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Article

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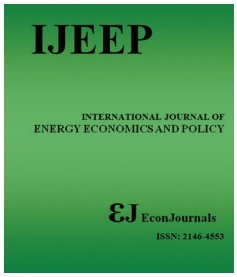

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Relationship Between Crude Oil prices and Macro-economic Variables: Evidence from BRICS Countries

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ABSTRACT

The article analyses the relationship between Crude oil Prices and Macro-economic variables in BRICS countries using Quarterly data from March 31, 1999 to December 31, 2019 and an Autoregressive Distributed lag model has been developed to study the long term relationship between Crude oil and Macro-economic variable. The study found out that the long term relationship exists between the variables. We have also identified that all the countries react differently to the fluctuations in Oil prices. But interestingly China and India share some commonalities in terms of reacting to the changes in Crude Oil prices. Additionaly we have also found that fluctuations in the Oil price effect Trade Openness in every country under study except Russia.

Keywords: Crude Oil Prices, Macro-economic Variables, Autoregressive Distributed Lag, Bound Test
JEL Classifications: C22, E40, E31, E50, Q43

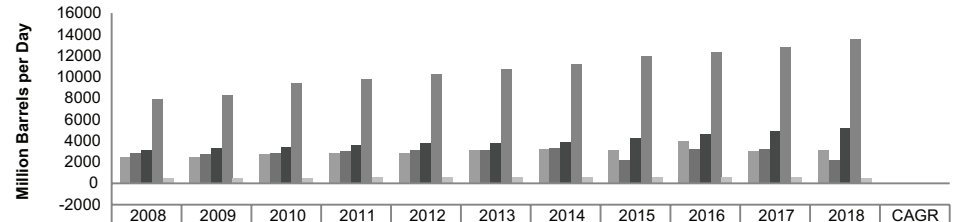
1. INTRODUCTION

The rise in the interdependence of global financial markets has accelerated the growth and sensitivity to commodity prices (Tang and Xiong, 2012). Oil considered the primary source of energy for the world. Currently, there are more than 100 Oil-exporting countries in the world, whereas Oil prices affect both the participant's Oil importers and Oil exporter. In the latest scenario, it has been noticed that the shoot up of global commodity prices may bring various challenges to most of the countries. Goldman Sachs coined the term BRIC in Global economic paper 2001, titled "Building Better Global economies BRIC." Instringlely in December 2010, South Africa joined the former group and formed BRICS. As per World Bank; The BRICS countries account for 25% of the world GDP, nearly 50% of the global population, and around 20% of global merchandise trade. The economic size of these countries also increased the share in world energy consumption. As per BP statistical review, 2017; The energy consumption rate of BRICS consuming 36% of the total primary energy has increased by 16% in the last decade (2006-2016).

In order to sustain high growth In the absolute sense, Oil consumption grew up by an average of 1.4 million barrels/day (mb/d). The developing world dominates this growth with China (0.7 mb/d), India (0.3 mb/d), and US (0.5 mb/d), accounting for almost two-thirds of the global increase (BP, 2019) Whereas Chinas contributes 4.5% to global renewables which is more the entire OECD countries combined. In BRICS, Crude Oil prices play a significant role in policymaking, since the fluctuations in crude Oil may harm the economy in various ways. Firstly, the effect can lead to a high cost of production with increased Inflation. Secondly, In markets, the investors and consumers confidence and level of growth of the economy may come down drastically. Also, the crude Oil importing countries will have to face various challenges compare to exporting countries.

Figure 1 indicates that there is a constant increase in Crude Oil consumption from 2008 to 2018 in BRICS countries. In Brazil, the

Figure 1: Crude oil consumption of BRICS countries (2008-2018)



	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	CAGR
Brazil	2481	2498	2714	2832	2884	3100	3210	3140	3960	3052	3081	2.19
Russia	2861	2775	2878	3074	3119	3134	3298	2146	3217	3207	2228	-2.47
India	3137	3300	3381	3550	3747	3789	3914	4245	4654	4870	5156	5.09
China	7914	8295	9446	9808	10242	10750	11239	11986	12304	12840	13525	5.51
South Africa	511	507	538	542	552	561	555	578	555	556	533	0.42

Source: Compiled from BP Statistical report on energy outlook, 2019

consumption of Oil was 2481 mb/d in 2008 has increased with a CAGR of 2.19% every year till 2018. Whereas China leads with a CAGR of 5.51% and India with 5.09% of consumption increase every year. Similarly, in South Africa, there is a small percentage increase that is 0.42% CAGR every year; interestingly, we can see a negative shift in the consumption of Oil in Russia.

2. LITERATURE REVIEW

Several studies have examined the relationship between Crude Oil prices and Macro-economic variables of selected countries and various groups of countries. While very few have investigated the relationship between selected Macro-economic variables and Crude Oil.

