Does Crude Oil Prices have Effect on Exports, Imports and GDP on BRICS Countries? An Empirical Evidence

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ABSTRACT

The complexity of the World Oil market has risen significantly in recent years and today's Oil prices require new methods to consider, model and forecast. In addition to the start of the Oil markets financialization era, structural changes have occurred on the global Oil market. This paper presents a simple framework for understanding the effect of oil prices on BRICS countries' macroeconomic variables over a period of time from January 1, 2000 to December 31, 2019 using the Cointegration, vector error correction model (VECM) and granger causality test. Our analysis shows that there is a long-term relationship between the Macroeconomic variables and Crude Oil, and also suggests that there is a uni-directional and bi-directional relationship between the variables in BRICS.

Keywords: Crude Oil Prices, BRICS, Granger Causality, Co-integration, Vector Error Correction Model
JEL Classifications: G12, G15, Q43

1. INTRODUCTION

BRIC has officially existed since 2001, when Goldman Sachs Investment Bank analyst coined the term to tie together fast-growing economies and fairly broad internal markets. The formal beginning of this partnership was in 2006 when the leaders of the four states – Brazil, Russia, India and China decided in the framework of the St. Petersburg Economic Forum to develop it. Later, South Africa joined the party in 2010 (O'Neill, 2001).

Given BRICS, its importance in global politics is increasing quite quickly. Although the association has a few problems that need to be resolved in the economic sphere, such as its members' lack of orientation towards internal trade and investment activity, its significance in terms of global political leverage is crucial. As per the (EIA, 2019) Russia, China and Brazil are in the top ten largest oil producers in the world (Figure 1). Where Russia produces 11.49 mb/d or 23.72 quad; which is equivalent to 11% of world share. Similarly, China and Brazil produce 4.89 mb/d (8.58 quad)and 3.67

mb/d (5.59 quad) respectively which contributes 9% of total world share in production of crude oil. Additionally; BP Statistical Review of World Energy, (2018) on the consumption side China, India, Russia and Brazil are the biggest consumers of the crude oil. Collectively, 25% of the total Crude Oil is consumed by the above countries. Given the importance of crude oil in the economy, the changes in the price of crude oil would therefore have a major effect on macroeconomic variables. Investors and policymakers in the BRICS would like, in order to gain diversification advantages and reduce risks, to understand how to compare C

rude Oil with the BRICS macroeconomic variables.

The main purpose of this paper is to investigate the causal relation between the prices of crude oil and the macroeconomic variables of BRICS countries. Hence, the specific research questions of this study are as follows:
1. Does crude oil prices co-integrate with macroeconomic variables of BRICS countries?

Figure 1: Total Crude Oil Consumption and Production of BRICS countries (2000- 2016)

Total Crude Oil Consumption																
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Brazil	4.49	4.45	4.42	4.30	4.46	4.55	4.62	4.93	5.27	5.28	5.70	5.86	6.10	6.37	6.65	6.50	6.05
China	9.65	9.88	10.67	11.85	14.00	14.28	15.33	16.19	16.46	17.35	19.04	20.49	21.56	22.51	23.56	25.04	23.91
India	4.71	4.71	4.87	5.02	5.23	5.24	5.69	6.07	6.27	6.41	6.60	6.67	7.06	7.14	7.36	7.97	8.76
Russia	5.33	5.36	5.31	5.32	5.29	5.34	5.53	5.49	5.74	5.52	5.93	6.28	6.38	6.69	7.14	7.00	6.91
South Africa	0.94	0.94	0.97	1.01	1.03	1.04	1.03	1.21	1.27	1.21	1.22	1.35	1.29	1.32	1.26	1.33	1.24

Total Crude Oil Production																
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Brazil	2.80	2.86	3.21	3.31	3.29	3.65	3.85	3.90	4.05	4.33	4.56	4.68	4.60	4.51	5.01	5.40	5.59
China	6.99	7.08	7.27	7.32	7.50	7.75	7.88	8.02	8.16	8.15	8.76	8.70	8.77	8.94	9.04	9.19	8.58
India	1.51	1.51	1.58	1.58	1.63	1.58	1.64	1.64	1.64	1.61	1.77	1.83	1.82	1.81	1.79	1.77	1.74
Russia	14.30	15.20	16.27	18.04	19.64	20.10	20.56	20.99	20.90	21.19	21.67	21.90	22.34	22.61	22.78	23.15	23.72
South Africa	0.07	0.07	0.05	0.07	0.12	0.08	0.05	0.04	0.04	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01

