Relationship between stock market and economy: empirical evidence from India

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ABSTRACT

The objective of this paper is to determine if the macroeconomic variables affect the Indian stock market. Sensex was chosen as the indicator of the Indian stock market. The study reveals that the Indian stock market has a positive relationship with macroeconomic variables like the wholesale price index, index of industrial production and short term interest rate and a negative relationship with oil prices and exchange rates. The paper provides a practical insight to the academicians to understand the various models used in the study. It also contradicts some of the theories and provides reasons why there are contradictory results.

Contribution/ Originality
The current study employs multiple macro-economic variables to investigate the relationship between economy and stock market of an emerging market.

Citation: Manas Mayur (2017). Relationship between stock market and economy: empirical evidence from India. Asian Journal of Empirical Research, 7(6), 124-133.

1. INTRODUCTION

In the last three decades India has witnessed many good and bad situations. Issues like inner stability, political issues, a fast increasing population, pressure due to terrorism, and security issues are few of the events that have affected the Indian economy greatly. Economic issues like tax rates, custom duties, and foreign investment policies also witnessed major changes in the last three decades. Some of the policies were productive but some may not work as per the expectation. Especially after the economy opened in 1991 to direct and indirect investments from foreign markets, various reforms made the Indian market very dynamic for foreign investors. These reforms have made the Indian economy as one of the fastest growing economies in the world.

Stock markets are sensitive to a wide variety of macro-economic factors. There has been no consensus however on the nature of relationship. No satisfaction GDP theory has emerged on the relation between financial markets and the macro economy in any particular direction. Current study evaluates the impact of various macroeconomic variables on the Indian stock market. The results are expected to help the local and foreign investors. The paper attempts to mathematically model the changes in the macroeconomic environment and their impact on the Indian stock market.

The study will help both local and foreign investors to understand the dependencies of the stock market on a macroeconomic scenario. It will also enable business houses to take the right decisions of expansion programmes. The study will also help the political decision makers in understanding the effects of their macroeconomic decisions on the stock markets.

The paper will initially discuss the various studies conducted on the subject in developing, and emerging economies followed by the studies conducted on Indian economy. This will follow by discussion on methodology adopted for the study in detail which will be followed by the data analysis and findings and finally conclusion.

2. LITERATURE REVIEW

Studies on relationship between macro-economic variables and stock market are discussed in following three sections in the literature review. First, the studies from developed countries are discussed then developing countries and finally India.

2.1. Effect of macroeconomic variables on stock markets in developed countries

Chen et al. (1986) examined the impact of macroeconomic variables on stock market returns for developed countries like US, UK etc. and found that changes in the risk premium, growth in industrial production, yield curve, expected inflation significantly affects the stock returns in developed countries.

Humpe and Macmillan (2009) analysed the relationship between macroeconomic variables and the stock markets in USA and Japan. They found that stock prices were positively related with industrial production and negatively related with the consumer price index and a long term interest rate in US. They showed an insignificant relationship between stock prices and the money supply. However, for the Japanese data they found that the stock prices were affected positively by industrial production and negatively by the money supply.

Gan et al. (2006) examined the relationship between macroeconomic factors and the stock market in New Zealand. They found a long run relationship between stock market and the macroeconomic variables like interest rate, money supply and real GDP during.

Funke and Matsuda (2002) examined the impact of macroeconomic news on stock prices in USA and Germany. They observed that the domestic news had a greater impact on the stock markets of the USA as compared to that of Germany. News on interest rates, inflation and business index had a greater

impact on the stocks in Germany. They found that the International news had affected the stock market more than the domestic news.

2.2. Effect of macroeconomic variables on stock markets in developing countries

Babayemi *et al.* (2013) analysed the relationship between macroeconomic variables and stock markets in Africa. They found a positive relationship between foreign direct investment and stock market and a negative relationship between money supply and stock market in African markets.

Gay (2011) studied the effects of macroeconomic variables on stock market returns in four emerging economies (BRIC) Brazil, Russia, India and China. He found a significant relationship between stock index price and exchange rate for all the countries except Russia.

Maysami *et al.* (2004) investigated the relationship between macroeconomic variables and stock market. They found a significant relationship between Singapore stock market and all macroeconomic variables. They further found that some of the sectorial indexes were not significantly related to all the macro economic variables.