In this section, we elaborate on the literature review on Crude Oil and Macro-economic determinants across various economies.

2.1. Studies Outside BRICS Countries

(Basnet and Upadhyaya, 2015) analyzed the impact of Crude Oil price shocks on Inflation, real output, and an Exchange rate of ASEAN-5 countries using the Structural VAR approach (SVAR). Where they have stated that the Macro-economic Variables are cointegrated and share the long term trend. They have also asserted that Oil price shocks do not explain the significant variation in Macro-economic variables.

Similarly; (Bhat et al., 2018) concluded that there exists a long term relationship between Crude Oil and Macro-economic Variables under study. Interestingly they pointed out the dominance of external shock in influencing domestic variables after their own Oil price shocks. (Zahran, 2019) Examined that Oil price shocks are significantly impacting Macro-economic variables in the short and medium-term but insignificant in the long run. Whereas (Arfaoui and Rejeb, 2017) found a negative relationship between Oil price and Macro-economic variables such as Exchange Rate and Gold prices. Identically; (Omolade et al., 2019) Investigated the influence of Crude Oil price shocks on the Macro-economic Variables with a conclusion that structural Inflation impacts more to Oil price than monetary Inflation. Similar results we have found out with (Koh, 2016), (Salami and Haron, 2018), (Ratti and Vespignani, 2016), (Aggarwal and Manish, 2020), (Malik et al., 2017) where they conformed the relationship between Crude Oil prices and Macro-economic Variables.

2.2. Studies Related to BRICS Countries

Similarly, few studies tries to examine the relationship between Macro-economic Variables and Crude Oil prices in BRICS countries. These studies show similar results but mixed conclusions; these are (Yildirim and Yildirim, 2019) examined and concluded that Crude Oil prices and Economic growth are having bidirectional causality whereas (Singh Tomar and Singh, 2016), concluded that there is no clear direction of causality between the Variables. Indistinguishably, (Sreenu, 2019), (Gupta and Sharma, 2018). (Mensi et al., 2017) (Raza, Shahzad, Tiwari, and Shahbaz, 2016) shows similar results. (Negi, 2015) concluded that China and India share a negative relationship with Crude Oil and Gross domestic Product whereas; Russia and Brazil have a positive relationship between the variables. So, the literature has helped us in choosing the Macro-economic variables that may gauge the Crude Oil in BRICS countries.

3. DATA

3.1. Data Description and Sources

The data set consists of quarterly observations from March 31, 1999 to December 31, 2019 for Brazil, Russia, India, China, and South Africa as a five developing and Emerging economies of the world. The data set of BRICS countries has been obtained from Bloomberg, Fred Reserve database, OECD (The Organisation for Economic Co-operation and Development database), World Bank, and Central and Reserve bank of respective countries. Based on the available literature as a set of potential variables, which includes Industrial Production (IP), Trade Openness (TO), Gross Domestic Product (GDP), Foreign Direct Investment (FDI), Exchange Rate(ER), Money Supply (MS), and Inflation. We have used M3 as a proxy of Money Supply, Consumer Price Index (CPI) as a proxy of Inflation and Trade Openness we have calculated with the help of Import, Export, and GDP and as a dependent variable, we have used WestTexes Intermediate (WTI) as a proxy of Crude Oil (As specified in Table 1). For the purpose of estimation following model has been used:

$$\ln(CRUDE_t)=\alpha+b_1*\ln(GDP_{t-1})+b_2*\ln(ER_{t-1})+b_3*\ln(INF_{t-1})+b_4*\ln(FDI_{t-1})+b_5*\ln(TO_{t-1})+b_6*(IP_{t-1})+b_7*(MS_{t-1})\,e_t \quad (1)$$

As per the above Equation (1), CRUDE is considered as a function of Gross Domestic Product (GDP), Exchange Rate (ER), Inflation (INF), Foreign Direct Investment (FDI), Trade Openness (TO), Industrial Production (IP), Money Supply (MS). There might exist a long term effect between Crude Oil and Macro-economic variable. To capture the effect of growth; we have used double log function, as shown in Equation (1). To estimate we have used the difference of log variable, i.e. in logarithmic form whereas e represents the error term in growth model as shown in Equation (2) and Equation (3).

