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Analysis of the impact of select macroeconomic variables on the Indian stock market: A heteroscedastic cointegration approach

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Abstract: The present study examines the impact of the macroeconomic variables on the stock prices in India. To fulfil the objective of the study monthly data of inflation, short-term interest rate, long-term interest rate, index of industrial production, exchange rate, money supply, and the stock indices of CNX Nifty and BSE SENSEX were collected from March 2005 to April 2013. Heteroscedastic cointegration approach was employed using a Johansen test of cointegration, OLS and GARCH (1, 1) model to find out the long-term relationship between the selected macroeconomic variables and the stock prices. It is evident from the study that there exist the long-term heteroscedastic relationships between the stock prices and the macroeconomic variables chosen for the study. Further, it is also evident from the study that while INF, MSE and the IIP are positively related to the stock prices, the SIR, LIR and the EXR are negatively related to the stock prices.

JEL Classifications: G10, G12, E31, E44, F31

Keywords: Stock market, India, macroeconomic variables, heteroscedastic cointegration

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1. Introduction

The stock market has always attracted the attention of the researchers worldwide as it is considered to be the barometer of the economy. It is also evident from the available literature that the economic factors have an influence on the stock market. Therefore, it becomes imperative to study the influence of the economic factors on the performance of the stock market return. Naka, Mukherjee, & Tufte (1998) studied the influence of select economic variables using vector error correction model and found the existence of the long-term equilibrium relationship among the selected macroeconomic variables. Studies have also highlighted the fact that stock market index's movement is sensitive to the changes in the macro environment as it considered to being the precursor of the future market prospects (Ahmed, 2008). The Indian economy has been continuously doing well over the years and this can be mirrored in the stock market index's performance. In recent years it can be observed that the overall economic performance is trailing; and this may take place due to various economic factors, such as inflation, interest rate, exchange rate, investment rate, and the global economic environment.

Further, the performance of the stock market returns is time varying, and to account for this time variation effect the heteroscedastic cointegration technique has been applied. The analysis of cointegration will unfold the relationship between the stock return and the select macroeconomic variables. The study is aimed to find out how the stock market reacts to the selected economic variables chosen for the study, namely, money supply, interest rate, inflation, exchange rate, and the industrial production. It has been widely debated whether monetary policy has a role in influencing the stock prices or not.

Thorbeke (1997) found that the stock price has a bearing of money supply, normally the stock prices increases with the increase in money supply. On the contrary, there is an argument that increase of the money supply can lead to inflation. This can further raise the risk-free rate and the nominal discount rate, thus establishing a negative relationship between money supply and the stock prices. Therefore, it needs to be investigated what bearing the money supply upon the stock prices.

Interest rate influences the stock prices as the interest rate goes up, so does the discounting rate or the required rate of return hence establishing a negative relationship between the two. Mukherjee & Naka (1995) found that changes in the interest rate, both short-term and long-term, affect the discount rate in the same direction.

Inflation is another determinant that impacts the stock prices; an increase in inflation increases the nominal risk-free rate and the discount rate. Thus, inflation tends to reduce the return on investment in the stock depicting a negative relationship between the two (Mukherjee & Naka 1995). The exchange rate is another variable chosen for the study. The variability in the exchange rate impacts the value of the firm irrespective of it has a foreign operation or not. If a firm is dealing in export, than exchange rate variability can have a bearing on the cash flows. Tripathy (2011) found that the variability of the exchange rate affects the trading volume. Index of industrial production (IIP) is another important indicator chosen for the study, which reflects the performance of the industrial sector. A good IIP number is indicative of the fact that the industrial sector is doing well, and this can have a positive impact on the stock market. Lee (1992) found that a positive relationship exists between IIP number and the stock market.

The present paper is aimed at to find out the impact of macroeconomic variables on the Indian stock market for a period spanning from 2005 to 2013.The time period of study is selected as during this period the capital market has undergone many far reaching changes attributed mainly due to the necessity of the time. The major policy guidelines related to capital inflows in India (Consolidated FDI Policy (CFP)) became effective from April 1, 2010. The other factors which motivated to choose the period of study were the adoption of the flexible exchange rate, growth of the Indian economy, and the decline in the post-financial crisis period.