Auzairy *et al.* (2011) analyzed the impact of stock market deregulations on Asian stock markets countries like Thailand, Malaysia and Indonesia. Stock market deregulation was calculated as the percentage change in foreign ownership of local shares. They found a significant positive relationship between exchange rate and stock market in Indonesia and Thailand.

Hussin *et al.* (2012) exmained the relationship between the Kuala Lumpur stock market and macroeconiomic variables. They found that Malaysian stock market was positively related to inflation and economic growth rate but inversely related with money supply, investment rate and foreign exchange rate.

2.3. Effect of macroeconomic variables on stock markets in India

Venkatraja (2014) studied the relationship between BSE and macroeconomic variables like industrial production, wholesale price index, gold price, foreign institutional investment and real effective exchange rate. They found that most of stock market variation can be explained by the 5 macroeconomic variables. He proved that inflation, foreign capital inflow, exchange rate and gold price had a positive impact on the Indian stock market. They also asserted that the effect of industrial production on the stock market was not significant.

Singh (2010) examined the relationship between the stock market and macroeconomic variables like the wholesale price index, Index of Industrial production and exchange rate. He showed that Index of Industrial production was the only variable that had a significant relationship with the Indian stock market (BSE).

Nath *et al.* (2014) investigated the relationship between oil prices and the Indian stock market. They showed a long term relationship between the oil prices and the Indian stock market. Ray and Vani (2003) examined macro-economic variables like the national output, interest rate, fiscal deficit, exchange rate, inflation, foreign institutional investment and money supply. They found a persistent relationship between all the variables and the stock market.

Naka *et al.* (1998) examined relationships between macroeconomic variables like industrial production index, the consumer price index, and the value of an investment earning the money market rate and the SENSEX. They found that industrial production was the largest positive determinant of Indian stock prices, while inflation was the largest negative determinant.

3. METHODOLOGY

3.1. Sample description
The paper establishes a relationship between the Indian stock market (Sensex) and the macroeconomic factors. I considered the quarterly data of the dependant and independent variables from March 2002 till September 2015. Apart from the minor fluctuations the data represents two major falls one in the year 2000 and the other one in the year 2008. The data also represents some of the best years of growth for Sensex.

Following regression model was initially used to determine the relationships between the Sensex and the macroeconomic variables

$$Sensex = \alpha + \beta_1\,(\,OP\,) + \beta_1\,(\,OP\,) + \beta_2\,(\,ER\,) + \beta_3\,(\,WPI\,) + \beta_4\,(\,IIP\,) + \beta_5\,(\,LIR\,) + \beta_6\,(\,SIR\,) + e$$

The results of this regression are discussed in conclusion segment of the paper.

3.2. Time series and its effect of regression
The dependant variable is the stock market i.e. BSE Sensex and the independent variables are the macroeconomic variables namely wholesale price index (WPI), Exchange rate (ER), and oil prices (OP), Industrial production (IP) long term interest rates (LIR) and short term interest rates (LIR). Since all these variables are represented by time series there are two issues which I need to address.

1. Time series variables influence each other with a time lag and
2. If the variables are non-stationary a problem known as spurious regression may arise.

Thus usually non-stationary time series variables are not included in a regression model. The best thing to do is to transform the variables to stationary before running a regression.

3.3. Autocorrelation
In many applications the dependant variable not only depends on the explanatory variable but also depends on itself. The autocorrelation function involves correlation between the variable and the lag of itself. This autocorrelation is denoted by r_p and is referred to as the correlation at lag p.

The mathematical model I will be using to analyse the autocorrelation is as follows.

$$Y_t = \alpha + \varphi\,Y_{t-1} + e$$

Here Y_t is the dependant variable and Y_{t-1} is the lag of dependant variable lagged 1 period which is 1 quarter. I am going to use Phillips-Perron test to check for unit root in the all the series because of its robustness to serial correlation. Philips-Pheron tests for all the variables were done and the findings are documented below.

3.4. Co integration
In order to deal with time series having unit root and which are non-stationary in nature I will analyse what causes the spurious regression and how it can be dealt with. Let us say that the dependant variable is named as Y and the independent variable are X. The regression equation for them can be represented by

$$Y_t = \alpha + \beta X_t + e_t$$

In order to explain co integration I will rearrange the above equation as follows.

$$e_t = Y_t - \alpha - \beta X_t$$

Johansson's test is used to understand the co integration between the variables.

