Macroeconomic Indicators and Stock Prices – Indian Evidence

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This paper attempts to study the relationship of stock returns with macroeconomic variables in Indian context. The data consists of 88 months from April 1996 to July 2003 comprising of all monthly macro indicators. We have considered 10 macro variables for the study: WPI, Exchange Rate, IIP, Foreign exchange Reserves, Stock Index, M3, Oil price index, Real Effective Exchange rate, 91-day Treasury Bills yield as well as 10-year yields. The study finds a long-term equilibrium relationship among the macroeconomic variables and stock market indicator through Johansen's cointegration test. The Granger Causality test finds short-term dynamics among macro variables. The Vector Error Correction Model (VECM) of Johansen illustrates that stock prices are co-integrated with the set of macroeconomic variables considered under the study. An OLS regression is done on first differences to study the robustness of the relationship among the macroeconomic variables. This robustness test gives us the result that the oil prices have a significant influence on stock price returns. The relationship of stock returns with other macroeconomic variables are not found to be significant except in case of exchange rate.

It is widely believed that stock market is related to macroeconomic fundamentals of an economy, as companies that are listed for trading in stock exchanges are the ones who contribute significantly to the economy's growth. The notion that macroeconomic factors can drive the movement of stock prices is now widely accepted. However, it was only in the past decade or so that attempts have been made to capture the effect of economic forces in a theoretical framework and calibrate these effects empirically. According to standard stock valuation model, the determinants of stock price are the expected cash flows from the stock and the required rate of return. Chen, Roll and Ross (1986) showed that economic variables have a systematic influence on stock return as a result of their effect on future dividends and discount rate and they provided the foundation for the belief in the existence of a long-term equilibrium relationship between stock price and related macroeconomic variables. A central issue in macroeconomics is the question of how financial markets are connected to the real side of the economy. The issue has gained momentum due to increasing cross border movement of funds as fund managers try to move to markets where possibility of higher returns vis-à-vis risk is high. The ongoing integration of international capital markets and the repeated occurrence of large financial crises have raised the concern about the topic beyond academic circles.

The co-integration of macroeconomic variables and stock market has been an extensive area of research in financial econometrics. In financial economics, there have been a number of studies concerning developed markets like US, Japan, UK and European markets (see Lee (1992), Mukherjee and Naka (1995), Poon and Taylor (1991),

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and Leigh (1997)). Some of the studies have also centered on emerging markets (Naka, Mukherjee and Tufte (1999). The stock market, being an important part of the financial system should have a systemic linkage with fundamentals of the economy. The economic reason behind the logic is the price of a stock necessarily reflects all the future cash flows discounted by the appropriate discount rate. The future cash flows depend on many economic factors like GDP growth, price index (WPI), interest rate, exchange rate fluctuations, global and domestic oil prices, etc.

The current study has focused on Indian market with about seven and a half years data set. We have considered this period because of economic reforms have stabilized in late 1990s after its introduction in early 1990s. Any study of stock market should consider the daily price data since the nature of the market is dynamic and lag effect of information value adjustment is very fast but if want to study the cointegration of stock returns with other macroeconomic variables, the data is the biggest hurdle. Monthly GDP figures in India are not available and only recently we have started getting the data quarterly. However, some other macroeconomic variables are available monthly. We have used these monthly data to study the long-term equilibrium relationship among the important macroeconomic variables and stock market.

This study also investigates the short run causal relationship between the stock market and other macroeconomic variables in India for the period April1996-July 2003. We have taken this period as stock market reforms in India gained momentum after 1995 and many regulatory changes were introduced in this period. In this study, we have used major macroeconomic indicators like Money supply, foreign exchange reserves, foreign exchange rate, real effective exchange rate, interest rate of short-term as well as long-term (91-day T-Bills yield and 10 year spot rate), oil prices, index of industrial production, wholesale price index and stock index(NIFTY). The WPI, IIP, oil price index and REER have a base of 1993-94. Money supply, 91-days T-bills cut-off yields, exchange rate time series and REER data have been collected from RBI website and various other publications.

Most of the studies in the area have been conducted for developed economies though recent literature deals in emerging markets. There has been very little work done in Indian market though financial sector reforms process has been initiated in early 1990s and gained momentum in mid-1990s. With market maturity, it has been found necessary to look at the Indian economy.

The structure of the paper has been arranged as follows: Section 2 deals with the existing literature, Section 3 deals with conceptual and methodological issues, Section 4 deals with data and results and Section 5 concludes the study.

2. Literature Review

In an early study, Geske and Roll (1983) found the linkage between macroeconomic variables and stock prices in US but found a negative relationship between stock prices and inflation. Chen, Roll and Ross (1986) found that economic variables like industrial production index, change in risk premium and inflation have a systematic influence on stock return and showed the existence of a long run equilibrium relationship. However, they also found that oil prices and consumption did not have significant effect on stock prices. In another study, Mukherjee and Naka (1995) found that Janapese stock prices are linked to money supply, inflation, real economic activity, long-term government bond rate, exchange rate and interest rate. In another study, Naka, Mukherjee and Tufte (1999) found that in Indian market, industrial production is the largest determinant of stock prices while inflation is the largest negative determinant. Lee (1992) showed a positive relationship between stock returns and the real economy in US. Gjerde and Saettem (1999) showed that the stock returns respond negatively to the change in the interest rate in Norway and found a positive relationship of stock returns with oil prices and real economic activity. Asian markets have been studied by Fung and Lie(1990), Leigh (1997), Granger, Huang and Yang (1998), Kwon and Shin (1999), Maysami and Koh(2000). In a study by Nath and Samanta, (2003a), it was found that the stock market and the exchange rate were not generally cointegrated in India and some amount of causal effect could be noticed only late in 1990s. In another study, Nath and Samanta(2003b) examined the changing pattern in extent of integration between foreign exchange and capital markets in India using daily data and found that in VAR-framework empirical results do not point much impressive causal relationship between returns except in some specific years. However, they found using Geweke's feedback measures strong bi-directional as well as contemporaneous causal relationship between these markets.

From the existing literature, the linkage between macroeconomic variables and stock prices have been established for major markets like US, Japan while for other markets the same cannot be said for certainty.