$$\Delta \ln(CRUDEI_t) = B_0 \sum_{i=1}^{t} B1\Delta + \ln(CRUDE_{t-j}) + \sum_{i=0}^{t} B2\,\Delta \ln(GDP_{t-j}) + \sum_{i=0}^{t} B3\,\Delta \ln(ER_{t-j}) + \sum_{i=0}^{t} B4\text{"}\ \mathbf{In}(INF_{t-j}) + \sum_{i=0}^{t} B5\,\Delta \ln(TO_{t-j}) + \sum_{i=0}^{t} B6\,\Delta \ln(IR_{t-1}) + \sum_{i=0}^{t} B7\,\Delta \mathbf{In}(IP_{t-j}) + B_8 e_{t-1} + u_t \quad (2)$$

$$\sum_{i=1}^{t} B1\,\Delta \ln(CRUDE_{-t-j}) + \sum_{i=0}^{t} B2\,\Delta \ln(GDP_{t-j}) + \sum_{i=0}^{t} B3\,\Delta \ln(ER_{t-j}) + \sum_{i=0}^{t} B4\,\Delta \mathbf{In}(INF_{t-j}) + \sum_{i=0}^{t} B5\,\Delta \ln(TO_{t-j}) + \sum_{i=0}^{t} B6\,\Delta \ln(IR_{t-1}) + \sum_{i=0}^{t} B7\,\Delta \mathbf{In}\ (IP_{t-j}) + \alpha_1 \ln(CRUDE_{-t-1}) + \alpha_2 \ln(GDP_{t-1}) + \alpha_3 \ln(TO_{t\,1}) + \alpha_4 \mathrm{InInf}_{t-1}) + \alpha_5 \ln(ER_{t-1}) + \alpha_6 \ln(IR_{t-1}) + \alpha_7 \ln(IP_{t-1}) + e_{t-1} \quad (3)$$

Where Δ represents changes in CRUDE and significant Macro-economic variables, and et-1 represents for error correction term (ECT).The coefficient sign explains the speed of adjustment to CRUDE towards the long term path and it is expected to be negative Katircioglu, (2010).

4. TECHNIQUES AND METHODS

To find out the relationship between the Crude Oil and Selected Macro-economic Variables of BRICS countries. We have used the Autoregressive Distributed Lag (ARDL) Cointegration technique or Bound Cointegration technique. But Firstly, as this data is time series, we must undergo the stationary properties of the data.

4.1. Unit Root Test

Most of the techniques applied in modelling the time series data are majorly concerned with Stationary properties of the data. If a time series has a unit root than series is considered as a non-stationary, while the absence of it entails stationarity. The non-stationary series can result in spurious regression. The statistical procedure applied to determine the stationarity of the time series is called "Unit root test." The present study uses the Augmented Dickey-Fuller (ADF) test to examine the properties of time series data and make them stationary.

4.1.1. Augmented Dickey-Fuller (ADF) test

It is the most common method of unit root test. Suppose consider the series "Y" for testing unit root. With this series, the following ADF model can be developed as in Equation (4):

$$\Delta Y_t = \mu + \delta Y_{t-1} + \sum_{i=0}^{n} \beta_1 \Delta Y_{t-i} + e_t \quad (4)$$

Where,
$\delta = \alpha - 1$
α = coefficient of Y_{t-1}
ΔY_t = First difference of Y_t
$\delta=0$ is the nu; hypothesis of ADF test and alternative is $\delta < 0$. If we do not reject the null hypothesis, then the series is said to be non-stationary and vice versa.

4.2. ARDL Cointegration Technique or Bound Cointegration technique

We cannot directly apply Johanson Cointegration test if selected variable under study are of mixed order of integration, or each variable is stationary but not in I(1). As in the case, we have to select ARDL modelling with the ordinary least square (OLS) model, which applies to both non-stationary and with mixed order of integration. From ARDL, with the help of simple linear trasformation Dynamic error correction (ECM) model can be derived. Wharas ECM integrates short-run dynamics with long-run equilibrium without losing long-run information and also helps to avoid the problem of spurious relationship.

The Model of ARDL as follows, as shown in Equation (5):

$$Y_t = \alpha + \beta a_t + \delta b_t + e_t \quad (5)$$

The error correction version of the ARDL model shown in Equation (6):

$$\Delta Y_t = \alpha_0 + \sum_{i=0}^{n} \beta_i \Delta Y_{t-1} + \sum_{i=0}^{n} \delta_i \Delta a_{t-1} + \sum_{i=0}^{n} e_i \Delta b_{t-1} + \lambda_1 Y_{t-1} + \lambda_2 a_{t-1} + \lambda_3 b_{t-1} + \mu_t \quad (6)$$

In the Equation (5) with β,δ and e represent short-run dynamics, and in Equation (6) λ_s exhibits long-run relationship. The null hypothesis is $\lambda_1 + \lambda_2 + \lambda_3 = 0$, symbolizes non-existence of long term relationship.