3.5. Vector error correction Model (VECM)
The model can be represented by the following mathematical equation.

$$\Delta Y_t = \varphi + \lambda_{et-1} + \text{Ш } \Delta X_t + \text{€}_t$$

Where e_{t-1} is the error obtained from the regression of Y with X and €_t is the error in the ECM model. Here ΔY_t is the dependant variable and ΔX_t is the explanatory variable.

3.6. Vector Auto regressive (VAR) Model
When Y and X have unit roots but are not co integrated or in other words the time series are non-stationary and are not trending together I should not use simple regression due to the problem of spurious regression. The presence of such characteristics will force us to run a regression between ΔY and ΔX so that I convert the time series first from non-stationary to stationary.

When I am running this model I assume that Y and X are non-stationary and when I take the first difference both Y and X becomes stationary. The VAR model is also extended to the Granger causality test through which I can understand whether X is causing changes in Y or Y initiates the changes in X. This model can be mathematically represented as.

$$Y_t = \propto_1 + \delta_1 t + \emptyset_{11} Y_{t-1} + \cdots.. + \emptyset_{1p} Y_{t-p} + \beta_{11} X_{t-1} + \ldots \ldots + \beta_{1q} X_{t-q} + \epsilon_{1r}$$

and

$$X_t = \propto_2 + \delta_2 t + \emptyset_{21} Y_{t-1} + \cdots.. + \emptyset_{2p} Y_{t-p} + \beta_{21} X_{t-1} + \ldots \ldots + \beta_{2q} X_{t-q} + \epsilon_{2r}$$

3.7. Variables
In our research paper the dependant variable is the Sensex. The explanatory variables with whom I am trying to find the relationship is as follows.

1. Oil process (OP)
2. Exchange rate (ER)
3. Wholesale price index (WPI)
4. Industrial production (IIP)
5. Long term interest rate (LIR)
6. Short term interest rate (SIR)

3.8. Data sources
The Sensex monthly closing data was collected and converted to quarterly data. Data related to stock market was collected from yahoo finance (part of Yahoo's network) which provides financial news, data and commentary including stock quotes, press releases and financial reports. The data with respect to the explanatory variables was collected from Indiastat which is India's most comprehensive database of socio-economic statistical data. In this case quarterly data was collected from the March 2002 till September 2015. Both the data were collated and brought in the quarterly format for analysis. Thus there were a total of 52 points which were used for analysis.

4. RESULTS & DISCUSSION

4.1. Multiple regressions
The data was inducted in quarterly format in STATA software and multiple regressions were carried out. The following was the result of the same.

Table 1: Economic variables and Sensex

Sensex	Coefficent
Oil Prices	-161.114*** (29.165)
Exchange rates	-505.8*** (119.506)
Wholesale price index	351.843*** (33.270)
Index of Industrial production	27.643*** (6.794)
Short term interest rate	1369.916** (489.350)
Long term interest rate	678.842 (656.293)
R-squared	0.9264
Adjusted R squared	0.9206

Oil prices: As per the results of the Sensex is negatively correlated with oil prices. This is in line with our theory which states that in a country like India which imports most of its oil requirements, when oil prices come down the companies which use oil as raw material benefit as the production costs come down. This leads to increase in the contribution margin thereby increasing the cash flows. This will lead to increasing in the stock prices.

Exchange rate: The exchange rate is negatively correlated with the Sensex. This is because as the value of the rupee goes down the Indian goods will become cheaper in the foreign markets. This will lead to increase in the throughput of Indian industries and will improve the Sensex.

Wholesale price index: The WPI affects the Sensex positively. This means that when the inflation increases the stocks tend to increase. This is because of the increase in price the companies enjoy better profits.

Industrial index of production: The IIP is also positively related to the Sensex. This is because the IIP is high when the demand for goods and services is high which again leads to increase in prices and the volume of the goods produced.

Short term Interest rate: The STIR is positively related to the Sensex. This is contradictory to our theory and the literature review. The significance level of this relation is 95 %. I will dwell more into this and check if any issues with spurious regression are hampering our results in our further analysis.

Long term interest rate: The long term interest rate is showing a non-significant relationship with Sensex. This needs further attention if issues related to spurious regression are interfering with the analysis.

