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WORLD OIL PRICE BEHAVIOUR AND ITS IMPACT ON BRIC FINANCIAL MARKETS–STOCHASTIC ANALYSIS

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ABSTRACT

With the growth of BRIC Nations touted to be World beaters in the years to come and aid in global growth processes, how are its financial markets positioned in relation to energy markets is sought to be studied with the time-series data of respective vital indices of Bovespo, MICEX, BSE Sensex and Shanghai Composite in relation to WTI Crude oil Index. The stochastics studied with tools like ERS Unit Root Test, Johansen Co-integration Test, Vector Error Correction Model and Impulse Response Analysis examines the relationships and establishes strong connect. The Paper examines both the short-run and long-run aspects in these markets and clearly establishes the relationships between Crude Oil Prices and stock market indices. The results from the impulse response function clearly reveals that in the case of oil exporting countries like Brazil and Russia, higher crude oil prices have positive impact and effects on stock indices. But, in India higher crude oil prices has negative effect.

KEYWORDS: BRIC Indices & Oil Prices, Stochastics in Crude Oil Prices, ERS Unit Root Test, Johansen Co-integration Test, VECM Estimation for Brazil, Impulse Response of MICEX to Crude Oil Prices

1.0 INTRODUCTION

The growth of Energy resources and in that 'Oil' has vital significance for the world, as it not only leaves environmental foot prints across borders but influences economies and markets. As per the Report of the US Energy information Administration (EIA), 2012, the US consumed 18.5 millions of barrels per day followed by China which consumed 10.3 million of barrels. India stood fourth as per this report after Japan by consuming 3.6 million barrels per day. The same Report cites Russia and Brazil of having consumed 3.2 and 2.8 million barrels per day respectively. The International Energy Agency (EIA), the world energy body reports that India and China collectively will contribute 42 % of the increase in oil demand globally during the period 2005-2030. What influences this will have across economies and markets would obviously engage the attention of any researcher. In the realm of global financial markets, it is well known that stock market is affected by oil prices in more than one ways. Sudden Oil price shocks have contagion effect across stock markets, currency markets and Bond markets. The macro- economic policy managers and central bankers often react to contain inflationary pressures in the economy by increasing interest rates that has an effect on the Bond prices discounting. (Basher, Haug & Sadorsk, 2010). In such an, in-explicably connected economy bounded by variables, known and unknown, it is worth examining the relationship between Oil Prices and Stock prices in Financial Markets.

It is reported by OECD and the now famous Goldman Sachs Report (Refereed commonly as BRIC Report) that nearly two thirds of the World's GDP will be contributed by the emerging economies by 2030. BRIC report also predicts that the growth and exponentially higher returns from BRIC economies will continue over the next 50 years and catapult them to be world's largest economies by surpassing the G-6 countries which includes UK, US, Japan, France, Italy and

Germany

It is in this backdrop, that this study is conceptualized to understand the dynamic relationship between Oil prices and stock markets of atleast the BRIC Nations.

2.0. CENTRAL RESEARCH PROBLEM & METHODOLOGY?

The Central research Problem of the study is to understand the relationship and impact between Oil Prices and the Stock Market Indices of the BRIC Nations – both in the short-run and in the long-run. The data set for the analyses is taken by using the ten year time-series data from Jan 2004 to 2014 of the closing Indices of Bovespa, MICEX, BSE Sensex, Shanghai Composite to represent the four BRIC Nations respectively. As regards the Oil / Brent prices, the closing prices of Crude Oil Index represented by the WTI (West Texas Intermediate) have been used.

The study uses many financial econometric and stochastic processes / tools like ERS Unit Root Test, Johansen Co-integration Test, Vector Error Correction Model (VECM) and Impulse Response function to study the relationships in the time-series data.

3.0. ANALYSIS & DISCUSSIONS

3.1 ERS Unit Root Test

Elliott, Rothenberg and Stock point optimal (ERS) unit root test (1996) was performed to determine whether the time series is non-stationary. Lag lengths and model of the test are performed according to the MAIC (Modified Akaike Info Criterion). The test is run taking first differences of all the series allowing intercept and deterministic time trend in the regression. The null hypothesis is rejected at 1 per cent level of significance indicating that all the series are stationary. This means that the selected series are integrated of order one, i.e. *I*(1).