3. Conceptual and Methodological Issues

The dynamic linkage may simply be examined using the concept of Granger's (1969, 1988) causality. Formally, a time series X_t Granger-causes another time series Y_t if series Y_t can be predicted with better accuracy by using past values of X_t rather than by not doing so, other information being identical. In other words, variable X_t fails to Granger-cause Y_t if

$$\Pr(Y_{t+m} \mid \Psi_t) = \Pr(Y_{t+m} \mid \Omega_t) \tag{1}$$

where $\Pr(\bullet)$ denotes conditional probability, ψ_t is the set of all information available at time t and Ω_t is the information set obtained by excluding all information on X_t from ψ_t.

Testing causal relations between two stationary series X_t and Y_t (in bivariate case) can be based on the following two equations

$$Y_t = \alpha_0 + \sum_{k=1}^{p} a_k Y_{t-k} + \sum_{k=1}^{p} \beta_k X_{t-k} + u_t \tag{2}$$

$$X_t = \varphi_0 + \sum_{k=1}^{p} \varphi_k Y_{t-k} + \sum_{k=1}^{p} \Phi_k X_{t-k} + v_t \tag{3}$$

where p is a suitably chosen positive integer; α_k's and β_k's, $k = 0,1, \ldots,p$ are constants; and u_t and v_t usual disturbance terms with zero means and finite variances. The null hypothesis that X_t does not Granger-cause Y_t is not accepted if the β_k's, $k>0$ in equation (2) are jointly significantly different from zero using a standard joint test (e.g., an F test). Similarly, Y_t Granger-causes X_t if the φ_k's, $k>0$ coefficients in equation (3) are jointly different from zero.

It may be mentioned that the above test is applicable to stationary series. In reality, however, underlying series may be non-stationary. In such cases, one has to transform the original series into stationary series and causality tests would be performed based on transformed-stationary series. A special class of non-stationary process is the I(1) process (i.e., the process possessing a unit root). An I(1) process may be transformed to a stationary one by taking first order differencing. Thus, while dealing with two I(1) process for causality, equations (2) and (3) must be expressed in terms of differenced-series. However, if underlying I(1) processes are cointegrated, the specifications so obtained must be modified by inserting the lagged-value of the cointegration relation (i.e., error-correction term) as an additional explanatory variable (Engle and Granger, 1987). In other words, equations (2) and (3) should be modified as

$$\Delta Y_t = \alpha_0 + \sum_{k=1}^{p} \alpha_k \Delta Y_{t-k} + \sum_{k=1}^{p} \beta_k \Delta X_{t-k} + \delta \ \mathrm{ECT}_{t-1} + u_t \tag{4}$$

$$\Delta X_t = \phi_0 + \sum_{k=1}^{p} \phi_k \Delta Y_{t-k} + \sum_{k=1}^{p} \Phi_k \Delta X_{t-k} + \eta \ ECT_{t-1} + v_t \tag{5}$$

where Δ is the difference operator and ECT_{t-1} represents an error correction term derived from the long-run cointegrating relationship between the I(1) processes X_t and Y_t. This term can be estimated by using the residual from a cointegrating regression. Clearly, if X_t and Y_t are I(1) but not cointegrated, the term ECT_{t-1} would be absent from equations (4) and (5).

Testing for the existence of potential cointegrating relationships among the variables in X_t involves testing for statistically significant eigenvalues (λ_i). The eigenvector (v_i) corresponding to the statistically significant eigenvalues (λ_i) is the coefficient of the variables in the cointegrating relationship. Johansen (1988) suggests the following two likelihood ratio tests, depending on the null and alternative hypotheses considered.

Trace Test:

Null hypothesis (Ho): There are at most p cointegrating relations ($r \leq p$)

Alternative hypothesis (H1): $r = n$

Test Statistic:

$$\lambda_{tr} = - T \sum \ln (1 - \hat{\lambda}_i) \tag{6}$$

The empirical distributions of the test have been calculated and reported in Johansen and Juselius (1990) for values of (n–r) from 1 to 5. The test is performed sequentially with r = 0,1,2,..........,n. If the null hypothesis of r = 0 at the most is accepted, then testing stops and one concludes that there is no cointegration. Otherwise, the testing procedure continues until for some value p we accept the null hypothesis of r = p at the most. This means there are p cointegrating vectors.

Maximum Eigenvalue Test:

Null hypothesis (Ho): There are at most p cointegrating relations ($r \leq p$)

Alternative hypothesis (Ha): $r = p + 1$

Test Statistic:

$$\lambda_{max} = - T \ln (1 - \hat{\lambda}_{p+1}) \quad (7)$$

the testing procedure is similar to the one explained above for the trace test, and the critical values could be found in Johansen and Juselius (1990).

Between Johansen's two likelihood ratio tests for cointegration, the trace test shows more robustness to both skewness and kurtosis (i.e., normality) in residuals than the maximum eigenvalue test (Cheung and Lai 1993): Therefore, we have employed the trace test to perform the cointegration tests and analyse the results. However, we have also shown the results of the Maxeigen value test. In this study, we define X_t as composed of n variables, which represent the national stock price indices of a selected group of ten countries.

Vector Autoregressive Analysis: Two decades ago, Sims (1980) provided a new macroeconometric, a simple and parsimonious framework: Vector Autoregressions (VARs). A univariate autoregression is a single equation; single variable linear model in which the current value of a variable is explained by its own lagged values. A VAR is a *n*-equation, *n*-variable linear model in which each variable is in turn explained by its own lagged values, plus current and past values of remaining *n–1* variables. This simple framework provides a systematic way to capture dynamics in multiple time series. The VAR is commonly used for forecasting systems of interrelated time series and for analyzing the dynamic impact of random disturbances on the system of variables. The mathematical representation of a VAR is

$$Y_t = A_1 Y_{t-1} + ... + A_p Y_{t-p} + BX_t + \varepsilon_t \quad (8)$$

where Y_t is a k vector of endogenous variables, X_t is a d vector of exogenous variables, $A_1 .... A_p$ and *B* matrices of coefficients to be estimated, and ε_t is a vector of innovations that may be contemporaneously correlated but are uncorrelated with their own lagged values and uncorrelated with all of the right hand side variables.

The VAR analysis enables us to analyze the variance decomposition of the forecast errors, providing insight information on unexpected variation in one variable with shocks from the other variables in the system. We can use VAR to decompose forecast error variance to measure the effect of each variable on itself and the other variables over different time horizons and also to provide information on dynamic responses to shocks in the system.

4. Data Characteristics and Analysis

The present study deals with a period of more than seven years (April 1996-July 2003). We have used monthly-published data of macroeconomic variables like oil prices (oil index), money supply (M3), Index of Industrial Production (IIP), foreign exchange reserves, foreign exchange rate (Rupee-US$ rate), wholesale price index, short-term interest rate (91-day T-Bills yield), ten year spot interest rate, REER, and the stock index (S&P CNX NIFTY). The data when plotted at levels (log values) showed a trend as given in Chart 1 and their difference series showed some stationarity as given in Chart 2.

