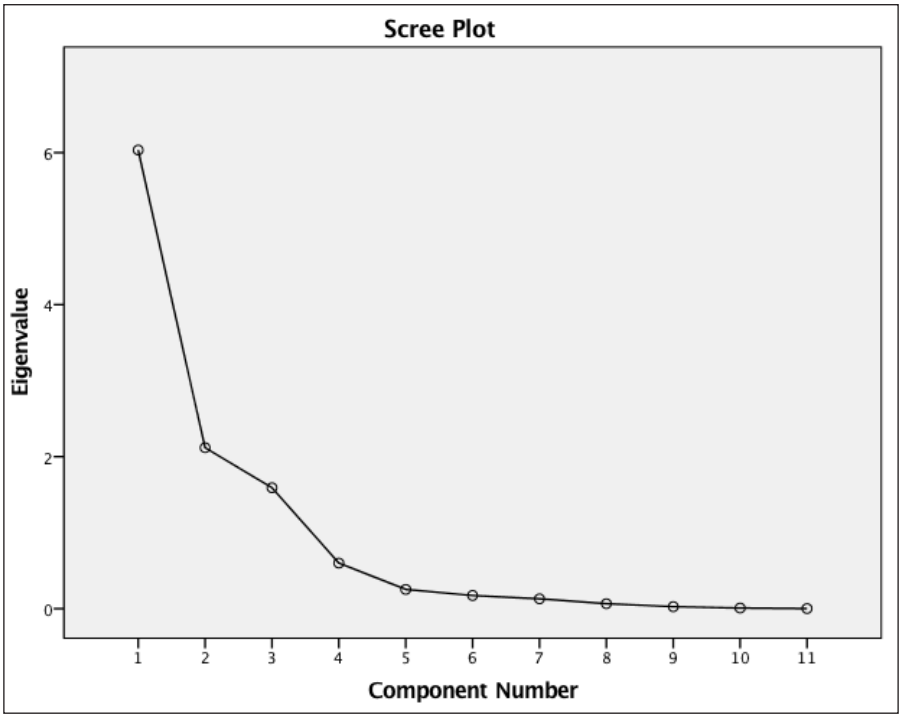

Figure 1: Scree Plot

Scree Plot is a graphical criterion to determine the number of factors. It has been plotted in the above figure. With the Scree Test (Cattell, 1966), the eigenvalue associated with each factor and look for a break between the factors with relatively large Eigen values and those with smaller Eigen values. The factors that appear before the break are assumed to be meaningful and the retained for rotation; those appearing after the break are assumed to be unimportant and are not retained. In Figure 1, component numbers are listed on the horizontal axis while Eigen values are listed on the vertical axis. The Figure 1 clearly shows that after component 3, the plot shows a clear break, hence, corroborate our earlier result of the extraction of three factors.

Table 5
The Rotated Component Matrix (Varimax Method and Kaiser Normalization)
Rotated Component Matrix[a]

	Component		
	1	*2*	*3*
M3	.981	.091	–.137
CPI	.975	.141	–.139
10-Yr Bond Yield	.032	.910	.229
Cold	.818	.368	–.276
Crude	.200	.860	–.193
USDINR	.891	.015	–.282
BCI	–.551	.177	.765
IIP	.903	.250	–.085
Call Money Rate	.146	.749	–.111
Average Price/Earning Ratio	.016	–.175	.959
Share Price	.940	.067	.260

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.[a]
[a]Rotation converged in 5 iterations.

The principal component analysis (PCA) method provides the relationship between the extracted factors and the variables included in the analysis. It is technically termed as the factor loadings. Factor analysis technique provides the facility of factor rotation to generate the orthogonal factors; accordingly, varimax technique of orthogonal rotation with Kaiser Normalization has been used. The results are presented in the table-6. Table-6 clearly shows the orthogonal transformation and the values of the factor loadings clearly identify each variable with only one factor. Variables like M3, CPI, GP, USD-INR, IIP andSP are identified with Factor-1. BY, COP and CMR are identified with Factor-2 and Factor-3 incorporates BCI and PE.

Twelve variables included in the study, due to their inter-related nature are converted into three factors and the violation of no multi co-linearity assumption of classical linear regression model has been successfully removed. Factor (F1) is labelled as Macro environment in the economy; Policy Rates and Crude has been intuitively labelled as F2 and F3 is assigned as Industrial Performance.

Table 6
Macro Economic Variables Grouped by Factors

Factor	*Variables*	*Name assigned to the Factor*
F1	Money Supply, Consumer Price Index, Gold Prices, USDINR rate, Industrial Production Index, Share Price	Macro Environment
F2	10-year Bond Yield, Call Money Rate, Crude Oil Price	Policy Rates and Crude
F3	Business Confidence Index, Average PE	Industrial Performance

It has been established in the above mentioned results that variables in the study can be reduced to three factors with 88.56% explanation of variance among themselves (Table 4). In this context, the BSE Sensex index has been regressed on these Three factors (Equation-2) whose factor score series have been provided by the SPSS while deriving the factors and S&P 500 and Nikkei 225. We have taken S&P 500 because it opens after BSE closes and Nikkei 225 is Japanese Index which opens before BSE. The results of such regression are presented in the Table 9.