Table 3.1: ERS Point-Optimal Unit Test Results

Indices	First Difference	
	Constant	Constant + Trend
Bovespa	0.035211***	0.16321***
MICEX	0.04999***	0.124380***
BSE Sensex	0.044476***	0.167933***
Shanghai Composite	0.044743***	0.171947***
Crude Oil Price	0.073263***	0.189885***

3.2 Johansen Co-Integration Test

Johansen co-integration test provide a mean to determine whether a set of endogenous variables for each of the BRIC countries share a common long-run stochastic trend, while allowing for the possibility of short-run divergences. To see whether non-stationary series in the level act together in the long-run, Johansen co-integration test developed by Johansen and Juselius (1990) is used. To identify the number of characteristic roots that are not different from unity, the trace test and maximum eigen value test are used.

Hypothesis

H_0: There is no co-integration relationship between variables.

H_1: There is co-integration relationship between variables.

The Results analysis for each of the BRIC Nations are tabulated below

For Brazil, Russia, India and China, the trace statistic indicates one co-integrating equation and maximum eigen value. Statistic indicates one co-integrating equation in each case except Russia which is significant at 5 per cent level. The results show that in Brazil, Russia, India and China the set of variables (crude oil price and stock market index) is co-integrated, as both the trace statistic and maximum eigen value statistic reject the null hypothesis of no co-integration and therefore there exists a stationary long-run relationship between the set of variables. This implies that there are common stochastic trends indicating a degree of economic integration between crude oil price and stock index for Brazil, Russia, India and China during the whole study period.

Table 3.2a: Multivariate Co-Integration Test Results for 'Brazil'

Hypothesis		Trace Test	Critical Values at 5 %
Null	Alternative		
r = 0	r = 1	15.8380 (0.0439)	15.4947
r ≤ 1	r =2	1.9223	3.8415
		Maximum Eigen Value Test	Critical Value at 5 %
r = 0	r =1	13.9257(0.0563)	14.2646

Table 3.2b: Multivariate Co-Integration Test Results for 'Russia'

Hypothesis		Trace Test	Critical Values at 5 %
Null	Alternative		
r = 0	r = 1	17.228 (0.0241)	15.4947
r ≤ 1	r =2	3.0723 (0.0806)	3.8415
		Maxi. Eigen Value Test	Critical Value at 5%
r = 0	r =1	14.5325*(0.0457)	14.2646
r ≤ 1	r = 2	3.0623 (0.0806)	3.8415

Table 3.2c: Multivariate Co-Integration Test Results for 'India'

Hypothesis		Trace Test	Critical Values at 5 %
Null	Alternative		
r = 0	r = 1	19.7941*(0.0442)	15.4947
r ≤ 1	r =2	8.2366 (0.3110)	4.2646
		Maxi. Eigen Value Test	Critical Value at 5 %
r = 0	r =1	16.9305*(0.0377)	16.2569
r ≤ 1	r = 2	8.2556 (0.03100)	4.2646

Table 3.2d: Multivariate Co-Integration Test Results for 'China'

Hypothesis		Trace Test	Critical Values at 5 %
Null	Alternative		
r = 0	r = 1	37.5396*(0.0000)	15.4947
r ≤ 1	r =2	2.2479 (0.1271)	3.8415
		Maximum Eigen Value Test	Critical Value at 5 %
r = 0	r =1	32.3018*(0.000)	14.2646
r ≤ 1	r = 2	2.2279 (0.1271)	3.8415

3.3 Vector Error Correction Model (VECM)

To determine co-integration relationship (co-integration vector) which reveals the existence of long-run relationship amongst endogenous variables, causal relations should be examined with vector error correction model (VECM). The corresponding VEC model is:

$$\Delta SI_t = \beta_{0+} \sum_{i=1}^{q} \beta_{1i} \Delta SI_{t-i} + \sum_{i=1}^{q} \beta_{2i} \Delta COP_{t-i} + \alpha_1 Z_{t-1} + e_{1t} \quad (1)$$

$$\Delta COP_t = \delta_{0+} \sum_{i=1}^{n} \delta_{1i} \Delta COP_{t-i} + \sum_{i=1}^{n} \delta_{2i} \Delta SI_{t-i} + \sigma_1 Z_{t-1} + e_{2t} \quad (2)$$