5. EMPIRICAL RESULTS

Table 2 exhibits stationary properties of data for all the selected Macro-economic variables of BRICS countries, respectively. Augmented Dickey-Fuller test has been used with the null hypothesis that series have Unit root. The results of the test imply that for Brazil, all the variables are stationary at I(1) except the

Table 1: Data description and variables

S. No.	Country	Macro-economic variables	Time period	Source	Symbol
1	Brazil	Exchange Rate to USD	Q1 1999-Q4 2019	Fred reserve	ER
2	Russia	Gross domestic product	Q1 1999-Q4 2019	OECD	GDP
3	India	Inflation	Q1 1999-Q4 2019	Fred serve	INF
4	China	Trade openness	Q1 1999-Q4 2019	Bloomberg	TO
5	South Africa	Foreign direct investment	Q1 1999-Q4 2019	Fred reserve	FDI
		Interest rates	Q1 1999-Q4 2019	Fred reserve	IR
		Industrial production	Q1 1999-Q4 2019	Bloomberg	IP

Source: Authors compilation

Table 2: Unit root analysis

Variables	Brazil		Russia		India		China		South Africa	
	ADF at level	ADF at First Difference	ADF at level	ADF at First Difference	ADF at level	ADF at First Difference	ADF at level	ADF at First Difference	ADF at level	ADF at First Difference
Exchange Rate (ER)	−1.7249 [0.4149]	−7.1699 [0.0000]	−0.1361 [0.9411]	−7.9871 [0.0000]	−0.3422 [0.9128]	−8.4803 [0.0000]	−1.1454 [0.6939]	−6.0656 [0.0000]	−0.8408 [0.8016]	−6.7393 [0.0000]
Foreign Direct Investment (FDI)	−0.7540 [0.8261]	-9.1762 [0.0000]	−1.6359 [0.4596]	−14.5632 [0.0000]	−1.0082 [0.7469]	−9.0696 [0.0000]	−0.7066 [0.8380]	−8.9821 [0.0000]	−4.6891 [0.0000]	-
Money Supply (MS)	−0.7206 [0.8483]	-12.0718 [0.0000]	−4.1472 [0.0000]	-	−2.5472 [0.1085]	−5.2090 [0.0000]	−2.6201 [0.0900]	−3.1976 [0.0230]	−0.9719 [0.7500]	−3.3028 [0.0181]
Gross Domestic Product (GDP)	−3.8593 [0.0000]	-	−0.4542 [0.8935]	−8.8422 [0.0000]	−1.0671 [0.7251]	−3.0469 [0.0350]	−2.0717 [0.2566]	−8.2649 [0.0000]	−5.0507 [0.0000]	-
Inflation Rate(INF)	−1.3981 [0.5790]	-3.4806 [0.011]	−2.4159 [0.1409]	−10.6207 [0.0000]	−2.1839 [0.2138]	−15.3609 [0.0000]	−1.9578 [0.3040]	−6.4186 [0.0000]	−0.5318 [0.8784]	−4.1792 [0.0000]
Trade Openness (TO)	−1.8788 [0.3407]	-7.8432 [0.0000]	−2.2979 [0.1751]	−11.2534 [0.0001]	−1.6339 [0.4608]	−13.6932 [0.0001]	−3.3127 [0.0174]	-	−7.1921 [0.0000]	-
Industrial Production (IP)	−2.1561 [0.2025]	−6.2890 [0.0000]	−2.3570 [0.1573]	−6.4137 [0.0000]	−1.2012 [0.6704]	−6.4518 [0.0000]	−8.6706 [0.0000]	-	−4.3360 [0.0008]	-

Numerator states t-statistics and Denominator [] states p-values

Table 3: Critical values for the ARDL modelling approach

K=7	0.10		0.05		0.01	
	I (0)	I (1)	I (0)	I (1)	I (0)	I (1)
F_0	2.22	3.17	2.5	3.5	3.07	4.23
F_1	2.38	3.45	2.69	3.83	3.31	4.63
F_2	1.70	2.83	1.97	3.18	2.54	3.91

K signifies the number of regressors in the ARDL model for the dependent variable, F_0, F_1 and F_2 represents the F-statistic of the Model with unrestricted intercept and restricted trend, unrestricted Intercept and trend, and unrestricted intercept and no trend respectively.
Source: (Narayan, 2005) for F-statistics.

Table 4: Bounds tests for level relationships

Variables	With deterministic trends		Without deterministic trends	
	F_0	F_1	F_2	Conclusion
F (lnCRUDE/lnIP,lnTO,lnGDP,lnFDI,lnER,lnMS,InINF)				
Brazil	6.45c	7.26c	7.70c	$H_{0\ Rejected}$
Russia	7.55c	7.65c	8.69c	$H_{0\ Rejected}$
India	3.178c	3.36b	4.31c	$H_{0\ Rejected}$
China	6.71c	6.72c	9.18c	$H_{0\ Rejected}$
South Africa	16.35c	18.39c	17.08c	$H_{0\ Rejected}$

To select a number of lags required for the cointegration test Schwartz Criteria (SC) was used. F_0, F_1 and F_2 represent the F-statistic of the Model with unrestricted intercept and restricted trend, unrestricted Intercept and trend, and unrestricted intercept and no trend respectively; "a," "b," "c" indicates that the statistic lies below the lower bound, falls within the lower and upper bounds and lies above the upper bound respectively.