Chart 1

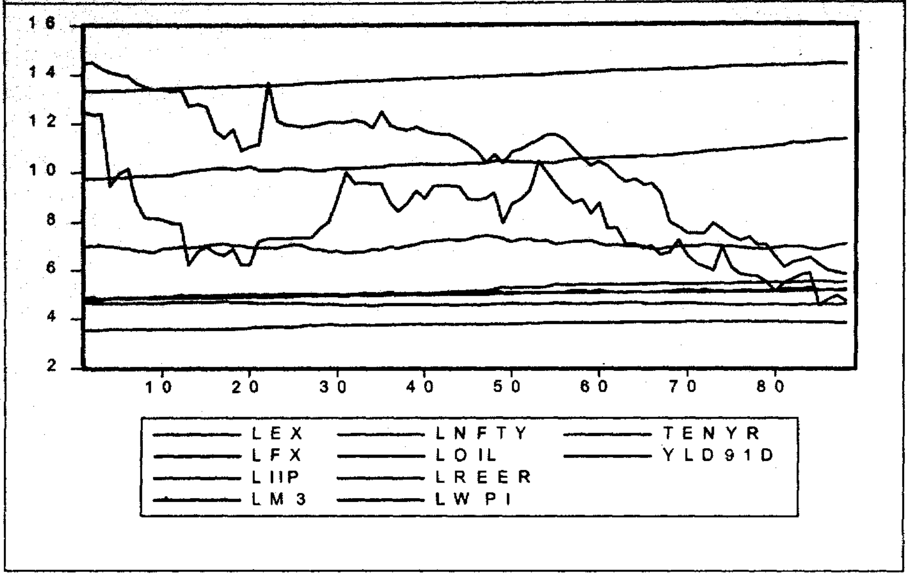
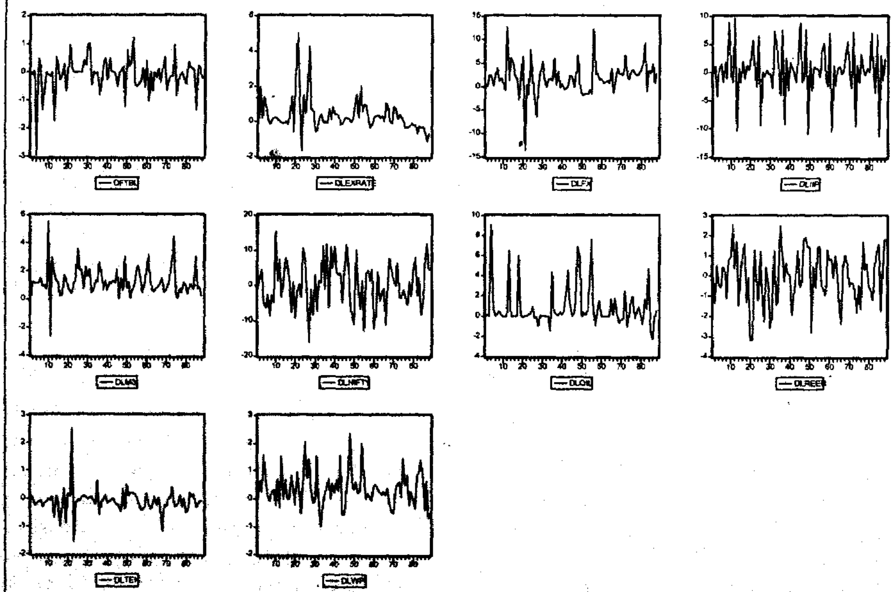


Chart 2



Before proceeding to use the data, we tested for the stationarity condition of the data using Augmented Dickey Fuller (ADF) test. While doing the test we used the equation of the auxiliary model:

$$z(t)-z(t-1)=a.z(t-1)+b(1).(z(t-1)-z(t-2))+...+b(p).(z(t-p)-z(t-p-1))+b(p+1)+b(p+2).t+u(t) \quad (9)$$

$t = p+2,...,n$, where $u(t)$ is white noise.

Table 1: Augmented Dickey Fuller Test Results

Variables	Test statistic# (p-values)	Optimal Lag
LOIL	-1.8409 (0.68000)	1
DLOIL	-3.6832** (0.02000)	4
LM3	-2.6472 (0.26000)	1
DLM3	-6.8078* (0.0000)	1
LFX	0.6811 (1.000)	1
DLFX	-6.1972* (0.0000)	1
LWPI	-2.9454 (0.1500)	1
DLWPI	-6.4268* (0.0000)	1
LIIP	-1.8688 (0.67000)	12
DLIIP	-2.9072 (0.16000)	12
LEXRATE	-0.2312 (0.9900)	1
DLEXRATE	-4.3470* (0.0000)	2
YLD91D	-1.5075 (0.82000)	3
DFYLD	-4.7637 (0.0000)	3
LNIFTY	-2.2284 (0.47000)	1
DLNIFTY	-5.6174* (0.0000)	1
TENYRYLD	-1.7462 (0.7200)	1
DFTENYR	-4.8224* (0.0000)	3
LREER	-2.1686 (0.5000)	1
DLREER	-5.3186* (0.0000)	2

*(**) indicates significant at 1% and 5% respectively.
Critical values of ADF statistic are -3.9676, -3.4144 and -3.129 at 1%, 5% and 10% significant levels.

We wanted to test the null hypothesis H_0: $z(t)$ is a unit root with drift process: a=0 and the alternative hypothesis H_1: $z(t)$ is a trend stationary process: $a<0$ and the test statistic being the t-value of a. We have conducted the ADF test for the unit root hypothesis against a linear trend stationarity hypothesis. The optimal lag length has been arrived using the Schwarz (SBC) criteria. The summary statistic of the stationarity test of all the variables is given in Table 1.