Source: Compiled from EIA report 2019

2. Does the crude oil price influence the BRICS macroeconomic variables?
3. Which macroeconomic variables should be regulated and adjusted by policy makers to sustain economic growth of BRICS countries?
4. How long does it take for the variables to return to normal when the long-run equilibrium experiences a shock?

It is expected that the findings from each of the research questions will have important consequences for investors and policy makers in their decisions on portfolio allocations, investment horizons and economic growth policy.

The following parts of the paper are set out as follows. Section 2 discusses the related Crude Oil and the macroeconomic variables literature involved. Section 3 sets out the methodologies to be used to achieve this paper's research goals. Section 4 includes the full analysis of the data and the analytical findings. Section 5 uses plausible explanations and past findings in the literature to discuss the results obtained from the previous section References make up the paper's end.

2. LITERATURE REVIEW

Some of the most commonly debated the relationship between Oil prices and macroeconomic variables. Many of the results from earlier studies suggest almost no connection between oil prices and returns on equity see Chen et al. (1986), Hamao (1989). Report by Ferson and Harvey (1995) concluded that the price of Oil has a huge effect on the return on investment of 18 financial markets. Huang et al. (1996) analyzed the relationship between oil and equity in the U.S. context with the use of vector autoregression

technique (VAR) and concluded that the wide market index such as S&P500 has little impact. Cong et al. (2008) conducted a report on the Chinese equity market about oil price shocks and found no major impact on real stock returns except for oil-related industries. In the presence of oil and exchange rate sensitivities for 15 countries in the Asia pacific region between 1994 and 2004, Nandha and Hammoudeh (2007) check the relationship between market risk (beta) and realized stock index return. They concluded with Oil which affects none of the sample countries. Jones and Kaul (1996) concluded that the reaction of the United States and the Canadian Stock market to Oil price shocks can be fully explained by changes in the expected value of future real cash flows. By comparison, Sadorsky (1999), Park and Ratti (2008) discussed the Oil-equity relationship based on VAR in his paper. He finds that a negative relationship exists, both in terms of return and volatility.

Faff and Brailsford (1999) and Sadorsky (2003) published research on the relationship between oil price and returns for the manufacturing sector. Nevertheless, the effect of oil on various industries differed, both studies found clear linkages between oil and equity returns. Maghyereh (2004) analyzed the complex relations in 22 emerging economies between oil price shocks and stock market returns. For 1998-2004, they used VAR model on daily data, and found poor evidence of a relationship between Oil price shocks and stock market returns in these emerging economies. His findings show that high energy consumption findings in a high shock to the oil price. In a multivariate VAR system, Papapetrou (2001) analyzed the Oil-equity relationship with respect to the Greek economy and concluded high influence of oil prices in explaining the returns on equities. Basher and Perry (2006), Fama (1970, 1981) used a pricing model of Multi-Factor Arbitrage and found good evidence that Oil price instability has an effect on the returns of emerging stock markets.

Sadorsky (2008) shows that rises in firm size or oil prices decrease stock market price returns, and increases in oil prices impact stock market returns more than decreases in oil prices do. Many of the recent research claims that the correlation between oil and economic activity is not entirely linear and that negative price shocks (price increases) appear to have a greater effect on growth than positive shocks do for example see Hamilton (2003), Zhang (2008) and Cologni and Manera (2009). Overall the work is split between crude oil and macroeconomic variables on analytical linkages. It is because of the vast number of variables affecting the relationship between crude oil and macroeconomic variables.

We do not consider an economic system of consensus that can sum up the relation between the oil shocks and the actions of the macroeconomic variables. So the present study aims to fill the research gap and results would help policy makers, government and investors in making investment decisions.

