VAR Modelling of Economic Policy Uncertainty Impact on the SENSEX

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***Abstract*— This paper examines the dynamic relationship between economic policy uncertainty in India and the SENSEX returns through the means of impulse responses of the two signals. The methodology employed is Vector Auto Regression on monthly data of the two variables from M3 2003: M11 2016. The study supports the semi strong form efficient market hypothesis for the Indian Stock market. The SENSEX returns do not change significantly for information signals and uncertainty signals in the Indian economy. Policy Uncertainty is quantitatively modeled from data mining of news and is obtained from an index. The results show that the fundamental factors driving the SENSEX continue to do so irrespective of uncertainty in the economy in the short term.**

Keywords*— *Economic Policy Uncertainty, Stock Returns, Vector Auto Regression

I. INTRODUCTION

The concepts of risk and uncertainty are widely mentioned and used in various fields of finance. Frank Knight in his seminal book 'Risk, Uncertainty and Profit' [1] had distinguished the two in terms of the ability to place probabilities and thereby measure the same. Risk is considered measurable while uncertainty being inherently impossible to predict and foresee, cannot be measured.

There are various forms of uncertainty in the economy affected by and affecting various agents. They can all be broadly classified as economic policy uncertainty. Events such as GST bill being tabled in the Indian Parliament [2], demonetization decision by the government of India on Nov 8th, 2015 [3] or vote for exit of Britain from the European Union [4]; these are examples of increasing economic policy uncertainty. Stock markets on the other hand are barometers of the Indian economy itself and a signal of sound economic strength of the country.

As per Efficient Market Hypothesis [5], any news event that has the potential to affect the stock markets long term must already be factored by the investors and traders in the open market. Recent work by [6] confirms that efficient markets theory is still relevant and holds true in general. Hence no long term effects must be observed in stocks subject to uncertainty in an information efficient market. Understanding the effect of a particular uncertainty on the stock market of the country and its duration of impact are important to policy makers. A sharp fall in the markets can entail investors losing millions of rupees. Capital Inflows and a robust market supports corporates in business expansion and any undue negative effects on the same can affect long term business growth in the country [7].

The challenge of course remains in being able to measure the policy uncertainty in the economy and thereby using it to analyze and predict its effect on the stock index returns and volatility. This paper uses a proxy for economic uncertainty as modelled by [12] in his study which uses data mining to arrive at a news based uncertainty index.

This paper aims to study the dynamic effects of how policy uncertainty in India affects the stock market returns. In particular, the study carries out impulse responses to shocks in both uncertainty and stock markets on each other and durations of impact. The results have practical applications on perceived policy effects on stock markets within India.

II. LITERATURE REVIEW AND HYPOTHESIS

Past Studies on how various types of uncertainty in the economy affect stock returns and the volatility of those returns have been carried out in various countries around the world. Study [8] was done in China, [10] [11] for the USA, and studies [13] [14] [15] [17] were done across many different countries. All the studies have been near unanimous on the fact that markets dislike uncertainty, while there exist some differences in the extent and the length of impact of a particular effect. Some studies have focused on how uncertainty within the country affects the country's own stock markets [8] while others have focused on the effect on economic uncertainty in one country on the stock market returns in across countries [15] [17]. They are discussed below.

Study by [8] finds that stock markets returns of the Shanghai Composite index is highly correlated with the economic policy uncertainty of China. It is found that the policy uncertainty has a negative effect on the Shanghai index for eight months duration while the stock market uncertainty itself contributes to a negative impact on the economic uncertainty in the country for a period of 4 months.

A firm level study by [9] aims to find a relationship between political connectedness of certain firms and their stock performance through data on elections in the US. The conclusion drawn is that firms not connected politically to the administration at the time are more liable to face policy risk.

A study by [10] classifies economic policy shock into four components and finds out how they affect investments made by firms in the US and their stock price volatility. The news based shock and federal expenditure policy shocks are found to be large and cause higher stock price volatility, while tax shocks and inflationary shocks in the economy are found to be statistically insignificant.