2. Literature review

The relationship between stock prices and the macroeconomic variables has found an important place in the analysis of stock price. This is due to the profound influence of the macroeconomic variables on the stock prices. In this context it becomes imperative to discuss the existing literature on the issue.

The relationship between the macroeconomic variables and the stock market was studied by Maysami & Koh (2000). They found a positive relationship between money supply and the stock return and a negative relationship between changes in the price level and the short and long-term interest rates, and the exchange rate. Kwon & Shin (1999) on the basis of their study concluded that the set of macroeconomic variables is cointegrated to the Korean stock market. But when they applied Granger causality test on the set of macro variables chosen for their study, they found that the Korean stock index is not a leading indicator for the economic variables. Ewing (2002), using the technique of 'Generalised impulse response analysis' on the NASDAQ financial 100 Index, applying the shock of four economic variables (i.e. inflation, monetary policy, output, and risk), found that monetary policy have an impact on stock return for a period of two month, and unexpected economic growth has a bearing on the stock return but it could not sustain in the long run, and the inflation is negatively related with the stock return. Ratanapakorn & Sharma (2007) examined the relationship between US stock prices index(S&P) and the chosen macroeconomic variables for a period (1975-1999). They examined the impact, both in the short run and the long run, and found that the stock

prices were negatively related to the long-term interest rate but positively related to the money supply, industrial production, inflation, exchange rate, and the short-term interest rate. Using the Granger causality test it was established that the macroeconomic variables cause the stock prices in the long run but not in the short term. They also highlighted the fact that US Market is not efficient because of presence of cointegration and causality; and future stock prices can be estimated on the basis of available information of the macroeconomic variables. Abdalla & Murinde (19997), in their study on the relationship between the exchange rate and the stock prices in the emerging economies of India, Korea, Pakistan and Philippines, found unidirectional causality in all the sample chosen for the study except the Philippines where the stock prices Granger-cause the exchange rate. Chancharoenchai, Dubog-Lu, & Mathur (2005) studied the relationship between the macroeconomic economic variables and the excess return in the six Southeast Asian economies pre Asian crisis 1997. They concluded that crisis was due to poor policy formulation on the part of the policy maker as they lacked both credibility and transparency. Husain & Mahmood (2001) used the cointegration and the error correction analysis to examine the relationship between the stock prices and the macro variables, namely consumption expenditure, investment spending and GDP. They found that there exist a long-term relationship between stock prices and the macro variables. The study also shows a unidirectional causality implying that the macro variables cause variability in the stock prices. Serfling & Miljkovic (2011) in their study on the impact to S&P 500 due to the factors such as dividend yield, yield on treasury, money supply, industrial production index, and the level of consumer price index, found significant interaction among the variables, as all expressing endogeneity to some extent.

3. Data and methodology

To fulfil the requirement of research monthly data were collected covering period from March 2005 to April 2013 with a sample size of 95 observations. The data were collected from the Reserve bank of India and the National Stock Exchange website. The CNX Nifty (NIF) and BSE (SENSEX) data are used as composite indexes representative for the Indian stock market. In India the changes in the WPI data are used as measure for the inflation rate, and therefore the monthly WPI data is taken to measure the inflation rate for the period of study. The monthly data of 91 days Treasury bill are used as a proxy for the short-term interest rate, and the data of long-term interest rate are collected from the term deposit rate for period more than 5 years. Exchange rate is another important determinant as it influences firm's cash flows having overseas operation. Therefore, it has been selected for the study to find out the influence of the exchange rate on the Indian stock market. The monthly IIP data are collected and used as a proxy measure of the overall industrial activity in India and to find how this has an influence on the stock market. M3 is used as proxy for the level of money supply. All variables in this study are converted into natural logarithm.

The present study is based on macroeconomic time series data, which can be non-stationary. The problem with non-stationary time series data lies with the fact that the regression analysis made on such data always yields dubious results. A series is said to be stationary if the mean and the auto covariance of the series are not time dependent. To overcome the problem of non-stationary the cointegration analysis can be employed. Engel and Granger (1987) or the maximum likelihood procedure of Johansen and the Juselius (1990) can be used for cointegration analysis. Engel and Granger method makes use of the following cointegrating equation.

