ANALYSIS OF INTERACTION BETWEEN GLOBAL CRUDE OIL PRICE, EXCHANGE RATE, INFLATION AND STOCK MARKET IN INDIA: VECTOR AUTO REGRESSION APPROACH

Shekhar Mishra,
Assistant Professor, Department of Business Management,
C.V. Raman College of Engineering, Bhubaneswar, PIN: 752054,
shekhar@cvrgi.edu.in, shekhar.ximb@gmail.com

Sathya Swaroop Debasish,
Associate Professor, Department of Business Administration, Utkal University,
Bhubaneswar,751004, sathyaswaroop2000@yahoo.com

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ABSTRACT

The present paper analyses the association between global crude oil price, exchange rate, inflation and stock market in Indian economic scenario. The paper employs Vector Auto Regression Model on monthly data from April 2001 to March 2017. The monthly data has been sourced from official website of Energy Information Agency (EIA), Reserve Bank of India (RBI) and Bombay Stock Exchange (BSE). The analysis reveals the variables being integrated of Order I (1) and negates the possible existence of long run relationship among them. The analysis shows the negative relationship between stock index and inflation and positive association with exchange rate and WTI crude oil price. The paper also indicates the indicates the WTI crude oil price increase cause increase in inflation and exchange rate depreciation. Although the increase in WTI crude oil price has a favourable impact on BSE Index, the paper necessitates the need of decrease in reliance upon crude oil price so as to curb the increase in inflation and exchange rate depreciation. The policymakers need to devise policies to keep control on the increase in inflation and conserve the foreign exchange.

Keywords: WTI, Inflation, Exchange Rate, Vector Auto Regression Model.

INTRODUCTION

Oil has always been termed as one of the key essential commodities in the global economy. Crude oil has always been considered to play a crucial role in economic activities at a global level as a whole. The oil price fluctuations have a capability of bringing in a paradigm shift in policies at macroeconomic level and decisions at microeconomic level of any nation as a whole.

Owing to key role of oil price fluctuations in any economy, many researchers have examined the interaction between global crude oil price and different macroeconomic variables like GDP, Foreign Exchange Reserve, Stock Market Fluctuation, Ratio of Export to Import to name a few. However, the outcome of studies has varied according to variations in the assumptions, research methods, variables, frequency of data etc. adopted by different researchers.

The present paper endeavours to analyse the relationship between global crude oil price, inflation, exchange rate and stock returns in India., one of the major oil importing country not only in Asia, but in the world. The paper employs Vector Auto Regression Approach to investigate the relationship between the given variables. The variables' stationarity is tested by employing, Augmented Dickey Fuller Test and Phillips-Perron Test. Akaike Information Criterion is taken as the parameter to estimate the appropriate lag order for the Vector Auto Regression Approach. The present paper intends to contribute to existing literature by analysing the relationship between the given variables in India, for which there is a dearth of studies.

Literature Review

A number of researchers have endeavored to examine the influence of global crude oil price shocks on macroeconomic variables of not only developed or oil exporting countries, but also in emerging and major oil importing nations too. Arinze (2011) when applied simple regression analysis on the variables, observed positive relationship between global crude oil price and inflation represented by Consumer Price Index. Le Blanc and Chin (2004) while estimating the influence of oil price fluctuations on inflation in U.S., Japan and select European countries by employing Augmented Phillips Curve Parameter Estimates found minimal effect of oil price fluctuations on inflation in economies under study. While comparing the same, the authors observed oil price having large impact on inflation in European countries under study as compared to that of United States. Roger (2005) highlighted the short run significance of oil price in European countries by analysing the short run trade-off between GDP and inflation in the countries under study. In small open economies like Ireland, Bermingham (2008) also observed the significant impact of oil price on inflation. For Euro area, Jacquinot et.al. (2009) also recognised oil price change as one of the major factor in estimating short run inflation. Similarly Castillo et.al. also found increase in oil price leavel causing higher level inflation.