The R squared value indicates that 92.994% of the variations in Sensex are explained by the macroeconomic variables considered which is significant. That means around 7% variations in Sensex are due to other variables and the model I have selected fits well.

I will now set the null hypothesis as

$$H_0 = Sensex\ is\ not\ affected\ by\ the\ macroeconomic\ variables$$

The table shows that the null hypothesis can be rejected ($p < 0.1$) and that the macroeconomic variables significantly affect the Sensex.

In order to test whether the time series are stationary or non-stationary Philips-Perron unit root test was performed.

Table 2: Tests for Unit Root and Stationarity: Philips-Perron test

	L1	Trend	Constant	t-statistics	5% critical value	Characteristic
Sensex	0.782***	95.006	880.556*	-15.769	-19.972	Non stationary
Oil prices	0.886***	0.017	8.093*	-7.792	-19.872	Non stationary
Exchange rate	0.937***	0.049	1.982	-4.051	-19.872	Non stationary
WPI	0.919***	0.160	7.770*	-6.093	-19.872	Non stationary
IIP	0.872***	-0.232	36.641	-6.315	-19.872	Non stationary
IR ST	0.766***	0.013	1.225	-15.055	-19.872	Non stationary
IR LT	0.624***	0.016	2.372	-20.514	-19.872	Stationary

As seen from the results of the Phillips-Perron tests it is evident that all the series except the long term interest rate are non-stationary and thus the issue of spurious regression can be there in the 5 variables. The long term interest rate is a stationary series and needs to be treated differently.

4.2. Co-integrating rank of VECM
The result of the tests is as follows.

Table 3: VAR results

Lag	p-value	FPE	AIC	HQIC	SBIC
0		2800000	23.368	23.412	23.486
1	0.000	2493.920	16.334	16.511	16.806
2	0.056	2584.38	16.364	17.675	17.190
3	0.601	3284.340	16.590	17.035	17.771
4	0.003	2873.460	16.432	17.010	17.967
5	0.011	2778.640	16.358	17.069	18.375
6	0.001	2356.490	16.131	16.976	18.375
7	0.007	2327.740	16.029	17.006	18.627
8	0.000	1812.92	15.650	16.761	18.603

As seen from the above result the maximum number of stars is there on lag order of 1 and lag order of 8. The p value for lag 1 and lag 8 are 0.000. Our data are quarterly data and thus lag order 8 means the lag will become to the tune of 2 years which is not possible. Thus I select the lag order as 1 for all the future tests.

I will now run the co-integrating rank of VECM tests and interprets the results.

Table 4: VECM results

MAXM rank	Parameters	Eigen value	Trace statistics	5% critical value
0	56	-	118.967*	124.240
1	69	0.533	78.592	94.150
2	80	0.363	54.669	68.532
3	89	0.323	33.927	47.210
4	96	0.262	17.790	29.680
5	101	0.174	7.630	15.410
6	104	0.939	2.398	3.760
7	105	0.044	-	-

The results of the co integrating rank of VECM indicate that the trace statistics for all the ranks are less than the 5% critical values. Thus there is no co integration between the series. This means that all the time series used except the long term interest rates are non-stationary and have unit roots but they are not co integrated. Thus I have to run the VAR model for all the time series.

4.3. VAR model

The results of the VAR model with dependant variables are tabulated as follows. The lag order was elected as L1 as per the Lag order selection statistic tests conducted above.

Table 5: VAR results

Independent variable	Sensex L1	Oil prices L1	Ex rate L1	WPI L1	IIP L1	IR ST L1	IR LT L1
Dependent variable							
Sensex	0.741***	-39.564*	-3.798	77.046**	6.619	-557.308*	1239.356**
Oil price	-0.003	0.6100**	-1.791**	-0.048	-0.048	-4.010	6.443*
Exchange rate	0.001	0.0188	0.889***	-0.004	-0.004	0.280	-0.543
WPI	0.001	0.038	-0.131	-0.011*	-0.011*	-1.301**	1.184**
IIP	0.003**	1.255**	3.437*	0.730***	0.730***	-11.522*	-3.4686
IR ST	0.001*	0.003	-0.402	-0.004*	-0.0048*	0.546**	0.127
IR LT	0.001	-0.006	-0.051	-0.000	-0.000	-0.065	0.698***

The results indicate that the Sensex is positively correlated with lag of itself, WPI and long term interest rate. At the same time Sensex is negatively correlated with oil prices and Short term interest rates. The lags of exchange rate and Industrial production index do not affect the Sensex significantly.