According to the Regression Results, we can observe that the 3 extracted factors, S&P 500 and Nikkei 225 explain 97.9% variation in BSE Sensex and the remaining 2.1% is from unknown factors. The significance is. 000 which explains that the model is fit and we can accept the Null Hypothesis. Also the R-squared value is very high i.e. 95.9% which justifies the model.

Table 7
Model Fit

Model	*R*	*R Square*	*Adjusted R Square*	*Std. Error of the Estimate*
1	.979a	.959	.957	1119.46483

[a]*Predictors:* (Constant), Macroeconomic Environment, Policy Rates & Crude, Industrial Performance, Nikkei 225, S&P500.

Table 8
ANOVA Summary
ANOVA[a]

Model		*Sum of Squares*	*df*	*Mean Square*	*F*	*Sig.*
1	Regression	3.642E+9	5	728345205	581.188	.000b
	Residual	156650187	125	1253201.49		
	Total	3.798E+9	130			

[a]*Dependent Variable:* BSE
[b]*Predictors:* (Constant), Macroeconomic Environment, Policy Rates & Crude, Industrial Performance, Nikkei 225, S&P500

Indian market is not exceptional, during the period under consideration it might has been affected by the company specific factors as well as the natural disasters. We can see that the value of the constant in the fitted model (Table-9) is highly significant. This has already been proved in the literature of many other developed and developing countries that favourable macro environment is a boon for the stock market and the stocks can trade with high PE values that the faith in the stock market improves considerably. The macro factors have an impacton Indian economy as well.

The coefficient of F1 i.e. Macroeconomic Environment turned out to be highly significant and thereby Indian Stock Market is highly responsive to the change. Industrial Performance i.e. F3 has significantly and

Table 9
Impact of Extracted Factor on the BSE Sensex
Coefficients[a]

Model	*Unstandardized Coefficients*		*Standardized Coefficients*	*t*	*Sig.*
	B	*Std. Error*	*Beta*		
(Constant)	13655.663	1013.408		13.475	.000
S&P 500	4.153	1.444	.291	2.875	.005
Nikkei 225	–.076	.097	–.052	–.785	.434
Macroeconomic Environment	3897.455	342.649	.721	11.374	.000
Policy Rates & Crude	73.022	152.188	.014	.480	.632
Industrial Performance	1172.470	109.872	.217	10.671	.000

[a]*Dependent Variable:* BSE

positively reflected in the performance of the BSE indices. But, F2 i.e. Policy Rates and Crude though positive but proved to be insignificant i.e. significance level is 0.632 in explaining the performance of stock market in India. We can also observe that Indian Stock Exchange is highly impacted by the ups and downs of the S&P 500 index but insignificant influence of the Japanese Index.

We may say that some impulses in the stock market are due to macro-economic changes, industry performance and the US stock market. We derive the following regression equation to explain the impact of various factors on the Indian stock market represented by BSE Sensex

$$BSE = 0.291 \times S\&P500 - 0.052 \times Nikkei + 0.721 \times F1 + 0.014 \times F2 + 0.217 \times F3 + 13655.663$$

8. CONCLUSION

This study highlights the effect of macroeconomic variables both internal and international, and financial and real variables on the Indian Stock Market. Indian Stock Market has been measured by BSE Sensex. Variables taken into consideration are based on monthly averages for the period of January, 2006 to November, 2016. It has been established that several macroeconomic variables are highly correlated and a regression equation may pose a severe multi co-linearity problem. Hence, we used Principal Component Analysis to derive common factors which can explain 88.56 percentof returns. The Principal Component Analysis has highlighted that three factors are sufficient to explain the impact of the 11 variables included in the study. Orthogonal rotation has clearly demarcated the variables in the factors labelled as Macro Environment, Industrial Growth and Policy Rates. Stock prices are greatly affected by investor's expectations so they respond very quickly to any publically disclosed information, for example, political or economic news. For this reason, while analysing stock prices it would be better to use macro-economic indicators such as inflation rate, fluctuations in Gold Prices, Crude Oil Price and USDINR rate. The study highlights that favourable macro environment in India is good for the stock market and the stocks can trade with high Price Earning (PE) ratio that faith in the stock market improves considerably. Indian stock market is highly responsive to the changes in the US stock indices. Industrial performance in terms of growth pattern is highly passively associated with the performance of the stock market. Confidence in the system is more responsible for fresh investments as compared to the policy rates. Nevertheless, weak effect of policy rates on stock market cannot be denied. Apart from the macroeconomic environment, stock market is affected by the performance of the firms as well as the unforeseen events.

However, there are few limitations to this study. We cannot predict the occurrence of recession, bursting of any bubble. Not all factors are taken into account. The measurement of certain important factors like employment rate, GDP, growth rate is done on yearly basis and aren't used in the study. Performing such analysis on yearly basis will narrow down the results and may not return the desired results. The changes in stock market indices is based on the demand and supply of the shares and the population investing in equity is relatively less as equity is a risky asset. There has not been much research on how to find the customer sentiment towards a particular event.

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