Cologni and Monera (2008) in most of the G-7 countries observed significant impact of oil price on inflation and output growth. The authors observed increase in oil price causing increase in inflation and decrease in output growth. In Russia, while examining the influence of oil price and monetary shocks on the nation's economy, Ito (2008), found 1% increase in oil price causing 0.25% increase in real GDP and 0.36% increase in inflation. In Taiwan, while applying ARDL Model with Augmented Phillips Curve on the data from January, 1982 to December, 2010, Chou and Tseng (2011) observed oil price having significant impact on inflation in long term. However in short term, the effect was insignificant. By using simple regression, Ali and Ramzan (2012), examined the effects of oil price on food sector prices in Pakistan. In their study, the authors observed, positive relationship between crude oil price and inflation in food prices. In Nigeria, When Phillip and Akintoye (2006) applied Vector Auto Regression Model on the data from year 1970 to 2003, did not observe any noteworthy influence of oil prices on output and inflation. However the authors observed significant influence of oil price shocks on exchange rate.

In Vietnam prior to year 1999, Nguyen and Seiichi (2007) observed bidirectional causality between real effective exchange rate and inflation level. The authors also observed existence of similar strong relationship between the given variables in other ASEAN nations like Malaysia, Singapore, Thailand and China. Arie et. al. (2010) also observed bidirectional causality between inflation and nominal exchange rate.

While analysing the relationship between oil price and industrial production, Cunado and Prez De Garcia (2003) observed index of industrial production having significant influence on oil price change. The influence of Industrial production on oil price volatility was also proved in the works of Serlettis and Shahmoradi (2005) and Ewing and Thompson (2007).

While analysing the influence of oil price shocks on international stock markets, Jones and Kaul (1996) postulated that in ost war period, the reaction of US and Canadian stock prices to oil price shocks can be entirely accounted for by the impact of oil price shocks on real cash flows alone. By employing Vector Auto Regression Model to examine to examine the influence of oil price volatility on real stock returns, Perry Sadorsky (1999) significant influence of oil price on stock returns. When Cong et.al. (2008) employed Multivariate Vector Auto Regression to analyse the relationships between oil price shocks and China Stock markets, the author did not find significant impact of the independent variables on the real stock returns of most of the stock indices except manufacturing index and some oil companies. Similarly Driesprong et.al (2008) also observed rising oil prices causing significant lowering of future stock returns of developed economies.

Abedeyi et.al. (2012) while estimating the impact of oil price shocks and exchange rates on real stock returns in Nigeria observed negative effects of oil price shocks on the stock returns. While applying Granger Causality test, the authors observed unidirectional causality running from oil price shocks to stock returns and from stock returns to oil price shocks. Korhonen et.al. (2009) postulated that in in oil dependent OPEC Countries higher oil price lead to appreciation of real exchange rate with elasticity of the same with respect to oil price typically ranging between 0.4 and 0.5. Similarly in Turkey Ortuk et.al. (2008) found international oil price Granger causing the USD/YTL exchange rate.

The present paper intends to extend the existing literature by analysing the combined interaction between global crude oil price, exchange rate, inflation and stock market behaviour in Indian economic scenario.

Research Methodology:

Data:

To analyse the dynamics of relationship between the given variables, the monthly data for the period April 2001 to March 2017, for BSE Stock Index, Consumer Price Index (CPI) as proxy variable for Inflation in India, Exchange Rate and Global Crude Oil Price is collected. The data for Global Crude Oil Price represented by WTI Crude is obtained from official website of Energy Information Agency. The historical data for BSE Stock Index is obtained from official website of Bombay Stock Exchange. The data for Consumer Price Index and Exchange rate is obtained from official website of Reserve Bank of India.

Unit Root Test:

To ascertain data stationarity Augmented Dickey Fuller Test and Phillips Peron Test are employed. Before proceeding to analysis of data Unit Root Test is imperative so as to avoid the problem of spurious regression. The process followed for testing the unit root in a given sample can be explained as follows.

The Augmented Dickey Fuller Test the modified version of Dickey Fuller Test comprises of 3 models which can be employed for obtaining required statistics

$$\Delta Y_t = a_0 + a_1 t + a_2 y_{t-1} + \sum_{s=1}^{k} b_s (\Delta Y)_{t-s} + U_t$$

Equation 1

$$\Delta Y_t = a_0 + a_2 y_{t-1} + \sum_{s=1}^{k} b_s (\Delta Y)_{t-s} + U_t$$

Equation 2

$$\Delta Y_t = a_2 y_{t-1} + \sum_{s=1}^{k} b_s (\Delta Y)_{t-s} + U_t$$

Equation 3

Y_t denotes the variables to be tested for stationarity and $\Delta Y_t = Y_t - Y_{t-1}$, t is the time trend.

The ADF test adds the lagged terms of dependent variable in the regression equation to take care of deterministic part of higher order correlation.