3. METHODOLOGY

To study the effect of crude oil movements on macroeconomic variables we have used quarterly data of export, import, crude oil and GDP for the period of two decades ranging from January 1, 2000 to December 31, 2019. The data has been collected from various sources; like central bank of Brazil, National Bureau of Statistics of China, Central Bank of Russian Federation, Reserve bank of India, South African Reserve Bank. To Study the effect between the variables following techniques were used.

3.1. Unit Root Test

It is crucial to ascertain the Stationarity of the variables before proceeding with any econometric tool. When a variable is not stationery, its mean and variance are not constant over time and an observation is associated with its lags that are more recent. Hence, stationarity checking of data is crucial. Additionally different stationery method was used to convert non-stationery series into stationery series. For the Difference-stationery process, the regression equation is as shown in Eq.(1):

$$\Delta(\Delta Y_t) = \alpha + \delta \Delta Y_{t-1} + e_t \qquad (1)$$

3.1. Granger Causality Test

It is common to apply the Granger causality test to empirically test the causality relationship. In a bivariate framework, it is said that the variable y_1 in the Granger sense causes the variable y_2 if the y_2 forecast improves considering lagged variables y_1.

3.2. Johansen Cointegration Test

To examine the long-term relationship between export, import, crude and GDP, Johansen's co-integration test was used. The Johansen's test approaches the co-integration test by testing the number of independent linear combinations for variables in the time series that yield stationarity. If two or more variables of the same order are combined, and if their linear combination is found to be stationary, then these variables are said to be co-integrated. Since Johansen's Co-integration test is responsive to the option of lag length a suitable lag structure was selected using the Akaie Knowledge Criterion (AIC), the Schwarz criterion (SC) and the likelihood ratio (LR) test.

3.3. Vector Error Correction Model

There may be an existence of a long-run equilibrium relationship between two or more variables but in the short-run there could be disequilibrium. The nature of the relationship among export, import, crude oil and GDP in the short-run can be investigated by implementing the vector error correction mechanism. A vector error correction model is a restricted VAR that has co-integration restrictions built into the specification. Since all the variables were found to be integrated of the same order; we have used Johansen Co-integration for a long term relationship. The error correction term of VECM specification signifies the rate at which it corrects its previous period disequilibrium or speed of adjustment to restore the long-run equilibrium relationship.

4. ANALYSIS AND INTERPRETATION

Table 1 elaborates the results of Unit root test results. Whereas all the macroeconomic variables are stationary at first difference and further stated that we can run Cointegration test to know the relationship between the variables. Table 2 displays the result of Johansen's Co-integration test. The following test has been performed by taking lag interval as 1-2, which has been selected as per the optimum lag length

Table 1: Unit root test results

Variables	ADF level		Phillip – Peron level		ADF first difference		Phillip – Peron first difference	
	T-stats	**Prob.**	**T-stats**	**Prob.**	**T-stats**	**Prob.**	**T-stats**	**Prob.**
WTICRUDE	−1.25	0.64	−4.61	0.56	−17.63	0.00	−25.30	0.00
BREXP	−1.60	0.47	−1.62	0.46	−3.35	0.01	−10.27	0.00
BRIMP	−1.09	0.71	−1.30	0.62	−3.52	0.01	−5.90	0.00
BRGDP	−0.59	0.86	−0.67	0.84	−3.78	0.01	−3.82	0.00
RUSEXP	−1.43	0.55	−1.51	0.52	−4.47	0.00	−7.12	0.00
RUSIMP	−1.34	0.60	−1.73	0.40	−3.54	0.01	−9.62	0.00
RUSGDP	−1.52	0.51	−1.46	0.54	−7.43	0.00	−7.58	0.00
INDEXP	−0.92	0.77	−0.91	0.77	−7.79	0.00	−7.79	0.00
INDIMP	−1.13	0.69	−1.09	0.71	−7.13	0.00	−7.10	0.00
INDGDP	1.87	0.99	1.85	0.99	−4.73	0.00	−7.88	0.00
CHNEXP	−0.85	0.79	−0.61	0.85	−3.39	0.01	−7.48	0.00
CHNIMP	−0.96	0.76	−1.01	0.74	−8.15	0.00	−8.43	0.00
CHNGDP	−0.81	0.80	2.64	1.00	−6.91	0.00	−4.90	0.00
SAEXP	−1.35	0.59	−1.29	0.62	−7.17	0.00	−7.48	0.00
SAIMP	−1.54	0.50	−1.39	0.57	−7.46	0.00	−8.43	0.00
SAGDP	−1.33	0.61	−1.35	0.59	−6.35	0.00	−6.33	0.00