For Brazil, India and China α_1 is found to be statistically significant (at 1% level) while σ_1 is not. It denotes that with respect to these three countries, only stock indices follows and adjusts to disturbances to restore long-run equilibrium, but that the crude oil prices do not react significantly. It was found that about 2.74%, 1.13% and 5.48% of dis-equilibrium is corrected each day by changes in Bovespa, BSE Sensex and Shanghai Composite respectively. For Russia, both α_1 and σ_1 are significant at 1% level, i.e. both MICEX and crude oil price react significantly and only 1.58% and 0.11% of disequilibrium is corrected each day by changes in MICEX and crude oil prices. In Brazil, India and China, while stock indices and crude oil prices are bound together in one long-run equilibrium relationship, stock indices follows and adjusts to innovations in the crude oil prices. Whereas, in Russia dis-equilibrium is adjusted by the long-run co-efficients of both stock indices and crude oil prices. Further, it was noticed that in China and Brazil, stock indices series with larger long-run adjustment coefficient, adjust more rapidly to shocks. However, in Russia and India, the speed of the long-run adjustment is much slower. as shown in below .

Table 3a: VECM Estimations for Brazil

	Δ *Bovespa*	**Δ *Crude Oil Price***
Z_{t-1}	-0.027362*** [-4.31603]	-7.90E-06 [-0.96482]
Δ *Bovespa* $_{t-1}$	0.037441 [1.29236]	-8.16E-05 [-1.53590]
Δ *Bovespa* $_{t-2}$	-0.037441 [0.60789]	-3.44E-05 [0.64612]
Δ *Crude oil Price* $_{t-1}$	-15.81486 [-0.99417]	-0.002055 [-0.07046]
Δ *Crude oil Price* $_{t-2}$	30.73258** [1.93031]	-0.010803 [-0.37005]
Constant	13.56566 [0.55680]	-0.030458 [-0.68177]
R^2	0.020460	0.004944
Adj. R^2	0.014654	-0.000954
F-statistics	3.523910	0.838197

Table 3a: VECM Estimations for Russia

	Δ MICEX	**Δ *Crude Oil Price***
Z_{t-1}	-0.015823*** [-2.75164]	-0.001110*** [2.76490]
Δ MICEX $_{t-1}$	0.011244 [0.38521]	0.000689 [0.34154]
Δ MICEX $_{t-2}$	-0.028514 [-0.97612]	-0.003504* [-1.73633]
Δ *Crude oil Price* $_{t-1}$	0.020525 [0.04925]	-0.003186 [-0.11068]
Δ *Crude oil Price* $_{t-2}$	0.792077** [1.90023]	-0.010975 [-0.38111]

Table 3a: Contd.,		
Constant	- 0.071026 [-1.11101]	-0.033379 [-0.75517]
R^2	0.008491	0.023676
Adj. R^2	0.02614	0.017889
F-statistics	1.444743	4.091281

Table 3a: VECM Estimations for India

	Δ BSE Sensex	**Δ *Crude Oil Price***
Z_{t-1}	-0.011655*** [-2.99538]	4.38E-05 [1.60071]
Δ BSE Sensex $_{t-1}$	0.066794** [2.32081]	-0.000631*** [-3.01628]
Δ BSE Sensex $_{t-2}$	-0.003758 [-0.13684]	0.000328*** [-3.01628]
Δ *Crude oil Price* $_{t-1}$	5.545805 [1.37652]	0.008564 [0.28678]
Δ *Crude oil Price* $_{t-2}$	7.232197* [1.79929]	0.003183 [0.10936]
Constant	-6.653931 [-1.08279]	-0.035615 [-0.79920]
R^2	0.026408	0.01243
Adj. R^2	0.020637	0.006359
F-statistics	4.576198	2.086088