Gross Domestic Product (GDP) which is at I(0) or at level. Russia shows similar results, but except Money supply (MS), all the other variables are stationary at I(1) or at first difference. Furthermore India demonstrates that all the variables are stationary at I(1) or at first difference only. Interstingly, China except for Trade openness (TO) and Industrial Production (IP) all other variables are stationary at first difference. In addition in South Africa Foreign Direct Investment (FDI), Groos Domestic Product (GDP), Trade Openness and Industrial Production(IP) all other variables are stationary at level or I(0) itself. The findings of the ADF test suggest to proceed for ARDL modelling and Bound test.

A structure of Unrestricted error correction model has been developed after determining the ARDL approach. As indicated by the Unit root test, all variables are stationary and integrated at I(0) or I(1). So now it is possible to study the long-run relationship between the variables using Bound test with the help of the regressors in Equation (2). The critical values of F-test using small sample are taken from (Narayan, 2005) and presented in Table 3.

Table 4 furnishes the results of Bound test for a level relationship between Crude Oil and all Macro-economic variables as elucidated in Equation (1). The bound test has been carried out with Restricted deterministic trend, Without deterministic trend and Unrestricted deterministic trend. Table 4 illustrates the Bound F-test using Autoregressive Distributed lag approach and upholds level relationship in the model. In all the cases of BRICS countries null hypothesis of $H_0 = \alpha1 = \alpha2 = \alpha3 = \alpha4 = \alpha5 = \alpha6 = \alpha7 = 0$ in,

Equation 3 do not accept. Accordingly, we can conclude that Crude Oil as a dependent variable has a long term relationship with all Macro-economic variables. So, now long-run coefficient can be estimated through ARDL approach and further, Conditional Error Correction model (ECMs) can be expected to study short term phenomenon and Error Correction Term (ECTs) of each country.

From Table 4. We have already concluded the long term relationship between the variables. For further analysis, we have to check the stability and reliability of the model with serial correlation and CUSUM plot before estimating the long run and short-run coefficient. For serial correlation, we have used Breusch-Godfrey Serial LM Correlation Test for each model with the null hypothesis of no serial correlation or autocorrelation between the variables because F-statistics is more than 10 per cent, 5 per cent and 1 per cent level of significance as stated in Table 5.

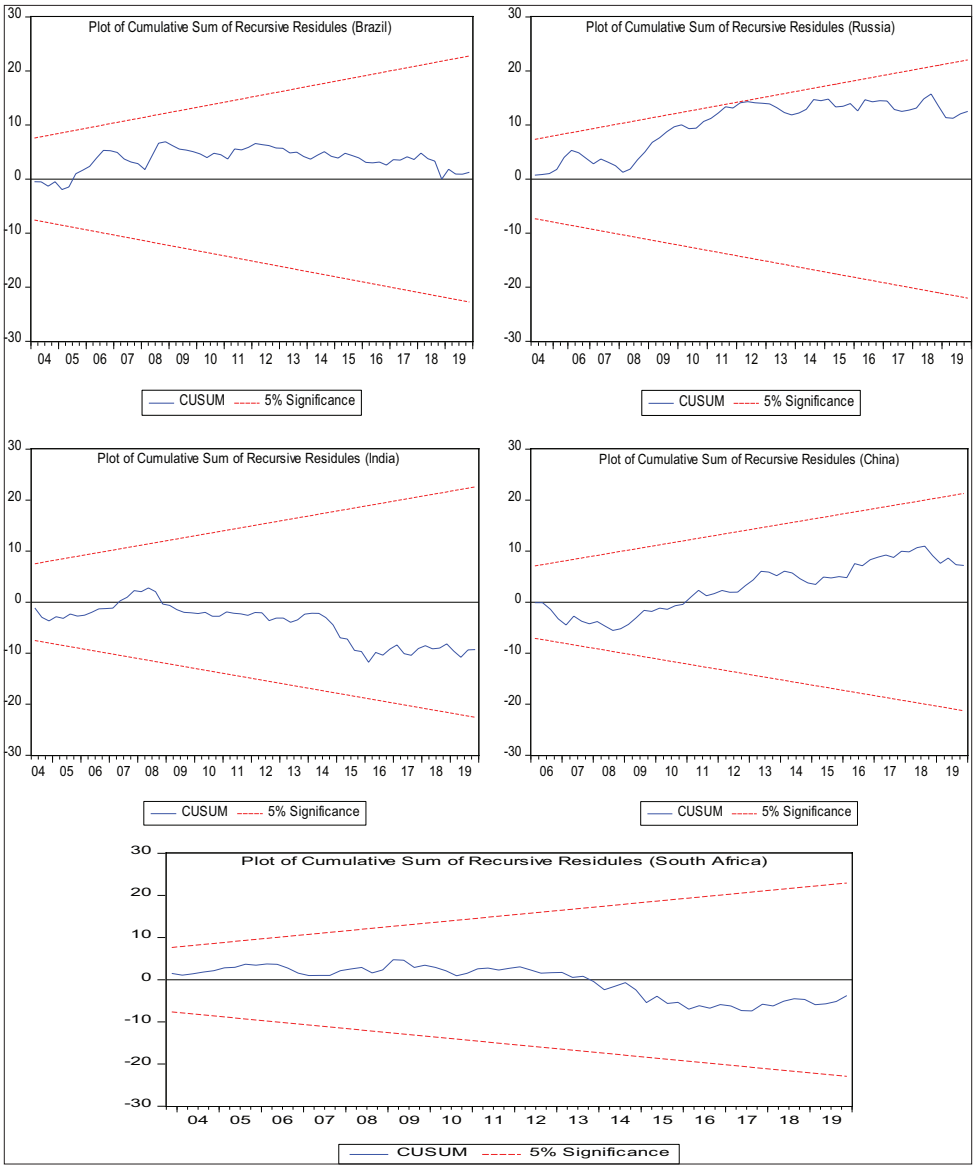
Whereas for analyzing the stability of the model. We have used the CUSUM test for ARDL models under study. The given plot in Figure 2 concludes that the models are stabled and can be used