Study by [11] finds the extent of dynamic correlations between the US S&P 500 returns, the US Volatility Index and a proxy for policy uncertainty in the economy as introduced by [12]. The correlations are found to be negative between uncertainty and index returns over time, except for during the financial crisis.

Study by [13] finds that a 1% increase in uncertainty in the economy attributes to an on average 2.807% decrease in unexpected return on stock market indices of 21 countries including India. The paper captures economic uncertainty through newspaper coverage, federal tax code provisions and disagreement between economic forecasters in the economy and the methodology used is correlations and panel regression models.

Study by [14] finds that valuation of assets such as stocks and their valuation ratios such as Price to Earnings predict and are predicted by volatility in aggregate consumption growth in the economy, a proxy for economic uncertainty. Increase in volatility in the economy according to fundamentals will increase expected returns and thereby lower expected asset prices. The study is done for the US, Germany, Japan and United Kingdom and finds net negative change in asset valuations associated with higher uncertainty.

Study by [15] analyses index returns and volatility spill overs of the economic policy uncertainty in the US and the stock markets of BRIC countries with the methodology used by [16]. As from previous studies, there is found to be a strong negative correlation between the US EPU and returns in BRIC countries, while the causality in variance is found to oscillate between positive and negative values.

Study by [17] estimates the effect of US monetary policy shocks on the stock markets of 25 countries. The monetary policy shock is found using the federal funds futures rate and methodology used is the event study methodology. The results indicate a strong surprise of foreign markets to unanticipated US monetary policy surprise with significant variation in their individual responses.

[18] conducted a study on effect of macro environment variables on returns of BSE Bankex returns. The findings are significant for the influence of FDI changes and Forex reserves on the stock returns.

Study by [19] finds that efficient market hypothesis does not hold true for many companies in the Nifty 50 by comparing the causality between returns and volume of trading.

The objective of the paper is to

A. Examine the effect of a shock on Indian Economic Policy Uncertainty on Indian Stock Market Performance.

B. Examine the effect of a shock on Indian Stock Market on Indian Economic Policy Uncertainty.

The hypothesis for testing as obtained from the literature review are as follows:

Ho1: The rise in Indian Economic Policy Uncertainty has a negative influence on the Indian Stock Market for the current period and future periods.

Ho2: The rise in the Indian Stock Market has a negative influence on Indian Economic Policy Uncertainty for the current period and future periods.

III. DATA AND METHODOLOGY

A. Data Description

The data collected is monthly from M3 2003: M11 2016 for a total sample size of 167. The data for Indian Economic Policy Uncertainty is obtained from the Policy Uncertainty Index based on the study by [5]. The Index is constructed based on data mining done on 7 popular newspapers in India and establishing a count based on pre-set keywords. This data is hence normalized to obtain the Indian EPU Index.

The Indian Stock Returns data is taken from BSE India for the SENSEX monthly returns for the period.

The software used for analysis is Gretl.

B. Methodology

For carrying out the analysis of the relationship between the two variables, a time series analysis is necessitated. Vector Auto Regression is employed as the methodology for carrying out this analysis. The formula for vector auto regression is as follows for two time series.

$$Y_{1t} = b_{10} + b_{11}Y_{1\,(t-1)} + b_{12}Y_{1\,(t-2)} + - - - - - - - - - - - - - + b_{1n}Y_{1\,(t-n)} + b_{20} + b_{21}Y_{2\,(t-1)} + b_{22}Y_{2\,(t-2)} + - - - - - - - - - - - - - b_{2n}Y_{2\,(t-n)}$$

$$Y_{2t} = b_{10} + b_{11}Y_{1\,(t-1)} + b_{12}Y_{1\,(t-2)} + - - - - - - - - - - - - - + b_{1n}Y_{1\,(t-n)} + b_{20} + b_{21}Y_{2\,(t-1)} + b_{22}Y_{2\,(t-2)} + - - - - - - - - - - - - - b_{2n}Y_{2\,(t-n)}$$

The first step towards carrying out time series analysis is identifying the stationarity of the time series. We cannot run a time series analysis on a non-stationary time series. We run the Augmented Dickey – Fuller test to identify the presence of a unit root. The formula for the same are given below along with the hypothesis.

$$X_t - X_{(t-1)} = c + (b - 1)\, X_{(t-1)} + e$$

Ho: b = 1 indicates non-stationarity of time series

Next we carry out VAR by identifying the lag order of the model necessary for the data from the different information

criterions. We use AIC, BIC and HQC for testing the same and select that lag order which provides the least value of these criterions.