$$y = \alpha_0 + \alpha_1 x_{1t} + \cdots + \alpha_k x_{kt} + \varepsilon_t \quad (1)$$

where it is supposed that each of the (k+1) series $y_t, x_{1t} \ldots\ldots x_{kt}$ has single unit root and is said to be stationary if the series ε_t are stationary. The Engel and Granger method is applicable only when the cointegrating equation as the Equation (1) is homoscedastic. On the contrary, if the cointegrating equation is heteroscedastic, the heteroscedastic cointegrating relationship is modelled using the standard generalized autoregressive conditional heteroscedasticity (GARCH) model as shown in the equation below:

$$y = \alpha_0 + \alpha_1 x_{1t} + \cdots + \alpha_k x_{kt} + \varepsilon_t, \qquad \varepsilon_t / \Omega_{t-1} \sim N(0, h_t), \tag{1a}$$

Where

$$h_t = \omega_0 + \omega_1 h_{t-1} + \omega_2 \varepsilon_{t-1}^2 \tag{2}$$

The heteroscedastic relationships can tested using the Lagrange Multiplier (LM) test as on the residual of equation (1).If the LM test shows heteroscedasticty, than heteroscedastic cointegration can be tested by GARCH(1,1) model and then carrying out unit root test on the standardised residual from the GARCH(1,1) model. Now if the standardised residual is stationary than the series can be considered to be heteroscedastically cointegrated.

TABLE 1. DESCRIPTIVE STATISTICS (APRIL 2005 TO MARCH 2013)

	NIF	BSE	INF	SIR	LIR	IIP	EXR	MSE
Mean	8.3711	9.5786	4.8707	1.8534	2.042	4.9787	3.8345	10.7317
SD	0.2909	0.2939	0.1571	0.2921	0.108	0.1649	0.0902	0.3929
Minimum	7.5509	8.7249	4.6298	1.1484	1.832	4.5691	3.6717	10.0561
Maximum	8.7223	9.9286	5.141	2.2362	2.169	5.2688	4.0328	11.3364

Notes: NIF - National Stock Exchange Fifty Index (CNX Nifty). BSE - Bombay Stock Exchange. INF - Inflation Rate in the economy(measured by the WPI). SIR - Short-term interest rate (91 Days treasury Bill issued by the RBI chosen for the study). LIR - Long-term Interest Rate (five-year time deposit rate set by the central bank). IIP - Index of Industrial Production. EXR - Exchange Rate Index of Indian Currency. MS - Money supply in the economy measured by M3.

4. Results

4.1 Unit test results

The unit test was carried out using Phillips-Perron (PP) Test .The test result based on PP is reported in Table 2. From result below in Table 2, it is clear that all the series consist of single unit root at the level.

TABLE 2. PHILLIPS-PERRON TESTS FOR PRESENCE OF UNIT ROOT

	T-statistics	First difference	Critical value at 1%	Critical value at 5%
NIF	-2.75737	-9.17936	-3.50067	-2.8922
BSE	-2.85349	-8.7049	-3.50067	-2.8922
INF	-2.57606	-7.19967	-4.05753	-3.4578
SIR	-1.72167	-11.2736	-3.50067	-2.8922
LIR	-2.11617	-9.67592	-3.50067	-2.8922
IIP	-1.75681	-19.3609	-3.50067	-2.8922
EXR	-0.90143	-8.14824	-3.50067	-2.8922
MSE	-1.76633	-10.5313	-3.50067	-2.8922

Notes: NIF - National Stock Exchange Fifty Index (CNX Nifty). BSE - Bombay Stock Exchange. INF - Inflation Rate in the economy(measured by the WPI). SIR - Short-term interest rate (91 Days treasury Bill issued by the RBI chosen for the study). LIR - Long-term Interest Rate (five-year time deposit rate set by the central bank). IIP - Index of Industrial Production. EXR - Exchange Rate Index of Indian Currency. MS - Money supply in the economy measured by M3.