Phillips Perron (P-P) Test is a non-parametric approach which controls the serial correlation while testing the Unit Root. The method estimates the non-augmented Dickey Fuller Test Equation as follows:

$$\Delta Y_t = \alpha y_{t-1} + X_t \delta + \varepsilon_t$$

Equation 4

Where X_t is optional exogeneous regressor which may consists of constant or a constant and trend.

The Phillips Perron (P-P) Test controls the serial correlation and heteroskedasticity in error terms of regression by modifying the t-statistics of α coefficients.

Johanssen Cointegration Test:

The precondition for application of Vector Auto Regression Model is absence of cointegration or long run relationship between the given variables. There should not be any cointegration among the stationary variables of order I (1). The two non-stationary series are said to be co-integrated if there exists a stationarity in linear combination between them or there exists a long run equilibrium relationship between the given variables. The Johanssen's Co Integration approach developed by Johanssen and Juesilius (1990) is employed to calculate the co-integrating regressions and ascertain the long run equilibrium relationship between the given variables.

The Johanssen Cointegration framework employs the maximum likelihood procedure to ascertain the presence of co-integrating vectors in non-stationary time series as Vector Auto Regression (VAR)

$$\Delta Z_t = c + \sum_{i=1}^{k} \Gamma_i \Delta Z_{t-1} + \Pi\, Z_{T-1} + \eta_t$$
(Equation 5)

Z_t is a vector of non - stationary (log level) variables and C is termed as constant term. The information on the coefficient matrix between the levels of Π is decomposed as $\Pi = \alpha\beta'$, where the relevant elements, the matrix are termed to be adjustment coefficients and matrix consists of co integrating vectors.

The Johanssen's Co integration approach employs two test statistics i.e. Trace Statistics () and maximum Eigen value statistic () to determine the number of co integrating vectors (Brooks, 2008). The test statistics i.e. and can be expressed as follows.

$$\lambda_{trace}\,(r) = -T \sum_{i=r+1}^{g} \ln(1-\hat{\lambda}_i) \quad \text{(Equation 6)}$$

and $\lambda_{max}\ (r, r+1) = -T\ln(1-\hat{\lambda}_{r+1})$ (Equation 7)

Where r is expressed as number of co integrating vectors under null hypothesis and is the estimated value for the ordered Eigen value from the matrix. The different co integrating vectors termed as Eigen Vectors will be associated with Eigen Value.

The test statistics are then compared with their respective critical values given Johanssen and Juleius (1990). If the test statistics are greater than their respective critical values, then reject the null hypothesis that there are r co integrating vectors in favour of alternative that there are r+1 (for and more than r (for

3.3 Vector Auto Regression Model:

The Vector Auto Regression Models were introduced and popularised by Shims in the year 1980. These models are the system of regression models and are termed to be intermediate between univariate time series models and simultaneous equation models. The term autoregressive in the VAR Models is attributed to the presence of lagged values of the dependent variable and the term vector is due to the vector of two or more variables.

The VAR models depicting the relationship between the given variables under study may be specified as follows:

$$lnBSE_T = \alpha_0 + \sum_{i=1}^{n} \alpha_1 lnBSE_{t-i} + \sum_{i=1}^{n} \alpha_2 lnCPI_{t-i} + \sum_{i=1}^{n} \alpha_3 lnExR_{t-i} + \sum_{i=1}^{n} \alpha_4 lnwti_{t-i} + \mu_t$$

(Equation 8)

$$lnBSE_T = \alpha_0 + \sum_{i=1}^{n} \alpha_1 lnBSE_{t-i} + \sum_{i=1}^{n} \alpha_2 lnCPI_{t-i} + \sum_{i=1}^{n} \alpha_3 lnExR_{t-i} + \sum_{i=1}^{n} \alpha_4 lnwti_{t-i} + \mu_t$$

(Equation 9)

$$lnBSE_T = \alpha_0 + \sum_{i=1}^{n} \alpha_1 lnBSE_{t-i} + \sum_{i=1}^{n} \alpha_2 lnCPI_{t-i} + \sum_{i=1}^{n} \alpha_3 lnExR_{t-i} + \sum_{i=1}^{n} \alpha_4 lnwti_{t-i} + \mu_t$$

(Equation 10)

$$lnBSE_T = \alpha_0 + \sum_{i=1}^{n} \alpha_1 lnBSE_{t-i} + \sum_{i=1}^{n} \alpha_2 lnCPI_{t-i} + \sum_{i=1}^{n} \alpha_3 lnExR_{t-i} + \sum_{i=1}^{n} \alpha_4 lnwti_{t-i} + \mu_t$$

(Equation 11)

Where: *lnBSE* = natural logarithm of BSE stock index
lnCPI = natural logarithm of Consumer Price index proxy variable for inflation.
lnExR = natural logarithm of Exchange Rate Variable.
lnwti= natural logarithm of WTI, proxy variable for crude oil price.
T = Current Time
α, β, γ and δ are the parameters of explanatory variables.