Table 5: Estimation of ARDL models and robustness

Test statistics F-Statistics	Dependent variable				
	Brazil ARDL (3,3,3,4,1,3,3,3)	Russia ARDL (3,3,0,0,2,1,0,4)	India ARDL (1,1,0,4,0,0,2,2)	China ARDL (2,4,1,3,2,0,3,2)	South Africa ARDL (1,1,1,1,0,0,1,1)
Serial correlation*	0.4860 (0.6174)	1.5010 (0.2314)	0.0789 (0.9242)	1.3230 (0.2748)	0.0721 (0.9305)

*Lagrange multiplier test of residual serial correlation. Figures in parentheses indicate p-values. ARDL model selected based on the Schwarz Bayesian Criterion

Figure 2: The plot of Cumulative Sum of Recursive Residuals of BRICS countries (Crude Oil as a dependent variable)



Source: Author's compilation

for further investigation because CUSUM statistics lies between 5% critical bound.

Table 6 estimates the level coefficient in the long run through the ARDL approach. In Brazil, the long term coefficient of Trade Openness, Industrial production and FDI is 0.88, 1.81, and 0.02 respectively significant at 1% and per cent level of significance. Whareas in the case of Russia, Exchange rate and Industrial Production, i.e. −0.71 and 1.37 is significant at 1% and 5% respectively. Although, India and China show a similar situation with Trade Openness and Money Supply, i.e. 0.80, 0.96 and −1.06, 0.12 respectively significant at 1% and 5% level. Additionaly, in India, GDP is significant at 5%, and in China, Inflation is at 10 per cent level. Whareas in South Africa, we can observe that only Trade Openness is 0.00, which is significant at the 5% level.

Table 6: Level coefficients in the long-run models through the ARDL approach

	Dependent Variable	Regressors							
	lnCRUDE	lnER	lnTO	lnGDP	lnINF	lnIP	lnMS	lnFDI	Intercept
Brazil	-	−0.01	0.88**	−1.01	1.84	1.81**	−0.00	0.02*	9.94
Russia	-	−0.71*	−0.07	0.00	1.43	1.37**	−0.10	0.00	2.06
India	-	0.02	0.80*	1.40**	1.34	0.18	−1.06**	0.00	7.02
China	-	0.80	0.96*	0.02	−3.71***	0.00	−0.12*	0.00	−57.21*
South Africa	-	−0.24	0.00**	1.76	−0.06	0.34	−1.02	−0.00	0.00

Source: Authors' compilation. *, ** and *** denote the statistical significance at the 1%, 5%, and 10% levels respectively.