As we can see from the Table 1, the test statistics for all variables show that the series are non-stationary at level but stationary in their first differences except for IIP. The significant test shows that other variables in their first difference except oil are significant at 1% level while the oil is significant at 5% level. Further, a simple regression of the variables shows some interesting results and coefficients give us the long-term relationship of the variables. We have also conducted the Phillips Peron Test for the unit root. While doing the test we used the equation of the auxiliary model:

$$z(t) = a.z(t-1) + b + c.t + u(t) \quad (10)$$

where u(t) is a zero-mean stationary process. The null hypothesis H0: z(t) is a unit root with drift process (a=1) and the alternative hypothesis H1: z(t) is a linear trend stationary process: a < 1. The test involved is based on n(Alpha-1), where Alpha is the OLS estimate of the AR parameter 'a'. The test employs a Newey-West type variance estimator of the long-run variance of u(t), with truncation lag m. We have used a lag of 3. The results are given in the Table-1B. The results are in similar lines as in ADF.

Having satisfied with the results of unit root tests, we proceed to conduct the Johansen's cointegration test for the variables. We have tried with various lags 1, 2, 3 and 4 but we have only 88 observations and 10 variables, we thought it prudent to test the results with 2 lags. The Johansen's cointegration test results are given in Table 2 that show

Variables	Alpha	Test Statistic*	p-values
LOIL	0.9342	–5.88	0.75
DLOIL	0.1034	–69.68#	0
LM3	0.7705	–19.66##	0.08
DLM3	–0.1642	–95.25#	0
LFX	0.9767	–2.15	0.97
DLFX	–0.0065	–86.64#	0
LWPI	0.8411	–15.83	0.16
DLWPI	0.0678	–76.31#	0
LIIP	0.3594	–60.96##	0
DLIIP	0.4661	–127.16##	0
LEXRATE	1.0112	–0.27	1
DLEXRATE	0.2735	–62.9#	0
YLD91D	0.8876	–9.08	0.51
DFYLD	–0.136	–97.25#	0
LNIFTY	0.9089	–9.64	0.47
DLNIFTY	0.0899	–78.34#	0
TENYRYLD	0.8741	–8.86	0.52
DFTENYR	–0.2383	–102.36#	0
LREER	0.9151	–8.56	0.55
DLREER	0.1206	–71.72#	0

Table 1B: Phillips-Peron Test Results

(##) indicates significant at 5% (10%) level
*5% Critical region: < –21.78 and
10% Critical region: < –18.42

existence of more than 2 cointegrating vectors at 1% significance level. Hence, we have to use the VECM so that it would restrict the long run behavior of the endogenous variables to converge to their cointegrating relationship while allowing for short-run adjustments dynamics.

For Null hypothesis regarding r, Trace Statistics is derived as

$$\lambda_{trace} = -T \sum_{i=r+1}^{N} \ln(1 - \lambda_{r+1})$$

where T is number of observations and λ_r is the r-th Eigenvalue in ascending order.

Linear Granger Causality Test Results

The test results of Granger Causality between various markets are presented in Table-3. We have tested the results with a lag of 2 as we have done in the cointegration test and report the lag 2 results.

Now, we move to forecast error decomposition using VECM. For the period, the error variances for each variable are explained by their own innovations. Table-4 gives the decomposition of forecast error variance for the variables. We have estimated the VECM model with 4 cointegrating vectors and then analysed the variance decomposition and impulse response.

Table 2: Cointegration Test Results (with lag of 2)

Period	Eigenvalues (Descending Order)	Null Hypothesis#	Trace Statistics*	Critical Value 5%	Critical Value 1%
1996-2002	0.69	r=0**	335.15	233.13	247.18
	0.51	r=<1**	235.40	192.89	204.95
	0.41	r=<2**	174.15	156.00	168.36
	0.38	r=<3*	129.76	124.24	133.57
	0.28	r=<4	89.47	94.15	103.18
	0.27	r=<5	61.16	68.52	76.07
	0.21	r=<6	34.25	47.21	54.46
	0.10	r=<7	14.38	29.68	35.65
	0.04	r=<8	5.14	15.41	20.04
	0.02	r=<9	1.36	3.76	6.65

- 'r' indicates number of cointegrating relationship.
*(**) denotes rejection of the hypothesis at the 5%(1%) level.

Table 3: Pairwise Granger Causality Tests (From Row to Column NOT =>) (Bracketed values are p-values) (1996-2003)

	DFTEN	DFYLD	DLEXRT	DLFX	DLIIP	DLM3	DLNIFTY	DLOIL	DLREER	DLWPI
DFTEN		0.0057	3.9989**	4.2931***	1.4853	1.001	0.0918	0.1906	0.4111	0.4217
		(.9942)	(0.0220)	(0.017)	(0.2325)	(0.3717)	(0.9123)	(0.8268)	(0.6642)	(0.6573)
DFYLD	1.4846		0.2317	0.6641	0.0176	0.4054	2.32189*	1.3708	1.2923	1.8284
	(0.2326)		(0.7937)	(0.5175)	(0.9826)	(0.668)	(0.1045)	(0.2597)	(0.2802)	(0.1672)
DLEXRT	9.8663***	1.0707		7.5833***	0.0627	0.0001	2.0771	0.5954	1.3178	2.2866
	(0.0002)	(0.3476)		(0.0009)	(0.9392)	(0.999)	(0.1319)	(0.553)	(0.2733)	(0.1081)
DLFX	11.971***	1.9169	0.0026		1.3249	1.953	0.0534	0.5703	0.1882	1.1551
	(0.0000)	(0.1537)	(0.9973)		(0.2715)	(0.1899)	(0.9480)	(0.5675)	(0.8287)	(0.3201)
DLIIP	0.0376	2.1446	1.6139	0.3890		0.8311	0.2370	0.0923	1.4113	3.5885**
	(0.963)	(0.1237)	(0.2054)	(0.6789)		(0.4392)	(0.7895)	(0.9118)	(0.2497)	(0.0321)
DLM3	0.3610	0.8438	0.8145	1.3167	4.3738**		0.3962	3.0667**	3.9583**	1.6955
	(0.698)	(0.4337)	(0.4464)	(0.2736)	(0.0157)		(0.6741)	(0.0520)	(0.022)	(0.1899)
DLNIFTY	0.2316	0.1696	1.0237	0.15	0.0098	3.0878**		1.8290	2.0551	0.6493
	(0.7937)	(0.8443)	(0.3638)	(0.8609)	(0.990)	(0.0510)		(0.1671)	(0.1346)	(0.5250)
DLOIL	0.1059	1.3670	0.9891	0.5348	0.3333	2.1298	2.1152		0.3550	0.4939
	(0.8996)	(0.2607)	(0.3763)	(0.5877)	(0.7174)	(0.1254)	(0.1272)		(0.1760)	(0.6120)
DLREER	3.7820**	3.5923**	0.1860	4.2153**	1.8257	1.8078	0.6554	1.0487		3.0888**
	(0.0269)	(0.032)	(0.8305)	(0.0181)	(0.1676)	(0.1705)	(0.5219)	(0.3550)		(0.0509)
DLWPI	0.7820	0.1568	1.7657	0.1419	2.9149*	1.5631	7.3255***	0.6846	1.8140	
	(0.4609)	(0.8551)	(0.1775)	(0.8678)	(0.0599)	(0.2157)	(0.0011)	(0.5071)	(0.1695)	

*, ** and *** denote rejection of null hypothesis at 10%, 5% and 1% significance level, respectively and NOT => implies does not Granger Cause.