Empirical Findings:

Unit Root Tests: As observed from Table 1, presenting the results of Augmented Dickey Fuller (ADF) Test statistics and Phillips Perron (P-P) Test statistics, conducted for the presence of Unit Root, the variables under study are integrated of Order (1) and show stationarity at first order difference of the variable.

However, Inflation represented by Consumer Price Index did not show stationarity at first order difference according to Augmented Dickey Fuller Test, but satisfied the stationarity condition according to Phillips Perron Test.

Variables	Level I(0)		First Order Difference I(1)	
	ADF Statistic	PP Statistic	ADF Statistic	PP Statistic
BSE Index (LBSE)	-1.62	-1.92	-12.50	-12.57
Exchange Rate (LExC)	-1.75	-1.81	-12.54	-12.51
Inflation (LInf)	-1.85	-1.72	-1.03	-10.37
Crude Oil (LWTI)	-2.11	-1.99	-9.82	-9.70

Table 1: Unit Root Test Statistics of the Variables

To ascertain the presence of any long run relationship among the given variables, Johanssen Cointegration test is conducted. The results of the test are presented in Table2 and Table 3.

Hypothesized No of CE(S)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None	0.079495	33.7054	47.85613	0.518
At most 1	0.060901	18.21563	29.79707	0.5502
At most 2	0.032733	6.465511	15.49471	0.6405
At most 3	0.001294	0.242066	3.841466	0.6227

Table 2: Trace Test for Johanssen Cointegration Test

Hypothesized No. of CE(s)	Eigenvalue	Max -Eigen Statistic	0.05 Critical Value	Prob.**
None	0.079495	15.48977	27.58434	0.7086
At most 1	0.060901	11.75012	21.13162	0.5725
At most 2	0.032733	6.223446	14.2646	0.5847
At most 3	0.001294	0.242066	3.841466	0.6227

Table 3: Maximum Eigen Value Statistics for Johanssen Cointegration Test

The results presented in Table 2 and Table 3 confirms the absence of any cointegration or long run relationship among the given variables under study. The outcome of the cointegration test paves for applying Vector Auto Regression Model to analyse the relationship between crude oil price, inflation, exchange rate and stock returns in India.

VAR Lag Order Selection Criteria

Before application of Vector Auto Regression Model, appropriate lag length is required to be estimated. The lag length is estimate by applying lag order selection criteria like Akaike Information Criterion (AIC), Schwarz Information Criterion (SIC) etc. The lag order selection criteria are presented in Table 4.

Lag	LogL	LR	FPE	AIC	SIC	HQ
0	1522.678	NA	7.28E-13	-16.59758	-16.52742*	-16.56914
1	1558.689	70.05286	5.85e-13*	-16.81627*	-16.46551	-16.67409*
2	1565.857	13.63081	6.44E-13	-16.71974	-16.08837	-16.46382
3	1577.821	22.22806	6.74E-13	-16.67563	-15.76365	-16.30596
4	1589.498	21.18478	7.07E-13	-16.62839	-15.43579	-16.14497
5	1603.22	24.2946	7.26E-13	-16.60349	-15.13029	-16.00633
6	1616.933	23.68044	7.47E-13	-16.57851	-14.82469	-15.8676
7	1633.91	28.57358*	7.42E-13	-16.58919	-14.55476	-15.76453
8	1644.839	17.91496	7.88E-13	-16.53375	-14.21872	-15.59536

Table 4: VAR Lag Order Selection Criteria

According to Akaike Information Criterion, Schwarz Information Criterion and Future Prediction Error, the appropriate lag length comes out to be 1. The appropriate lag length is estimated from minimum values of employed information criterion and the same is to be used in the model estimation.