Based on the lag, we now run the VAR Model and test for non – stationarity or stability of the VAR system just generated. Hence we check the plot of the AR Roots on a graph to see if any of the eigen values of those complex roots fall outside the unit circle. Any root outside the circle indicates a variable that is non stable.

Finally impulse responses can be obtained to understand the dynamic effects between the two time series.

IV. RESULTS

The time series plots of the SENSEX and Indian EPU monthly are given below in Figure 1. As we can see, the Sensex time series chart can be seen to have a clear uptrend, while the Indian EPU chart is highly volatile in nature over the years. Initial impressions are that the SENSEX series is non stationary while the Indian EPU may be stationary in nature. This is tested using the Augmented Dickey Fuller test.

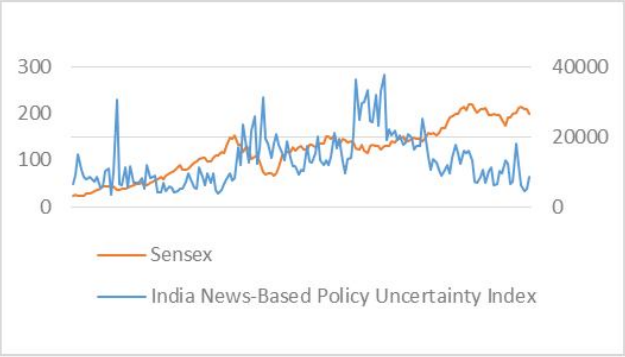

Figure 1: Time Series Plot

The results of the Augmented Dickey Fuller Test in Table 1 show that the p values all are >0.05 indicating the presence of a unit root. Hence the two time series are non-stationary and need to be converted before further analysis is possible. The first difference of each of the variables with themselves is taken to convert them into stationary time series.

TABLE 1: Augmented Dickey Fuller Test

Variable	Test Statistic	P Value	Sig
SENSEX	-1.14068	0.6691	
EPU	-2.36509	0.1518	

Selection of the lags for the VAR System involves looking at the information criterions given in Table 2. The log returns and Akaike Information Criterion (AIC) provide the least value for lag order 3 while Bayesian Information Criterion (BIC) and Hannon – Quinn Information Criterion (HQC) prefer lag order 2.

The model finally picked is for lag order 3 in order to take into account all dynamics in the relationships without excluding any in the error terms.

TABLE 2: VAR System Lags

Lags	loglik	p(LR)	AIC	BIC	HQC
1	-2058.16		26.807	26.925	26.855
2	-2041.62	0	26.644	*26.841**	*26.724**
3	-2035.74	*0.0192**	*26.62**	26.896	26.732
4	-2034.6	0.6858	26.657	27.012	26.801
5	-2031.99	0.26561	26.675	27.109	26.851
6	-2028.16	0.10478	26.677	27.19	26.885

Running the VAR model provides the following results with significance levels. The model for both the vector auto regression equations are given in Table 3 and Table 4.

TABLE 3: Eq 1. d_IPU

Variable	*Coefficient*	*p-value*	
const	−0.499114	0.8560	
d_IPU_1	−0.560507	<0.0001	***
d_IPU_2	−0.433432	<0.0001	***
d_IPU_3	−0.0323304	0.6856	
d_Sensex_1	−0.00808656	0.0045	***
d_Sensex_2	0.00129149	0.6536	
d_Sensex_3	0.00700862	0.0152	**

TABLE 4: Eq 2. d_Sensex

Variable	*Coefficient*	*p-value*	
const	123.197	0.1308	
d_IPU_1	2.81013	0.2430	
d_IPU_2	3.83177	0.1212	
d_IPU_3	2.39488	0.3106	
d_Sensex_1	0.0183486	0.8249	
d_Sensex_2	0.0224603	0.7915	
d_Sensex_3	0.117472	0.1655	

The regression shows that modelling of SENSEX returns present period is not possible with past values of SENSEX and EPU alone as seen in the constant term.