Table 3a: VECM Estimations for China

	Δ Shanghai Composite	**Δ *Crude Oil Price***
Z_{t-1}	-0.053783*** [-5.56498]	-8.00E-05 [0.43249]
Δ Shanghai Composite $_{t-1}$	0.049575* [1.70892]	-0.000350 [-0.64887]
Δ Shanghai Composite $_{t-2}$	-0.054900** [-1.86144]	0.000101 [0.18521]
Δ *Crude oil Price* $_{t-1}$	-4. 007285** [- 2.65299]	-0.001816 [0.06242]
Δ *Crude oil Price* $_{t-2}$	2.390326 [1.54237]	-0.006370 [-0.21814]
Constant	0.11879 [0.0505]	-0.036026 [0.70191]
R^2	0.043546	0.0000971
Adj. R^2	0.027678	-0.004365
F-statistics	7.58198	0.156785

3.4 Impulse Response Analysis

To measure the impulse response functions, the structural VAR (SVAR) model as used by Kilian & Park (2009) which states that, a shock to the i^{th} variable has a straightforward and direct impact on the i^{th} variable and at the same time it is also transmitted to the other endogenous variables in the system with the help of the dynamic lagged structure of the VAR. It is given by

$$e_t = \begin{pmatrix} e_{1t}^{crude\ oil\ price} \\ e_{2t}^{stock\ indices} \end{pmatrix} = \begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{pmatrix} \begin{pmatrix} \epsilon_{1t} \\ \epsilon_{2t} \end{pmatrix}$$

Here, ε_{1t} , and ε_{2t} , correspond to white noise error term and e_{1t} and e_{2t} represents the residuals from VECM equations. Any disturbance in ε_{1t} is quickly and directly transmitted to e_{1t} through the first equation and also to e_{2t} through the second equations respectively. Similar reactions occur in case of any disturbances in ε_{2t}. Therefore, it is found that a random shock is one innovation in SVAR model which forms a chain reaction with the other variables over time in the system.

The analysis of the suggests, that in the case of **Brazil,** crude oil price shocks have positive impact on Bovespa and crude oil price is directly related with Bovespa and is moving in tandem. Brazil being an oil exporting country, higher crude oil prices boosts Brazilian stock markets is a phenomenon that can be noticed. Similarly, in **Russia** too there is direct relationship between crude oil prices and stock markets. This means when crude oil prices increases, MICEX also increases and vice versa. In **India**, the crude oil price shocks have less significant effect on BSE Sensex. BSE Sensex adjusts to oscillations in crude oil prices, but the relative speed of the adjustment is slow. On the other hand, when response of crude oil price to BSE Sensex is studied, an inverse relationship between these two variables are observed. All the figures are tabulated below from **Figure-3.4a to Figure -3.4d**.