suggested by different tests like Akaie information criterion (AIC), Schwarz criterion (SC) and the likelihood ratio (LR) test (Amisano and Giannini, 1997). The result of Johansen's Co-integration test indicates presence of at least one co-integrating vectors for Brazil and

Table 2: Cointegration test results

Country	No. of CE(s)	Eigenvalue	Trace statistic	Critical value (0.05)	Prob.**	Eigenvalue	Statistic	Critical value	Prob.**
Brazil	None*	0.399	62.45	47.85	0.00	0.399	31.11	27.58	0.01
	At most 1*	0.263	31.35	29.79	0.03	0.263	18.65	21.13	0.03
	None*	0.329	64.25	47.85	0.00	0.329	24.36	27.58	0.00
Russia	At most 1*	0.305	39.88	29.79	0.00	0.305	22.21	21.13	0.03
	At most 2*	0.227	17.66	15.49	0.02	0.227	15.77	14.26	0.02
India	None*	0.410	48.96	47.85	0.03	0.802	98.85	27.58	0.00
	At most 1	0.142	16.77	29.79	0.65	0.142	9.40	21.13	0.79
China	None*	0.802	127.54	47.85	0.00	0.802	98.85	27.58	0.00
	At most 1	0.239	28.69	29.79	0.06	0.239	16.71	21.13	0.18
South Africa	None*	0.346	51.59	47.85	0.02	0.346	25.90	27.58	0.02
	At most 1	0.241	25.68	29.79	0.13	0.241	16.85	21.13	0.17

*denotes rejection of the hypothesis at the 0.05 level, **MacKinnon-Haug-Michelis (1999) P-values

Table 3: Vector error correction model results

Country	Brazil	Russia	India	China	South Africa
ECT coefficient	−0.48231	−0.19526	−0.86	−0.40325	−0.62632
Std. Error	0.05212	0.0887	0.03217	0.04262	0.06718
t-statistic	−3.52864	2.33458	−4.56985	−5.97858	−7.45875
Prob.	0.0000***	0.0000***	0.0023***	0.0025***	0.0500**

*Denote significance level *** at 1%, ** at 5% and * at 10%

Table 4: Granger causality results

Null hypothesis	Brazil		Russia		China		India		South Africa	
	F-statistic	Prob.	F-statistic	Prob.	F-Statistic	Prob.	F-statistic	Prob.	F-statistic	Prob.
DCRUDE does not Granger Cause DEXPO	2.6617	0.0432**	1.5615	0.1991	3.9867	0.0070***	1.0494	0.3913	0.8839	0.4804
DEXPO does not Granger Cause DCRUDE	4.0492	0.0064***	2.0657	0.0993	1.1511	0.3436	0.3933	0.8125	1.0937	0.3699
DGDP does not Granger Cause DEXPO	4.6596	0.0028***	5.5293	0.0009***	1.4271	0.2387	1.3760	0.2556	3.9785	0.0070***
DEXPO does not Granger Cause DGDP	1.2306	0.3098	4.3421	0.0043***	1.8010	0.1434	4.8622	0.0022***	1.7261	0.1590
DIMPO does not Granger Cause DEXPO	3.5805	0.0121**	3.3695	0.0162**	0.7633	0.5542	9.9943	0.0000***	1.1769	0.3323
DEXPO does not Granger Cause DIMPO	3.7734	0.0093***	3.8032	0.0089***	2.2826	0.0734*	8.5941	0.0000***	9.3482	0.0000***
DGDP does not Granger Cause DCRUDE	1.3995	0.2477	4.5303	0.0034***	3.8248	0.0087***	0.1081	0.9791	0.4283	0.7875
DCRUDE does not Granger Cause DGDP	1.4517	0.2309	2.4163	0.0609*	0.8369	0.5083	2.1762	0.0851*	2.4698	0.0565*
DIMPO does not Granger Cause DCRUDE	4.4090	0.0039***	4.0643	0.0063***	0.6959	0.5984	0.2832	0.8875	2.9679	0.0282**
DCRUDE does not Granger Cause DIMPO	2.1944	0.083*	2.9915	0.0273**	6.0646	0.0005***	1.4031	0.2465	1.4230	0.2401
DIMPO does not Granger Cause DGDP	1.7192	0.1605	5.7790	0.0007***	2.5311	0.0519*	2.3267	0.0690*	1.4288	0.2382
DGDP does not Granger Cause DIMPO	9.7474	0.0000***	5.4153	0.0011***	0.6437	0.6339	0.7470	0.5646	10.5124	0.0000***