Estimation from Vector Auto Regression Model

After obtaining the appropriate lag length from lag order selection criteria, The VAR model is estimated from the monthly of the variables from the period, April, 2001 to March 2017. The results of the VAR model estimation are presented in Table 5

	LBSE	LINFINDIA	LEXCINDIA	LWTI
LBSE(-1)	0.995509	-0.001106	-0.016002	0.037227
	-0.02394	-0.00266	-0.00789	-0.03114
	[41.5810]	[-0.41565]	[-2.02939]	[1.19534]
LINFINDIA(-1)	-0.028233	1.000601	0.059251	0.053787
	-0.07567	-0.00841	-0.02492	-0.09843
	[-0.37312]	[118.977]	[2.37758]	[0.54647]
LEXCINDIA(-1)	0.067841	-0.003397	0.926143	-0.260026
	-0.10272	-0.01142	-0.03383	-0.13362
	[0.66046]	[-0.29753]	[27.3757]	[-1.94605]
LWTI(-1)	0.002908	0.00484	0.002892	0.915248
	-0.01948	-0.00216	-0.00641	-0.02534
	[0.14930]	[2.23574]	[0.45077]	[36.1254]
C	-0.096696	0.006717	0.162067	0.773549
	-0.26995	-0.03	-0.08891	-0.35116
	[-0.35819]	[0.22387]	[1.82279]	[2.20282]
R-squared	0.991408	0.99955	0.980243	0.966446
Adj. R-squared	0.991223	0.99954	0.979818	0.965724
Sum sq. resids	0.833313	0.010295	0.090395	1.410083
S.E. equation	0.066934	0.00744	0.022045	0.087069
F-statistic	5365.444	103279.8	2307.049	1339.31
Log likelihood	247.9889	667.5954	460.1157	197.7564
Akaike AIC	-2.544386	-6.938171	-4.765609	-2.018392
Schwarz SC	-2.459248	-6.853033	-4.680471	-1.933254
Mean dependent	9.403295	4.515188	3.915369	4.074259
S.D. dependent	0.714459	0.346983	0.155178	0.470296
Determinant resid covariance (dof adj.)		6.02E-13		
Determinant resid covariance		5.42E-13		
Log likelihood		1613.226		
Akaike information criterion		-16.683		
Schwarz criterion		-16.34244		

From the estimated results presented in Table 5, R^2 of 0.9914 indicates 99% of variation in BSE Index is explained by explanatory variables. The adjusted R^2 of 0.9912 i.e. 99% indicates the robustness of explanatory variables in explaining the variation in BSE Index. Similarly, R^2 for Exchange Rate, Inflation and Crude Oil

Price of 0.9995, 0.98025 and 0.9664 respectively explains 99%, 98%, and 96% variations in the dependent variables by explanatory variables. The adjusted R^2 of 99%, 97% and 96% shows the robustness of explanatory variables in explaining the variations in inflation, exchange rate and crude oil price respectively. To interpret the individual parameters of the variables, Block F Test is employed to analyse the collective influence of the explanatory variables.

Block F- Test

The estimation from Block F Test is presented in Table 6. The Lag exclusion test points towards the parameters of all lag 1 variables being significant as well as jointly significant.

Chi-squared test statistics for lag exclusion:					
Numbers in [ ] are p-values					
	LBSE	LINFINDIA	LEXCINDIA	LWTI	Joint
Lag 1	21461.78	413119.4	9228.197	5357.241	458878.1
	[0.000000]	[0.000000]	[0.000000]	[0.000000]	[0.000000]
df	4	4	4	4	16

Table 6: VAR Lag Exclusion Wald Test

Granger Causality Test

The estimated results from the Granger Causality Analysis is presented in Table 7. From the estimated results it can be observed that there exists a unidirectional causality running from Grobal crude oil price to inflation, Stock index and inflation to exchange rate and from exchange rate to global crude oil price. Apart from there is absence of causality among the rest variables.

Table 7: Granger Causality Test of the Variables.