VECM Equation:

D(DLNIFTY) = 1.1800*(DLOIL(–1)–0.1594*DLREER(–1)+4.1511*DLWPI(–1)–0.1900*DLIIP(–1)+2.087*DLM3(–1)–0.3093*DFTBL(–1)–7.2533*DLTEN(–1)–0.1014*DLNIFTY(–1)–5.858)–0.74665*(DLFX(–1)–2.2906*DLREER(–1)–19.446*DLWPI(–1)–2.042*DLIIP(–1)–3.5330*DLM3(–1)+5.4131*DFTBL(–1)+22.1414*DLTEN(–1)+0.2561*DLNIFTY(–1)+13.572)–2.4020*(DLEXRATE(–1)+1.3354*DLREER(–1)+9.0430*DLWPI(–1)+0.4835*DLIIP(–1)+1.6473*DLM3(–1)–1.45105*DFTBL(–1)–10.215*DLTEN(–1)–0.0493*DLNIFTY(–1)–7.237)–0.9999*D(DLOIL(–1))–1.05448*D(DLOIL(–2))+0.6645*D(DLFX(–1))–0.1192*D(DLFX(–2))+2.8798*D(DLEXRATE(–1))–0.6492*D(DLEXRATE(–2))+1.8178*D(DLREER(–1))+0.06015*D(DLREER(–2))–0.17402*D(DLWPI(–1))–2.249*D(DLWPI(–2))–0.175016*D(DLIIP(–1))+0.18122*D(DLIIP(–2))–0.740786*D(DLM3(–1))+0.40218*D(DLM3(–2))+1.5034*D(DFTBL(–1))–2.8897*D(DFTBL(–2))+0.2231*D(DLTEN(–1))+2.4600*D(DLTEN(–2))–0.46680*D(DLNIFTY(–1))–0.18200*D(DLNIFTY(–2))+0.0913

However, it can be seen that other macro variables like oil prices, foreign exchange reserves as well as the exchange rate, WPI and short-term interest rate have greater explanatory power in explaining the variation in stock prices than money supply and index of industrial production. This may be due to the fact that money supply as well as IIP has a higher lag for effective realization. To further investigate the dynamic responses between the variables we also calculated the impulse response of the VAR system and results are given in Table-5. The impulse response graphs are also presented in the Charts (See Page 12). An impulse response function traces the effect of a one time shock to one of the innovations on current and further values of the endogenous variables. Innovations are usually correlated and may be viewed as having a common component that cannot be associated with a specific variable in order to interpret the results.

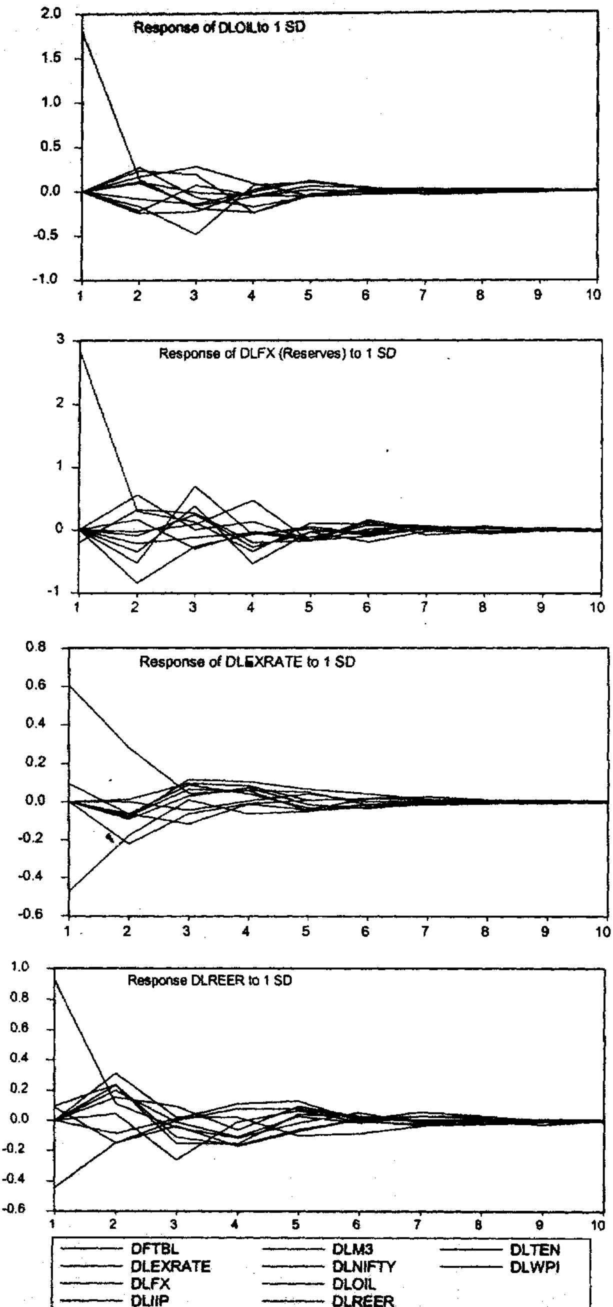
Table 4: Decomposition of Forecast Error Variance for Variables