Past SENSEX can be said to not affect present period SENSEX due to the random walk nature of the variable. There are also many insignificant p values for the equation thereby indicating that EPU has no significant effect on SENSEX returns at all.

The lags of Policy uncertainty seem to have a comparatively large and negative impact on present period policy uncertainty equation. There is some significance in this equation thereby indicating that SENSEX returns and past period EPU's affect the present period EPU in India.

The complex roots are plotted on a unit circle in Fig. 2 below. All six roots which are the lagged values of IPU and Sensex all fall within the unit circle. This indicates the stability of the model.

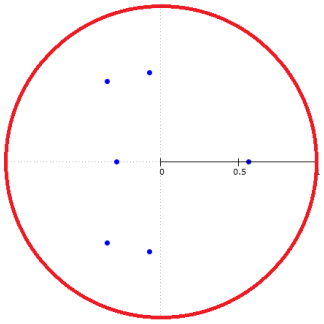

Figure 2: VAR Inverse Roots

Impulse responses give us more insights on the dynamic interaction effects between the two time series. They are given below in Figures 3 to 6.

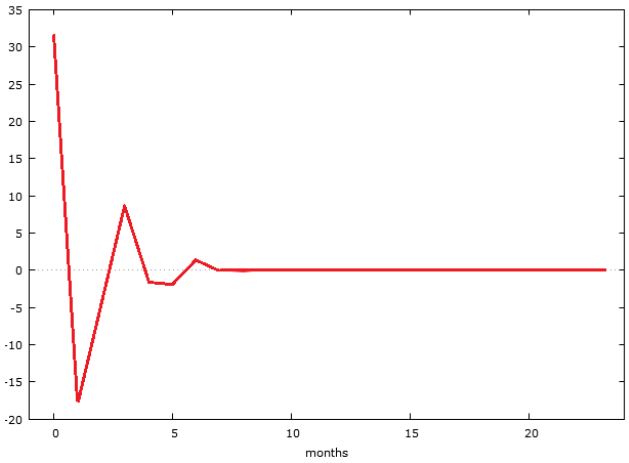

Figure 3: Response d_IPU to d_IPU

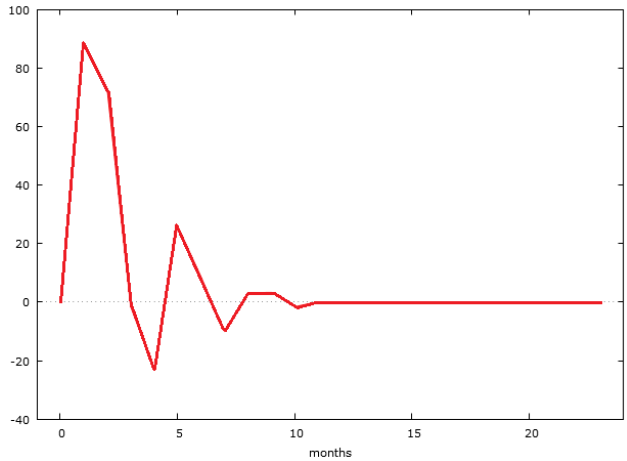

Figure 4: Response d_Sensex to d_IPU

As per Fig. 3 a shock to Indian Policy Uncertainty in the present month causes a sharp negative fall in own variable in the next month. This then hovers around the mean and neutralizes by the 6th month. Hence the effect of a shock to Indian EPU and its effect on itself lasts for 6 months.

Fig. 4 shows that a shock to Indian EPU causes the Sensex to shoot up by around 80 points on average for the next 2 months. This effect then causes the Sensex to fall back down to 0 and is volatile for the next few months. The shock's effect lasts for around 10 months for India's case. But as seen in the VAR Model, this equation has insignificance of variables.