4.2 Cointegration test results

The Johansen test of integration is employed to find out the number of cointegrating vectors. To carry out this the model has included a constant in the cointegrating equation and both the Schwarz Bayesian Criterion (SBC) and the Akaike Information Criterion (AIC) has been used for the selection of the lag length. There are two test statistics for cointegration in the Johansen test for cointegration as shown in the following expression.

$$\lambda_{trace}(r) = -T\sum_{i=r+1}^{g}\ln(1-\hat{\lambda}_i) \quad (3)$$

And

$$\lambda_{max}(r,r+1) = -Tl(1-\hat{\lambda}_{r+1}) \quad (4)$$

Where r is the number of cointegrating vectors and λ_{trace} is joint test where the null is the number of cointegrating vectors is less then equal to r against the alternative that they are more than r and λ_{max} has the null of number of cointegrating vectors of r against the alternative of $r = 1$. T is the number of observation used in the model and $\hat{\lambda}_i$ is the i^{th} ordered eigenvalue from the $\boldsymbol{\Pi}$ matrix. The result reported in the Table 3 below was obtained using three lags as per the AIC criteria. The result shows two cointegrating equation for NIF at 5% level of significance both in terms of trace test and maximum eigenvalue test. Similarly for the BSE it was found that there are two cointegrating vectors both in terms of trace test and maximum eigenvalue test as depicted in the Table 3.

TABLE 3. JOHNSEN COINTEGRATION TEST

	NIF		BSE		Critical Value (Trace) 5%	Critical Value (λ_{max}) 5%
	Trace	(λ_{max})	Trace	(λ_{max})		
r= 0	155.6434	46.7435	155.6434	47.3310	125.6154	46.2314
r≤1	108.8999	41.8743	108.2128	41.9324	95.7536	40.0775
r≤ 2	67.0255	24.3700	66.2802	23.9377	69.8188	33.8768
r≤ 3	42.6554	14.9198	42.3425	15.0231	47.8561	27.5843
r≤ 4	27.7355	12.2059	27.3194	11.9059	29.7970	21.1316
r≤ 5	15.5296	11.6239	15.4135	11.4967	15.4947	14.2646
r≤ 6	3.9056	03.9056	03.9167	03.9167	03.8414	03.8414

Notes: *r* - the number of cointegrating vectors. NI F refers to National Stock Exchange Fifty Index (CNX Nifty). BSE - Bombay Stock Exchange.

TABLE 4. COINTEGRATING RELATIONSHIP ESTIMATED BY THE OLS AND GARCH (1, 1)

	OLS		GARCH(1,1)	
	Coefficients	T-Value	Coefficients	T-Value
Panel A: NIF			*Mean Equation (1a)*	
Constant	5.6397*	5.9697	5.5185*	11.2923
INF	0.7120	0.7907	0.8658	01.4774
SIR	-0.0133	-0.1589	-0.0352	-0.7461
LIR	-0.3985*	-2.1087	-0.1199	-1.1802
IIP	0.8308*	2.7802	-1.2653*	0.9076
EXR	-1.8901*	-7.9853	0.2903	-8.3558
MSE	0.2993	0.7419		1.2125
			Variance Equation (2)	
ω_0			0.0008	1.6856
ω_1			-0.0022	-0.0178
ω_2			1.2376*	4.2983
	LM test	24.3526	*Unit root*	-5.1808
	p-value	0.0000	*p-value*	0.0000
Panel B: BSE			*Mean Equation (1a)*	
Constant	6.9069*	6.7385		16.7129
INF	0.8817	0.9024		2.0993
SIR	-0.0234	-0.2579		-1.7032
LIR	-0.3716	-1.8122		-1.8805
IIP	0.8793*	2.7674		1.4297
EXR	-1.9341*	-7.5309		-9.4490
MSE	0.1891	0.4525		0.1991
			Variance Equation (2)	
ω_0			0.00053	1.2358
ω_1			-0.02479	-0.2441
ω_2			1.2990*	4.4420
	LM test	24.3526	Unit root	-5.1744
	p-value	0.0000	p-value	0.0000

Notes: The LM test is the test of conditional heteroscedasticity and is obtained by regression of the squared residuals on its own lag. The unit root test is performed on the standardized residuals of GARCH (1 1) and * denotes that the statistics are significant at 5 percent level. NIF - National Stock Exchange Fifty Index (CNX Nifty). BSE - Bombay Stock Exchange. INF - Inflation Rate in the economy(measured by the WPI). SIR - Short-term interest rate (91 Days treasury Bill issued by the RBI chosen for the study). LIR - Long-term Interest Rate(five-year time deposit rate set by the central bank) . IIP - Index of Industrial Production. EXR - Exchange Rate Index of Indian Currency. MS - Money supply in the economy measured by M3.