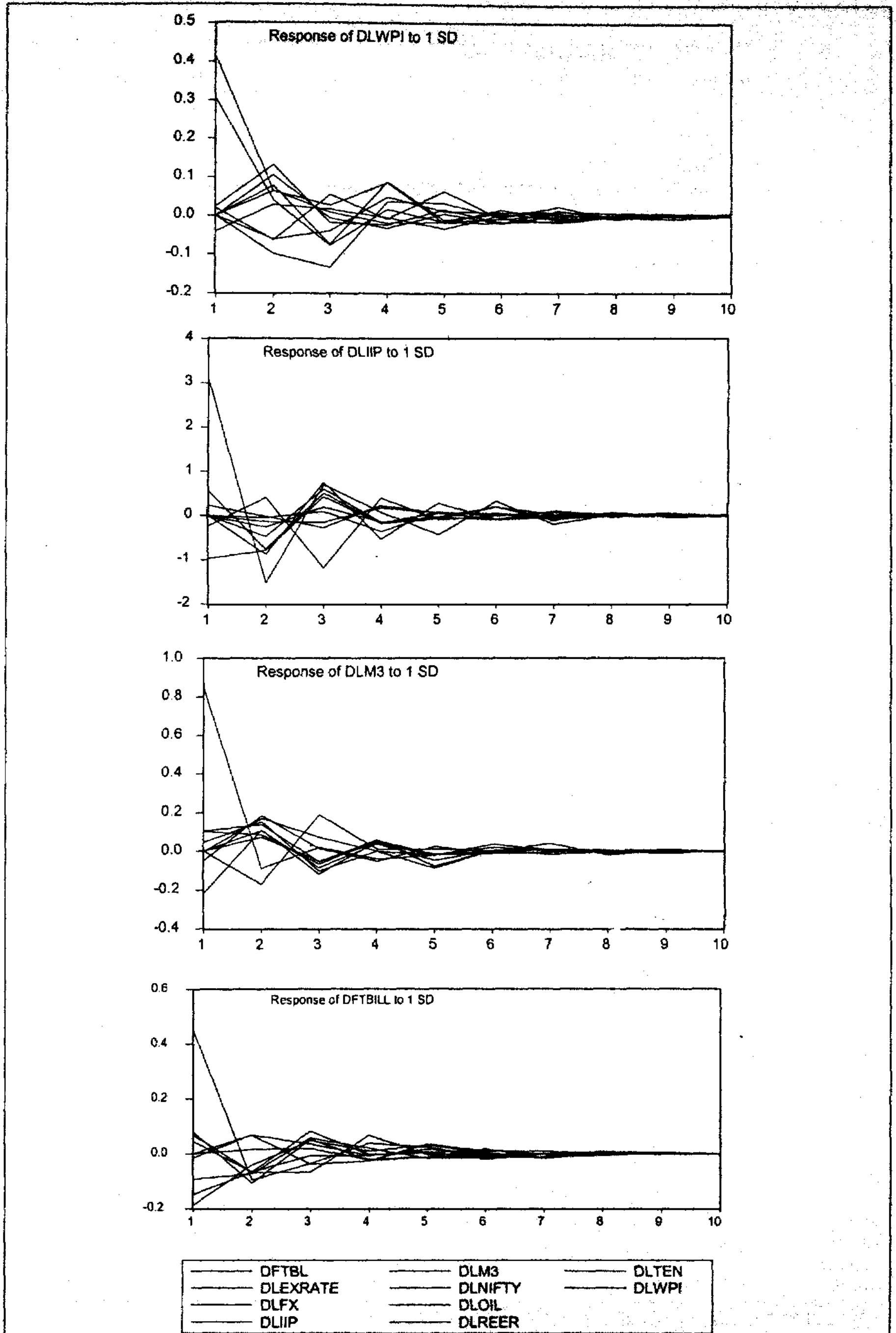
Period	S.E.	DLOIL	DLFX	DLEXRT	DLREER	DLWPI	DLIIP	DLM3	DFTBL	DLTEN	DLNIFTY
					Variance Decomposition of DLOIL:						
2	1.84	81.96	0.04	2.70	2.62	3.55	0.06	6.94	1.98	0.00	0.15
3	2.09	64.12	0.03	4.07	3.55	3.05	3.05	22.02	2.69	0.01	0.42
4	2.31	53.12	0.04	3.40	3.57	5.89	0.59	20.84	2.82	2.29	7.46
5	2.43	50.86	1.02	3.21	3.58	5.82	0.64	22.18	2.59	2.72	7.38
					Variance Decomposition of DLFX:						
2	3.65	1.84	83.38	6.74	0.73	0.18	0.68	1.44	0.12	4.29	0.60
3	4.03	2.64	79.48	8.02	0.69	0.99	1.71	1.18	0.40	4.38	0.50
4	4.41	2.24	73.45	7.47	0.78	1.79	3.81	3.92	0.38	3.69	2.48
5	4.72	2.96	73.07	7.14	0.70	3.53	3.35	3.50	0.34	3.23	2.19
					Variance Decomposition of DLEXRATE:						
2	1.04	2.08	26.02	67.83	0.63	0.12	0.10	0.39	1.02	1.70	0.10
3	1.15	1.76	21.79	67.43	0.70	2.06	1.31	2.04	1.16	1.51	0.25
4	1.27	1.76	22.84	67.26	0.66	1.83	1.08	2.06	1.01	1.24	0.27
5	1.41	1.44	21.91	69.49	0.67	1.52	0.98	1.68	0.98	1.11	0.23
					Variance Decomposition of DLREER:						
2	1.28	4.75	16.41	28.81	43.91	1.03	0.47	0.05	3.43	1.01	0.15
3	1.43	4.09	18.61	26.37	39.25	0.85	0.60	5.80	2.97	1.19	0.27
4	1.57	3.38	17.03	27.59	34.50	5.97	0.88	4.88	2.94	2.46	0.37
5	1.76	4.39	16.94	29.86	29.23	6.09	1.52	4.22	3.85	3.38	0.52
					Variance Decomposition of DLWPI:						
2	0.55	11.63	2.05	7.40	2.72	69.54	1.95	0.28	4.41	0.02	0.00
3	0.64	11.85	1.54	9.35	2.75	61.69	2.06	6.83	3.56	0.33	0.04
4	0.69	10.45	1.30	8.11	4.18	52.71	3.45	5.99	3.16	5.54	5.10
5	0.76	8.83	6.04	8.85	3.52	45.93	2.91	9.67	3.30	6.15	4.80
					Variance Decomposition of DLIIP:						
2	3.82	2.74	10.47	0.67	3.81	11.49	66.37	3.80	0.08	0.52	0.04
3	4.51	2.91	17.21	1.33	8.84	9.60	52.50	6.75	0.06	0.65	0.15
4	4.73	4.30	16.12	1.22	8.73	10.77	48.85	6.21	0.82	0.71	2.28
5	4.94	4.90	20.23	1.28	8.08	11.14	44.93	5.70	0.92	0.70	2.11
					Variance Decomposition of DLM3:						
2	1.02	4.57	0.77	1.63	2.93	1.11	8.16	71.42	3.14	0.67	5.60
3	1.08	4.15	2.53	1.48	2.71	1.14	7.43	71.50	2.83	0.62	5.61
4	1.15	6.39	2.27	1.86	2.37	2.17	10.98	63.98	2.66	2.40	4.93
5	1.25	6.62	4.61	2.19	2.04	6.12	10.49	58.42	2.42	2.75	4.33
					Variance Decomposition of DFTBL:						
2	0.59	14.31	4.99	2.64	10.56	0.58	6.26	0.17	53.04	0.17	7.29
3	0.65	11.97	6.23	3.24	14.16	0.53	8.77	2.65	45.63	0.79	6.03
4	0.72	12.02	6.12	3.60	11.80	2.45	8.58	2.51	46.38	1.35	5.20
5	0.75	10.96	6.25	3.27	12.04	3.50	7.91	2.69	46.10	1.85	5.42
					Variance Decomposition of DLTEN:						
2	0.43	2.73	26.03	8.52	0.95	1.70	2.23	4.11	4.44	49.07	0.22
3	0.47	2.93	21.87	16.44	0.88	3.94	1.92	3.57	4.08	43.24	1.13
4	0.50	2.71	22.73	14.98	1.09	5.80	3.14	3.24	4.10	41.20	1.02
5	0.56	6.03	22.17	16.36	1.58	5.97	2.50	3.24	5.31	36.02	0.83
					Variance Decomposition of DLNIFTY:						
2	6.49	10.04	7.92	6.17	2.18	10.57	0.02	0.63	1.78	0.46	60.22
3	8.00	7.56	6.22	7.21	3.24	18.33	0.33	2.64	8.50	0.69	45.28
4	8.60	7.53	5.83	9.08	5.44	19.10	0.32	3.04	7.36	0.73	41.57
5	9.10	6.78	5.30	9.44	5.52	21.04	0.40	4.33	6.62	0.66	39.91