Table 7: Conditional Error Correction Models through the ARDL approach

Panel (A) Brazil				Panel (B) Russia				Panel (C) China			
Dependent variable: CRUDE (3,3,3,4,1,3,3,3)[a] selected based on Schwarz Bayesian Criterion				Dependent variable: CRUDE (3,3,0,0,2,1,0,4)[a] selected based on Schwarz Bayesian Criterion				Dependent variable: CRUDE (2,4,1,3,2,0,3,2)[a] selected based on Schwarz Bayesian Criterion			
Regressor	Coefficient	Standard error	t-test	Regressor	Coefficient	Standard error	t-test	Regressor	Coefficient	Standard error	t-test
$CRUDE_{t-1}$	0.43	0.12	3.51	$CRUDE_{t-1}$	0.59	0.12	4.86	$CRUDE_{t-1}$	0.29	0.13	2.14
$CRUDE_{t-2}$	−0.02	0.13	−0.18	$CRUDE_{t-2}$	−0.03	0.14	−0.22	$CRUDE_{t-2}$	0.03	0.13	0.25
$CRUDE_{t-3}$	−0.22	0.11	−2.03	$CRUDE_{t-3}$	−0.17	0.10	−1.75	$CRUDE_{t-3}$	0.19	0.11	1.72
BER	−0.02	0.15	−0.12	RER	−0.72	0.14	−5.06	$CRUDE_{t-4}$	0.19	0.08	2.23
BER_{t-1}	−0.51	0.20	−2.59	RER_{t-1}	−0.50	0.20	−2.53	CER_{t-1}	0.81	1.02	0.79
BER_{t-2}	−0.71	0.26	−2.70	RER_{t-2}	0.96	0.18	5.24	CER_{t-1}	−0.70	1.52	−0.46
BER_{t-3}	0.33	0.26	1.27	RER_{t-3}	−0.52	0.18	−2.94	CER_{t-2}	3.36	1.68	2.00
BFDI	0.02	0.01	2.79	RFDI	0.00	0.00	0.96	CER_{t-3}	−3.56	1.24	−2.87
$BFDI_{t-1}$	0.01	0.01	1.52	RGDP	0.00	0.01	0.26	CER_{t-4}	2.53	0.86	2.95
$BFDI_{t-2}$	−0.02	0.01	−1.94	RINF	1.43	1.01	1.41	CFDI	0.00	0.01	0.64
$BFDI_{t-3}$	0.02	0.01	2.82	$RINF_{t-1}$	0.13	1.46	0.09	$CFDI_{t-1}$	−0.01	0.01	−1.99
BGDP	−1.01	1.01	−1.00	$RINF_{t-2}$	−2.05	0.94	−2.18	CGDP	0.02	0.17	0.14
$BGDP_{t-1}$	−1.37	1.29	−1.06	RIP	1.38	0.67	2.07	$CGDP_{t-1}$	0.56	0.28	2.04
$BGDP_{t-2}$	−0.41	1.25	−0.33	RIP_{t-1}	−1.01	0.54	−1.87	CINF	−3.71	1.86	−2.00
$BGDP_{t-3}$	−1.28	1.29	−1.00	RMS	−0.10	0.20	−0.52	$CINF_{t-1}$	3.85	2.24	1.71
$BGDP_{t-4}$	2.40	1.19	2.02	RTO	−0.08	0.13	−0.61	$CINF_{t-2}$	3.80	1.37	2.78
BINF	1.85	1.46	1.27	RTO_{t-1}	0.40	0.11	3.52	$CINF_{t-3}$	3.09	1.51	2.05
$BINF_{t-1}$	2.77	1.41	1.96	RTO_{t-2}	−0.22	0.12	−1.82	CIP	0.00	0.03	0.17
BIP	1.82	0.79	2.30	RTO_{t-3}	−0.12	0.09	−1.35	CIP_{t-1}	−0.05	0.03	−1.61
BIP_{t-1}	−2.02	0.94	−2.14	RTO_{t-4}	0.21	0.08	2.50	CMS	−0.12	0.04	−2.91
BIP_{t-2}	−0.18	1.04	−0.17	C	2.07	4.42	0.47	CMS_{t-1}	0.20	0.12	1.62
BIP_{t-3}	1.50	0.80	1.88	ECT_{t-1}	−0.61	0.08	−7.21	CMS_{t-2}	−0.18	0.14	−1.26
BMS	−0.01	0.66	−0.01					CMS_{t-3}	−0.05	0.16	−0.33
BMS_{-1}	−1.91	0.71	−2.68					CMS_{t-4}	−0.34	0.20	−1.76
BMS_{t-2}	−0.11	0.64	−0.17					CTO	0.97	0.21	4.65
BMS_{t-3}	1.97	0.75	2.62					CTO_{t-1}	1.50	0.31	4.83
BTO	0.88	0.24	3.72					CTO_{t-2}	−1.00	0.31	−3.19
BTO_{t-1}	0.37	0.24	1.54					CTO_{t-3}	0.21	0.34	0.63
BTO_{t-2}	−0.01	0.31	−0.04					CTO_{t-4}	−0.82	0.26	−3.12
BTO_{t-3}	−0.58	0.23	−2.52					C	−57.22	10.80	−5.30
C	9.95	10.87	0.92					ECT_{t-1}	−0.38	0.06	−5.68
ECT_{t-1}	−0.83	0.14	−5.69								
Adj. R2= 0.9738, S.E. of Regr. 0.08, AIC = 1.88, SBC= −0.92,F-stat. = 96.02, F-prob. = 0.000, D-W stat. =2.18				Adj. R2= 0.9733, S.E. of Regr. = 0.08, AIC = −1.89, SBC=−1.23,F-stat. 89.50, F-prob. = 0.000, D-W stat. =2.14				Adj. R2= 0.9798, S.E. of Regr. = 0.07, AIC =−2.14, SBC=-1.22, F-stat. = 98.89, F-prob. = 0.000, D-W stat. =2.22			

'a' Denotes p lag structures in the model

Table 7(a): Conditional Error Correction Models through the ARDL approach (continued).