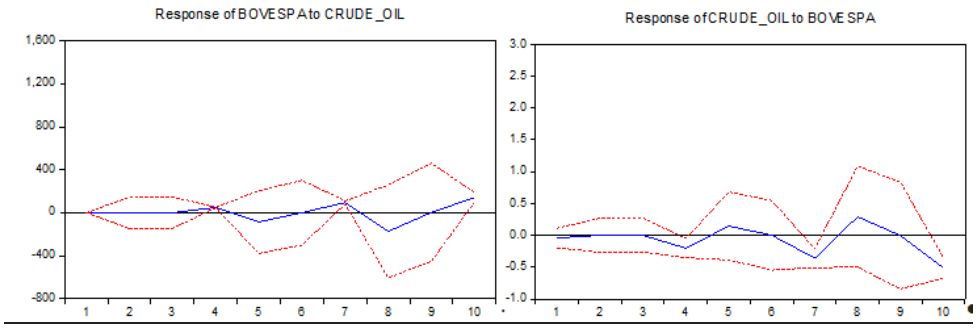

Figure 3.4a: Impulse Response of Bovespo to Crude Oil Prices

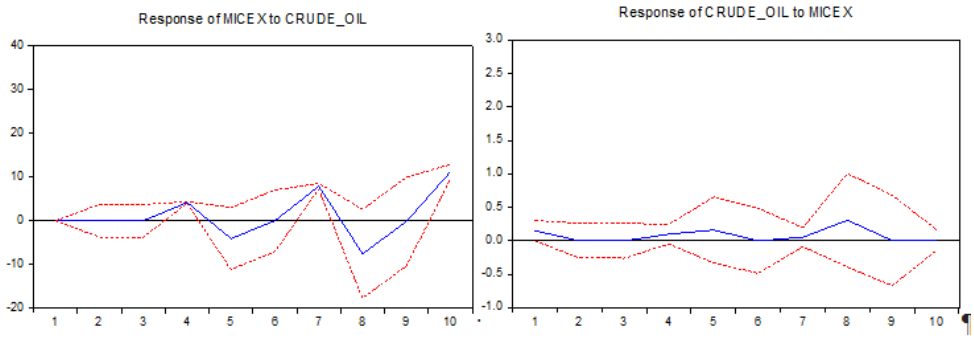

Figure 3.4b: Impulse Response of MICEX to Crude Oil Prices

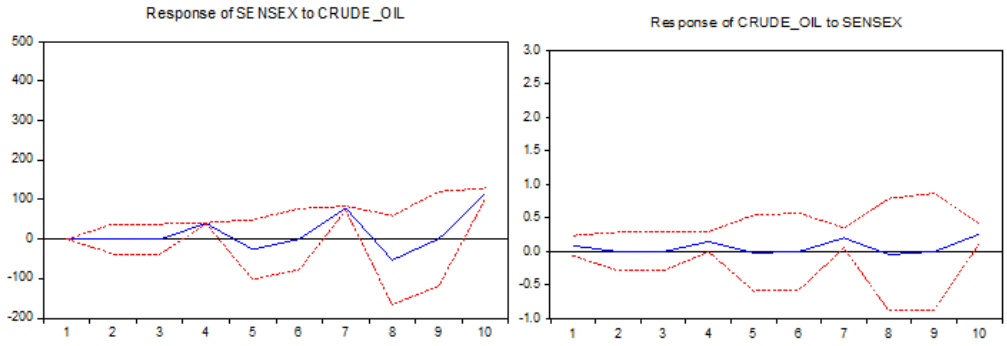

Figure 3.4c: Impulse Response of BSE Sensex to Crude Oil Prices

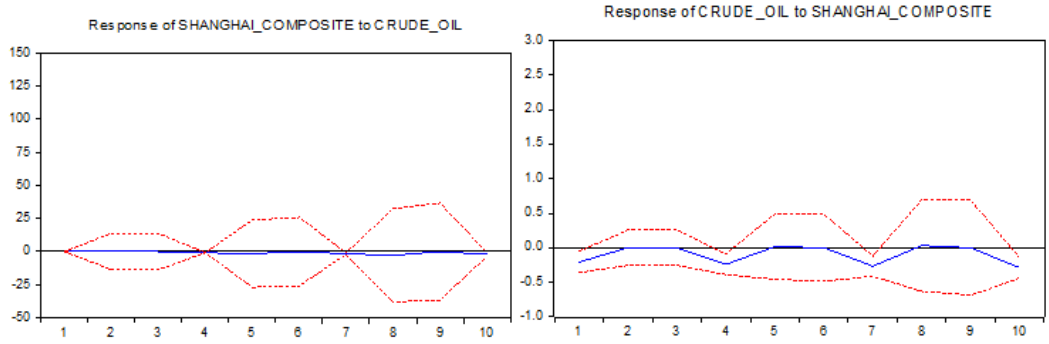

Figure 3.4d: Impulse Response of Shanghai Composite to Crude Oil Prices

4.0 CONCLUSIONS

In Conclusion, it can be said that the results of Johansen co-integration analysis reveals the existence of common stochastic trends indicating degree of integration between crude oil prices and stock indices in each of the BRIC countries studied during the whole study period. The results of VECM reveals that in the case of Brazil and China, while crude oil prices and stock indices are bound together in long-run equilibrium relationship, stock indices follows and adjusts to crude oil price shocks much faster in Russia and India. The impulse response function clearly reveals that in the case of oil exporting countries like Brazil and Russia, higher crude oil prices have positive impact and effects on stock indices. But, in India higher crude oil prices has negative effect on stock indices.

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