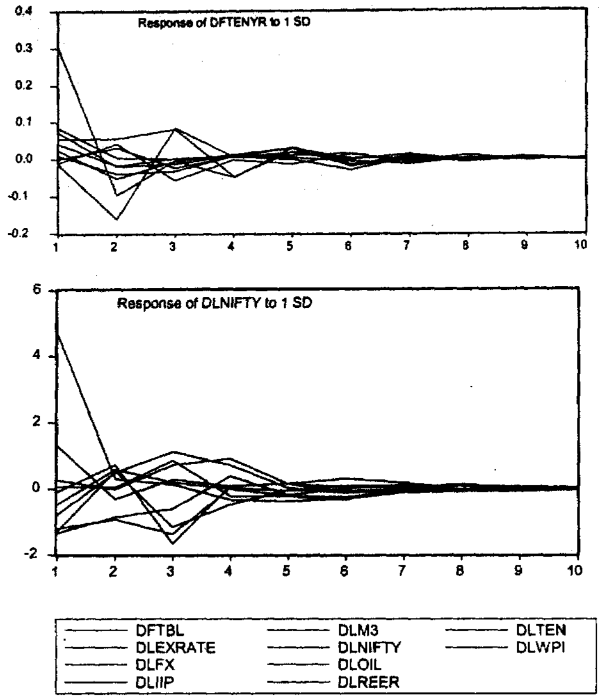
Table 5: Impulse Response of a unit shock (S.D. innovation) in one variable on the other variables

Period	DLOIL	DLFX	DLEXRT	DLREER	DLWPI	DLIIP	DLM3	DFTBL	DLTEN	DLNIFTY
				Response of DLOIL:						
2	0.33	0.04	-0.30	0.30	0.35	0.04	-0.48	0.26	-0.01	-0.07
3	0.17	0.00	0.29	0.26	0.11	0.01	-0.85	0.23	-0.02	0.12
4	0.18	0.02	-0.06	0.19	-0.43	0.17	-0.39	-0.18	0.35	0.62
5	0.40	-0.24	-0.09	0.14	-0.17	0.08	-0.44	0.04	0.20	0.19
				Response of DLFX:						
2	0.41	1.18	-0.95	0.31	-0.16	0.30	-0.44	0.12	-0.76	-0.28
3	0.43	1.35	-0.64	-0.12	-0.37	0.43	0.01	-0.22	0.38	0.04
4	0.07	1.16	-0.38	0.20	-0.43	0.68	-0.76	-0.09	-0.06	-0.63
5	0.47	1.41	-0.37	-0.06	-0.66	-0.08	-0.12	0.04	-0.06	-0.07
				Response of DLEXRATE:						
2	-0.02	-0.22	0.56	0.08	0.04	-0.03	0.06	-0.11	-0.14	-0.03
3	0.03	-0.07	0.39	-0.05	0.16	-0.13	0.15	-0.07	-0.04	0.05
4	0.07	-0.29	0.44	-0.04	0.05	0.01	0.08	0.03	-0.01	-0.03
5	0.01	-0.26	0.54	0.05	0.02	-0.04	0.00	-0.06	-0.04	-0.01
				Response of DLREER:						
2	0.28	-0.50	-0.43	0.22	0.13	0.09	-0.03	0.24	-0.13	0.05
3	0.08	-0.33	-0.26	0.29	0.02	0.07	-0.34	0.07	0.09	-0.05
4	-0.01	-0.20	-0.38	0.22	-0.36	-0.10	0.04	-0.11	0.19	-0.06
5	0.23	-0.33	-0.50	0.24	-0.20	0.16	-0.10	0.22	0.21	-0.08
				Response of DLWPI:						
2	0.00	-0.03	0.15	-0.09	0.18	-0.08	-0.03	0.12	0.01	0.00
3	-0.11	0.00	0.12	0.05	0.20	-0.05	-0.16	0.03	0.04	0.01
4	-0.05	0.00	0.03	-0.09	0.06	0.09	-0.03	-0.03	0.16	0.16
5	-0.02	-0.17	0.11	0.00	0.10	0.01	-0.16	0.06	0.09	0.05
				Response of DLIIP:						
2	0.45	-0.35	0.12	0.66	-0.64	-1.15	-0.75	0.11	-0.27	0.08
3	0.44	1.41	-0.42	-1.12	-0.53	1.00	0.91	-0.01	0.24	0.16
4	0.61	0.31	-0.03	-0.39	-0.67	0.48	-0.12	0.41	-0.16	-0.69
5	0.48	1.15	0.20	0.13	-0.56	-0.18	0.03	0.20	0.12	0.06
				Response of DLM3:						
2	0.04	0.07	0.12	0.04	0.05	0.25	0.11	0.18	0.08	-0.24
3	-0.02	-0.15	0.01	-0.03	-0.04	0.03	0.29	0.00	-0.01	0.08
4	-0.19	-0.03	0.09	-0.01	-0.12	0.24	0.13	0.05	0.16	0.01
5	-0.14	-0.21	0.10	-0.02	-0.26	0.14	0.26	-0.05	0.11	-0.05
				Response of DFTBL:						
2	-0.09	-0.07	0.03	-0.07	0.00	-0.02	-0.01	0.04	0.02	0.16
3	-0.02	0.09	-0.07	-0.15	0.01	0.12	0.10	0.09	-0.05	0.00
4	-0.10	-0.07	-0.07	-0.02	0.10	0.08	0.04	0.21	-0.06	-0.03
5	-0.01	-0.06	0.00	-0.09	0.08	0.03	0.05	0.15	-0.06	0.06
				Response of DLTEN:						
2	0.06	-0.20	0.10	-0.03	0.02	0.06	-0.08	0.03	0.02	0.02
3	0.04	0.04	0.15	0.02	0.08	-0.02	-0.02	0.03	0.09	0.05
4	-0.01	-0.08	0.01	0.03	0.07	0.06	0.00	-0.03	0.07	0.00
5	0.11	-0.11	0.12	-0.05	0.06	0.00	-0.05	0.08	0.10	0.01
				Response of DLNIFTY:						
2	-0.94	0.19	-0.45	-0.30	-1.53	-0.09	0.45	-0.07	-0.23	1.62
3	-0.78	0.80	-1.42	-1.07	-2.70	0.45	1.19	-2.16	0.50	1.89
4	0.86	0.58	-1.45	-1.40	-1.55	0.17	0.75	-0.11	0.31	1.34
5	-0.21	0.29	-1.05	-0.74	-1.82	-0.30	1.16	-0.20	-0.10	1.52