In order understand the causality between the series the Granger causality tests was run and the following are the results.

Table 6: Granger causality test results

Independent variable	Sensex	Oil prices	Ex rate	WPI	IIP	IR ST	IR LT	All
Dependent variable								
Sensex	-	0.094*	0.965	0.042**	0.177	0.090*	0.003**	0.000***
Oil price	0.996	-	0.011**	0.154	0.225	0.134	0.055*	0.038**
Exchange rate	0.404	0.491	-	0.381	0.399	0.461	0.254	0.002**
WPI	0.84	0.231	0.267	-	0.082*	0.004**	0.034**	0.001**
IIP	0.036**	0.009**	0.054*	0.011**	-	0.087*	0.674	0.173
IR ST	0.093*	0.797	0.373	0.878	0.057*	-	0.552	0.080*
IR LT	0.842	0.525	0.18	0.256	0.96	0.651	-	0.157

The results confirm that the oil prices, WPI, IRST and IRLT affect the Sensex significantly. Variables like exchange rate, IIP and long term interest rate have no short term effect on Sensex. However all the macroeconomic variables put together will highly impact the Sensex behaviour.

VAR test was again run by considering the Sensex as the dependant variable and the following results were documented.

Table 7: VAR results

	Sensex L1	Oil prices	Ex rate	WPI	IIP	IR ST	IR LT
Sensex	0.746***	-39.564	-77.207	80.487*	4.908	-279.593	1008.477**

The results indicate positive long run relationship with lag of sensex, WPI and long term interest rate. The effect of other variables in not significant on the sensex.

5. SUMMARY AND CONCLUSIONS

The current study was an attempt to study the relationship between Indian stock market (Sensex) and the macroeconomic variables like Oil prices, Exchange rate, and Wholesale price Index, Index of industrial production, Short term interest rates and long term interest rates. The data period was chosen from March 2002 till September 2015. Quarterly samples were taken and analysed using STATA.

Multiple regressions analysis showed that the Sensex had significant positive relationship with Wholesale price index, Index of industrial production and short term interest rate. Also Sensex was shown to be negatively related to oil prices and exchange rates. The relationship of Sensex with Long term interest rate was found to be non-significant.

Philips-perron unit root tests proved that all the time series except long term interest rate exhibited non-stationary characteristics. There was no co integration found between the series. VAR tests and Granger causality tests indicated a positive short run relationship between Sensex and lags of Sensex itself, WPI and long term interest rates. However Sensex showed negative short run relationship with oil prices and short term interest rates. The Sensex showed insignificant relationship with lags of exchange rates and Index of industrial production.

The granger causality tests showed a short run causality running from WPI, and short term interest rates to Sensex. Also all the macroeconomic variables put together had a very significant effect on the Sensex. Vector auto regression was then run with Sensex as the dependant variable and macroeconomic variables as the exogenous variables and Sensex was found to be positively related to wholesale price index and long term interest rate in the long run. All other variables have non-significant impact on Sensex.

5.1. Implications of the study
This paper which analyses the relationship between macroeconomic variables and Sensex will be very useful to different people and its usefulness is summarized below.

Investors: For investors this study will help in understanding how the macroeconomic variables influence the stocks. Sometimes it is observed that even though the performance of the company for the year is good still there is a downward movement in the stock prices. One of the key parameters affecting this movement will be the policy changes which affect the macroeconomic variables which in turn affect the stocks.

Policy makers: The paper should help the policy makers in understanding the effect of the many factors on the stock market. For example if the Rupee depreciates then theoretically it is expected that Indian goods will become cheaper in foreign markets thereby increasing the production which should positively affect the stocks. However in our study it was observed that the exchange rates have no significant effect on stocks.

Academicians: The paper provides a practical insight to the academicians to understand the various models used in the study. It also contradicts some of the theories and provides reasons why there are contradictory results.

Foreign Investors: Most of the times the foreign investors put their money in markets which are growing. The foreign investors generally look at the potential of a country to provide business environment which promotes industrial growth. This paper can help to understand the effect of government strategies on Indian stock markets for the foreign investors.

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