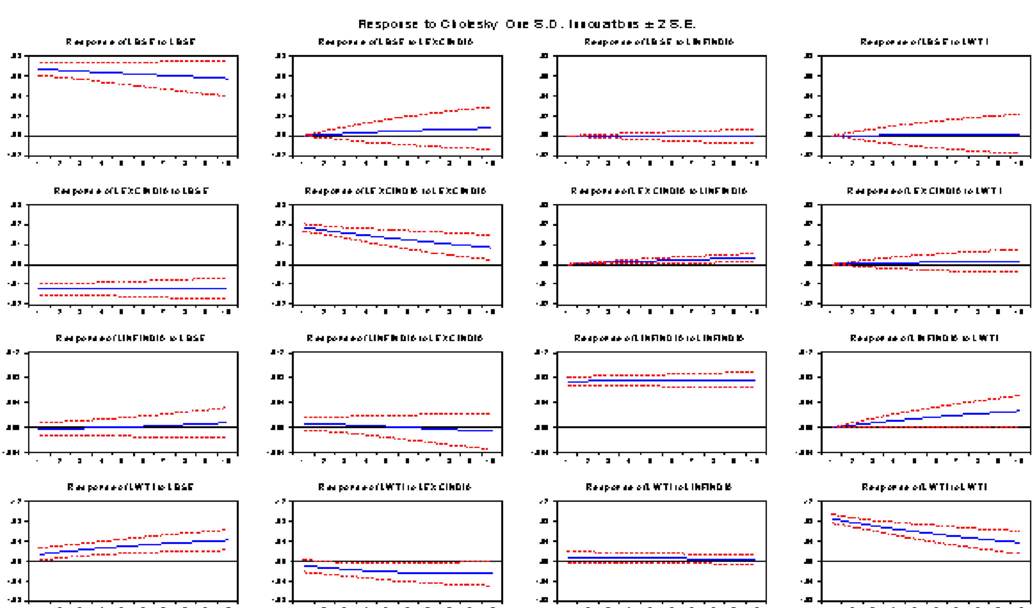
Dependent variable: LBSE			
Excluded	*Chi-sq*	*df*	*Prob.*
LINFINDIA	0.139222	1	0.7091
LEXCINDIA	0.436213	1	0.509
LWTI	0.022289	1	0.8813
All	0.954327	3	0.8123
Dependent variable: LINFINDIA			
Excluded	*Chi-sq*	*df*	*Prob.*
LBSE	0.172767	1	0.6777
LEXCINDIA	0.088525	1	0.7661
LWTI	4.998538	1	0.0254
All	13.694	3	0.0034

Dependent variable: LEXCINDIA			
Excluded	*Chi-sq*	*df*	*Prob.*
LBSE	4.118432	1	0.0424
LINFINDIA	5.652864	1	0.0174
LWTI	0.203195	1	0.6522
All	10.22864	3	0.0167
Dependent variable: LWTI			
Excluded	*Chi-sq*	*df*	*Prob.*
LBSE	1.428849	1	0.232
LINFINDIA	0.298628	1	0.5847
LEXCINDIA	3.787104	1	0.0516
All	11.53597	3	0.0092

Impulse Response Function (IRF)

The Impulse Response Function for given Vector Auto Regression Model for the variables is presented in Figure 1. From Impulse Response Graph it can be observed that Stock Index to global crude oil price and exchange rate has remained positive but for inflation the response has remained negative. The response of exchange rate has remained positive to impulse from inflation and global crude oil price but negative to Stock index. The Inflationary index initially remained negative and then become positive to

Figure 1: Impulse Response Graph for Vector Auto Regression Model



impulse from stock index and for exchange rate the response of inflation is initially positive and then becomes negative. The response of inflation to WTI crude oil price has remained positive all throughout. The response of WTI Crude Oil Price remained positive to impulse from inflation and Stock index but became negative to impulse from exchange rate. From the impulse response graph it can be observed that the impulse responses have rarely returned to equilibrium path.