*Denote significance level *** at 1%, ** at 5% and * at 10%

Russia at the 5% level of significance. This result has been supported by Trace test as well as Max Eigen values. Whereas for India, China and South Africa null hypothesis of no Co-integration can be rejected at 5% level of significance as P-value is less than 0.05. Thus on the basis of above observation, it can be concluded that there exists a long term relationship among all the variables pertaining to BRICS countries. Therefore the vector error correction framework is being used to model the joint dynamics and causal relations among export, import, crude oil and GDP from BRICS countries.

The result of vector error correction model from Table 3 is carried out using intercept and no trend in linear trend deterministic trend specification. Co-efficient of the variable in the result shows that whether today's value is affected by the past value of that variable. Cointegration result shows that in all countries at least one variable is cointegrated, so VECM is applied with one or two cointegrating factor and two lags in each country equation has been estimated. The Selection of lag length criteria is based on AIC and SIC value.

From the results of Table 3 we can conclude that the Crude Oil and Macroeconomic Variables has the long term relationship. Whereas error correction model helps to measure the speed of adjustment between the macroeconomic variables and crude oil. We also conclude that there exist a long and stable relationship between the variables as error correction term is negative and significant. The coefficients are Brazil (-0.48), Russia (-0.19), India (-0.86), China (-0.40) and South Africa (-0.62) which states that the deviations in crude oil is being corrected by 48% in Brazil, 19% in Russia and 86%, 40% and 62% in China, India and South Africa respectively.

Below Table 4 shows the result of pair-wise Granger Causality at 1%, 5% and 10% level of significance denotes the rejection of the null hypothesis. In the case of Brazil, it is found that Crude Oil and Export have a bi-directional relationship among them whereas Import and Crude Oil shares a uni-directional relationship. Similarly, Russia's GDP, Crude Oil and Import have Bi-Directional relationships with each other but in the case of India, it shows the uni-directional relationship among import, export and crude oil. Interestingly in the case of China and South Africa study shows Uni-directional relationship with GDP and Crude Oil together. We have also found out there is no causality between Crude and GDP in Brazil but shares uni-directional relationship in India, China and South Africa. Additionally, we have found uni-directional relationship between Import and Crude in Brazil and India and shares bi-directional relationship in Russia and China. Table 4 also indicates that Export as a macroeconomic variable shares a bi-directional relationship in only in Brazil whereas in other countries there is no causality involved except in China which is uni-directional.

5. CONCLUSION

BRICS considered as a major economic cluster of countries in the whole world. The present study tries to build the relationship between the GDP, export, import and crude oil of the BRICS countries. The empirical results suggest that there is a relationship among Crude Oil and other macroeconomic variables used in the study. The study reveals that there exists a short-term relationship of crude oil with import and export but long-term relationship between crude oil and GDP. GDP is the highest influencing factor to attract Crude Oil inflow in BRICS countries. The present study only tries to explain the relationship among the selected variables which are gross domestic product, export and Import with crude oil of BRICS Countries. Further study can be conducted extensively on other macro economic variables which affects FDI and Economies as whole.

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