The result is reported in Table 4 and it can be observed that the p-value is 0 percent for both NIF and BSE and thus highly significant. Hence this also indicates the presence of heteroscedastic cointegration in the long run which verifies our findings on the basis of Johansen cointegration discussed in the previous section. This further necessitate the estimation of GACRCH (1, 1) model. The result of which is exhibited in Table 4 and the unit root test carried out on the standardized residual for both the NIF and BSE is highly significant indicating the heteroscedastic relationships to be stationary.

Hence on the basis of the results obtained in Table 4 it can be concluded that there is heteroscedastic relationships between the two market indices chosen for the study and the six macroeconomic variables. It can be further ascertained from the Table 4 that the results obtained from the GARCH (1, 1) model do vary considerably from the results obtained under the OLS model but the sign of the coefficient is consistent and the coefficient and the T-values do vary. We will now discuss Table 4 in details in Section 5.

5. Discussion

5.1 Inflation

The relationship between inflation and the stock price is found to be positive for both the indices NIF and BSE. This contradicts the earlier findings by Fama (1981) and Mukherjee & Naka (1995) who in their study found negative relationships between inflation and the stock prices. The findings of positive relationships between the inflation and the stock price may be attributed to the fact that inflation raises the value of the firm equity (Kessel, 1956; Ioannidis & Kontonikas, 2005). Thus inflation can have both positive as well as negative influence on the stock prices.

5.2 Short-term interest rate

The short-term interest rate has direct bearing on the companies as unexpected increase in the short-term interest rate make their borrowing costly and if the company is already having higher proportion of debt, that will lead to substantial amount of capital out flow and thus reducing the EPS. This further aggravates the market sentiments as the demand for such share will decline resulting in lower market price for such shares. The relationships between the interest rate and the stock prices are said negatively correlated (French, Schwert, & Stanbaugh, 1987). The study also established that the short-term interest rate was negatively related to the both the NIF and the BSE.

5.3 Long-term interest rate

The relationship between the stock prices and the LIR is negatively related in India. This is in consonance with the theory of cash flow discounting model. According to the model the present value of the stocks is calculated by discounting the future cash flows. Other factor associated with this negative relationship is that the interest rate offered in the bond or other deposits. If the interest rate rises so bond will become more attractive and people will pull out the money from investment made in the stocks to make investment in the bonds.

5.4 Index of industrial production

The relationship between the IIP and the stock price is found to be positive and significant in India. IIP is used as proxy measure of the real activity in India. Chen et al. (1986), Ratnapakorn & Sharma (2007) also found that there is a positive relationship between the stock prices and the IIP.

5.5 Exchange rate

The relation between the stock prices and the exchange rate index is found to be negative and significant as can be seen in the Table 4. The Indian rupee is mostly fixed against the US dollar. The exchange rate is one of the most determining factors of the stock price. The stock price depends on the degree of trade balance. If there is appreciation of the domestic currency than an exporting firm competitiveness will decline and will have negative impact on the stock prices. On the hand, if the country is import dominant, the appreciation of the domestic currency will lead to lowering the import cost and thus delivering a positive impact on the firm stock price.

5.6 Money supply

The effect of the money supply on the stock price is found to be positive as it can be seen in the Table 4. This is consistent with the findings of Mukherjee & Naka (1995), Maysami & Koh (2004), Ratanapakorn & Sharma, (2007) who in their study found positive relationship between money supply and stock prices. As money supply stimulates the economy and have a positive impact on the stock prices provided everything remain stable.

6. Conclusion and discussion

The present study is carried out to find out the relationships between the Indian stock market and the macroeconomic variables. The study is carried out employing the heteroscedastic cointegration approach and it was found that long-term relationship do exist between the Indian stock market and the macroeconomic variables. While INF, MSE and the IIP are positively related to the stock prices and the SIR, LIR and the EXR are negatively related to the stock prices. The study shows that the Indian stock market respond to the changes in the macroeconomic variables in the long run despite being impacted by other short-term volatility.

The study thus confirms the significance of the macroeconomic variables on the stock prices in India in the long run. Thus an investor who is interested in investing in the Indian stock market should be prepared for the long-term investment. The study also highlights the fact the government should take measures by initiating policy so that the macroeconomic variables do not negatively influence the stock market and good portion of the saving can be channelized to the stock market in India. As the Indian economy is expected to grow at good pace in the years ahead that investor who will remain invested for long term are going to benefit out of it despite the short-term volatility.

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