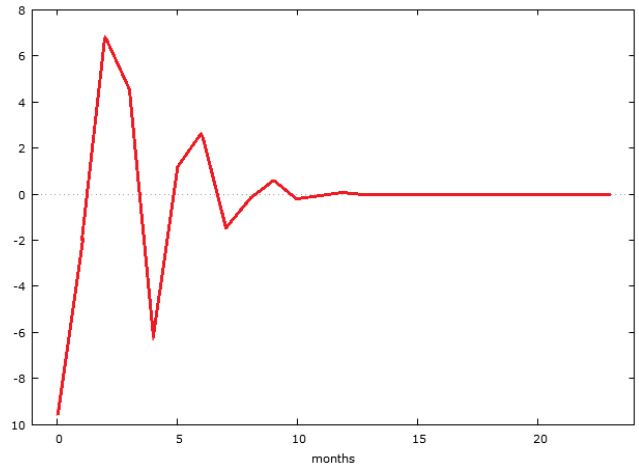

Figure 5: Response d_IPU to d_Sensex

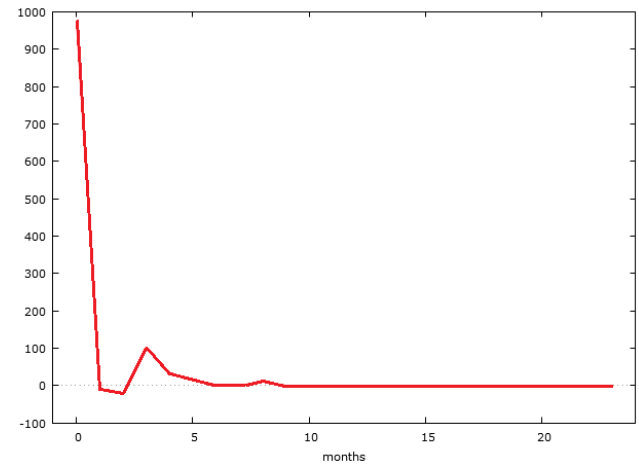

Figure 6: Response d_Sensex to d_Sensex

Shock to Sensex in the present period as per Fig. 5 causes Indian EPU to be negative and low for the current period. The effect then causes EPU to be volatile and hover around the mean for a period of around 10 months. The effects are not that pronounced for this response. Hence we may say that current period the time series are negatively correlated, but its effect hovers around the mean and drops to 0 over the months.

Finally, the shock to Sensex in the current period causes the index to immediately drop to 0 in the next month seen in Fig. 6. There is no observable effect that is prolonged over the

months for this shock. This may be expected given the nature of the time series (stock returns).

V. CONCLUSION

From our study we find that the influence of Uncertainty on the SENSEX returns is very low or non-existent as opposed to that seen in many other countries in the world. The effect is also positive in nature as opposed to negative in other advanced economies. This gives support towards semi strong form efficient markets hypothesis [5] in Indian stock markets.

The SENSEX returns cannot be easily predicted from the India EPU since major dynamics of returns cannot be explained by uncertainty in Indian economy as modelled by Baker as seen in the VAR coefficients.

Rise in Economic Policy Uncertainty in India causes the SENSEX returns to rise for the next 2 – 3 months due to this effect. The VAR Equation also throws insignificant values for the SENSEX Modelling equation. This gives us the conclusion that the Sensex in India is not significantly affected by perceived uncertainty in Indian Economic Policy. The fundamental factors driving the country such as demographic dividend, growing incomes and industry growth rates all have contributed to a very strong rise in stock returns.

Increase in Sensex causes the Policy Uncertainty in India to be negative but stabilizes to 0 after some variation. The effects on Uncertainty does not seem too strong for any changes in Sensex as a driver.

VI. LIMITATIONS

The limitations for study is that a different methodology towards analysis of the data such as Garch or ARIMA can be used which will provide us further long run effects and interactions between the variables. Further, a proxy for Indian EPU constructed from news [5] is used. A different proxy may give us further insights on the same.

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