Table 8: Variance Decomposition of the Variables

Variance Decomposition of LBSE:					
Period	S.E.	LBSE	LINFINDIA	LEXCINDIA	LWTI
1	0.066934	100	0	0	0
2	0.093908	99.98252	6.49E-05	0.016717	0.000694
3	0.114111	99.94491	0.000176	0.052687	0.002224
4	0.130742	99.89029	0.000298	0.10491	0.004502
5	0.14505	99.82142	0.000408	0.170721	0.007453
6	0.157683	99.74074	0.000491	0.247758	0.01101
7	0.169028	99.65041	0.00054	0.333935	0.015117
8	0.179341	99.55231	0.000555	0.427413	0.019723
9	0.188799	99.4481	0.000541	0.526574	0.024785
10	0.197535	99.33923	0.000508	0.630001	0.030264
Variance Decomposition of LINFINDIA:					
Period	S.E.	LBSE	LINFINDIA	LEXCINDIA	LWTI
1	0.00744	0.062354	99.93765	0	0
2	0.010551	0.051383	99.78534	0.010896	0.152383
3	0.012968	0.039073	99.45054	0.040325	0.47006
4	0.015037	0.029132	98.96345	0.091895	0.915527
5	0.01689	0.025711	98.34939	0.168181	1.456722
6	0.018594	0.033151	97.6295	0.270732	2.06662
7	0.020191	0.055796	96.82134	0.400137	2.722728
8	0.021704	0.097844	95.9395	0.556126	3.406532
9	0.023153	0.163232	94.9961	0.737699	4.102966
10	0.024548	0.255559	94.00128	0.943252	4.799911
Variance Decomposition of LEXCINDIA:					
Period	S.E.	LBSE	LINFINDIA	LEXCINDIA	LWTI
1	0.022045	30.3372	0.592517	69.07029	0
2	0.030465	32.15236	0.754872	67.08625	0.006524
3	0.036488	33.94182	0.938337	65.09845	0.021392
4	0.041234	35.69575	1.141906	63.1181	0.044241
5	0.045151	37.405	1.364428	61.1559	0.074667
6	0.048477	39.06126	1.604627	59.22188	0.112234
7	0.051356	40.65713	1.861125	57.32527	0.156479
8	0.053886	42.18617	2.132474	55.47444	0.206918
9	0.056133	43.64294	2.417174	53.67683	0.263055
10	0.05815	45.02301	2.713704	51.93891	0.324386

Variance Decomposition of LWTI:					
Period	S.E.	LBSE	LINFINDIA	LEXCINDIA	LWTI
1	0.087069	2.607307	0.574477	1.291969	95.52625
2	0.119235	3.799415	0.559453	2.032729	93.6084
3	0.141852	5.217531	0.538109	2.875152	91.36921
4	0.159571	6.837907	0.511845	3.775046	88.8752
5	0.174264	8.632657	0.482169	4.692678	86.1925
6	0.186914	10.57167	0.450597	5.594171	83.38357
7	0.198104	12.6243	0.418576	6.452206	80.50492
8	0.208208	14.76077	0.387421	7.246105	77.60571
9	0.217477	16.95318	0.358274	7.961452	74.7271
10	0.226084	19.17618	0.332088	8.589416	71.90232
Cholesky Ordering: LBSE LINFINDIA LEXCINDIA LWTI					

Stability of the Vector Auto Regression Model

From the Auto Regressive Inverse Roots of the Vector Auto Regression Model, it can be observed that the polynomial roots are within the unit circle indicating the stability of the model.

Table 9: Auto Regressive Inverse Roots of VAR Model.

Root	Modulus
0.997063	0.997063
0.962937 - 0.018370i	0.963113
0.962937 + 0.018370i	0.963113
0.914563	0.914563
No root lies outside the unit circle.	
VAR satisfies the stability condition.	

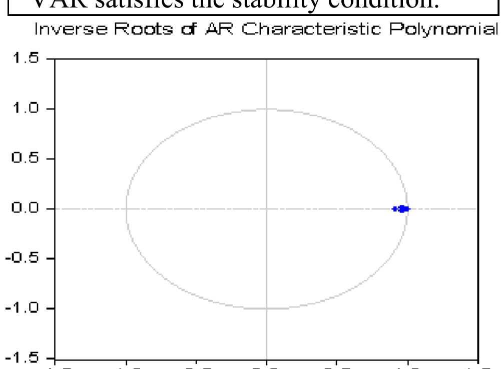


Figure 2: Graph of AR Inverse Root.

Conclusion

The present paper employed Vector Auto Regression Model to analyse and estimate the association between global crude oil price, exchange rate, inflation and stock index in Indian economic scenario. From the paper it can be well observed that there is a negative association between stock index and inflation which may be attributed to decrease in consumer purchasing power due to increase in inflation and in turn has a negative impact on the stock index. There exists a positive relationship between BSE Index and Exchange Rate and WTI Crude Oil Price. There exists a negative association between inflation and BSE Index and exchange rate. The increase in WTI crude oil price raises the cost of production for an oil importing country and thus causes increase in inflation and the same is well evident in case of data pertaining to India presented here. Similarly depreciation in exchange rate also causes increase in inflation. The increase in WTI crude oil price also causes depreciation in exchange rate value which may be attributed to increase in demand of U.S. Dollar in which majority of trade is done.

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