The impulse response graphs are also presented in the charts below




Response of DLWPI to 1 SD
Response of DLIIP to 1 SD
Response of DLM3 to 1 SD
Response of DFTBILL to 1 SD
DFTBL
DLEXRATE
DLFX
DLIIP
DLM3
DLNIFTY
DLOIL
DLREER
DLTEN
DLWPI



Robustness of Relationship

To study robustness of the results, we further explore the relations in 10 dimension systems, i.e., the stock returns and the ten possible combinations of nine variables from the original of eight. Tha (OLS) regression has been carried out on the first difference series. Table 6a presents the results.

Table 6a: Coefficient Test

	EXRATE	FX RESV	IIP	WPI	M3	OIL	REER	TENYR	YLD91D
NIFTY	–	+	+	–	+	–**	+	–	+
Without									
EXRATE		+***	+	–	–	–***	+	–	+
FX RESV	–**		+	+	+	–**	+	–	–
IIP	–	+		–	–	–***	+	–	+
WPI	–	+	+		+	–**	+	–	+
M3	–	+	+	+		–**	+	–	+
OIL	–	+	+	–	+		+	–	+
REER	–	+	+	+	+	–**		–	+
TENYR	–***	+	+	–	+	–**	+		–
YLD91D	–	+	+	+	+	–**	+	–	
Overall	–	+	+	?	+	–	+	–	+

*,** and *** indicating significant at 1%, 5% and 10% level

Table 6b: Coefficients										
	EXRATE	FX RESV	OIL	IIP	M3	REER	WPI	TENYR	YLD91D	NIFTY(-1)
NIFTY	-	+	-**	+	+	+	-	-	-	+
Without										
EXRATE		+***	-**	+	+	+	-	-	+	+
FX RESV	-***		-**	+***	+	+	-	-	-	+
OIL	-	+		+	+	+	-	-	+	+
IIP	-	+	-***		+	+	-	-	+	+
M3	-	+	-**	+		+	+	-	-	+
REER	-	+	-**	+	+		+	-	-	+
WPI	-	+	-**	+		+	+	-	-	+
TENYR	-***	+	-**	+	+	-	-		-	+
YLD91D	-	+	-**	+	+	+	-	-		+
NIFTY(-1)	-	+	-**	+	+	+	-	-	+	
Overall	-	+	-	+	+	+	-	-	-	+

*,** and *** indicating significant at 1%, 5% and 10% level

From the above, we find that oil prices have significant influence in explaining the stock prices whereas the other variables have not been significant. The situation did not change when we dropped one variable at a time except in case of exchange rate (in two situations it became significant). Surprisingly, we found that other economic factors did not have significant influence on stock returns. However, their economic relationship has been confirmed through signs except for 91-day T-bills yield which showed a positive relationship with stock prices. This may be due to the fact that 91-day T-Bills rates are more rigid compared to ten year yields as there is little liquidity in T-Bills in the secondary market and there is limitation on the quantum of available T-Bills in the secondary market. The same analysis was also carried out including the lagged values of stock index and situation did not change except in case of T-Bills yield which showed the positive relationship. It has to be remembered that except in case of oil prices and to a small extent in case of exchange rate, other variables are not statistically significant to explain the stock prices. The results remained the same. The Table-6b gives the results of the same.

In order to examine what lag of stock returns would be providing us best fit for regression, we examined the partial autocorrelation of the residuals with the help of standard normal values (dividing the partial autocorrelation residuals with standard deviation of the population $\sqrt{(1/n)}$ and find that the values are not significant at even 10% level. And hence we decided to use lag of 1 month for the stock index while doing the coefficient test in the analysis.

5. Conclusion

This study investigates whether the macroeconomic indicators can explain stock market prices in Indian market. The data consisted of 88 months from April 1996 to July 2003 comprising of all monthly macro indicators. The series was found to be stationary in first differences except for IIP which was found to be stationary in the level. We have considered ten macro variables for the study: WPI, Exchange Rate, IIP, Foreign exchange Reserves, Stock Index, M3, Oil price index, Real Effective Exchange rate, 91-day Treasury Bills yield as well as 10-year yields. The study finds a long-term equilibrium relationship among the macroeconomic variables and stock market indicator through Johansen's cointegration test. The Granger Causality test finds short term dynamics among macro variables. The VECM of Johansen illustrates that stock prices are cointegrated with the set of macroeconomic variables considered under the study.

We conducted an OLS regression on first differences to study the robustness of the relationship. This robustness test gives us the result that the oil prices have a significant influence on stock price returns. The relationship of stock returns with other macro variables were not found to be significant except in case of exchange rate. ⅄

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