Panel (C) India			
Dependent Variable: CRUDE (1, 1, 0, 4, 0, 0, 2, 2)[a] selected based on Schwarz Bayesian Criterion			
Regressor	Coefficient	Standard error	T-test
$CRUDE_{t-1}$	0.62	0.10	6.44
IER	0.03	0.38	0.08
IER_{t-1}	–0.72	0.38	–1.89
IFDI	0.01	0.01	0.97
IGDP	1.40	0.58	2.43
$IGDP_{t-1}$	1.29	1.18	1.10
$IGDP_{t-2}$	–4.01	1.06	–3.77
$IGDP_{t-3}$	0.31	1.27	0.25
$IGDP_{t-4}$	1.22	0.93	1.31
IINF	1.35	0.95	1.42
IIP	0.18	0.63	0.29
IMS	–1.07	0.46	–2.33
IMS_{t-1}	–1.05	0.46	-2.28
IMS_{t-2}	0.90	0.52	1.71
ITO	0.80	0.15	5.30
ITO_{t-1}	0.38	0.19	2.05
ITO_{t-2}	–0.41	0.19	–2.20
C	7.02	19.36	0.36
ECT_{t-1}	–0.99	0.07	–12.82
Adj. R2=0.9732, S.E. of Regr.0.09, AIC=–1.67, SBC=–1.10, F-stat.=78.56, F-prob.=0.000, D-W stat.=2.04			

Panel (D) South Africa			
Dependent Variable: CRUDE (1, 1, 1, 1, 0, 0, 1, 1)[a] selected based on Schwarz Bayesian Criterion			
Regressor	Coefficient	Standard error	t-test
$CRUDE_{t-1}$	0.00	0.10	0.05
SAER	–0.25	0.21	–1.19
$SAER_{t-1}$	–1.13	0.22	–5.19
SAGDP	1.77	1.25	1.41
$SAGDP_{t-1}$	1.71	1.30	1.32
SAINF	–0.07	0.14	–0.49
$SAINF_{t-1}$	0.20	0.14	1.43
SAMS	–1.03	0.84	–1.23
SFDI	0.00	0.00	–1.11
SIP	0.35	0.26	1.32
SIP_{t-1}	–0.46	0.25	–1.88
SATO	0.00	0.00	2.29
$SATO_{t-1}$	0.01	0.00	2.68
C	0.01	0.07	0.14
ECT_{t-1}	–0.35	0.06	–5.53
Adj. R2=0.98, S.E. of Regr. 0.07, AIC=–2.14, SBC=–1.22, F-stat.=85.64, F-prob.=0.000, D-W stat.=2.22			

"a" Denotes p lag structures in the model

Finally, Table 7 and Table 7(a) provides the estimation of Error Correction Model (ECM) and Error Correction Term(ECTs). It is noticed that ECT in all BRICS countries is negative and statistically significant. Likewise China and South Africa show Error term less then 50%, means there are some variables that make Crude Oil react to its long-run equilibrium other than those Microeconomic variables under study. In China and South Africa, the estimated ECT is −0.38 and −0.35 ($p<0.01$) expresses that Crude Oil in China reacts to its long-run equilibrium by 38% speed of adjustment quarterly and South Africa is at 35% speed of adjustment.

Whereas the remaining countries, the highest ECT has been obtained from India (-0.99), Brazil (-0.83) and Russia (-0.61) respectively. Which are statistically significant at ($P<0.01$). Additionaly, Table 7 and Table 7(a) shows the short-run dynamics of the ARDL process. Similarly, all independent and dependent variable shows a mixed reaction (either Positive or Negative) with each other.

6. CONCLUSION

The connection between Crude Oil and Macro-economic variables is relevant to BRICS countries because it is quite vulnerable to Oil prices shocks and interdependencies among the variable will put forward underlying importance for Managerial decisions of Investment and policymakers, Government and Investors as a whole. The aim of this paper is to highlight the relationship between Crude Oil and Macro-economic Variables of an Emerging and developing BRICS countries using Autoregressive Distributed lag, and Bound test approach with the quarterly observations for the period March 31, 1999 to December 31, 2019.

Indeed we found that there exists a long term relationship between Crude Oil and Macro-economic variables which are Industrial Production, Trade Openness, Gross Domestic Product, Foreign Direct Investment, Exchange rate, Money Supply and Inflation. From the results, it is clear that fluctuations in the Crude Oil prices lead to changes in the Macro-economic variables and leads to changes in the economies as a whole.

REFERENCES

Aggarwal, P., Manish, M.K. (2020), Effect of oil fluctuation on stock market return: An empirical study. International Journal of Energy Economics and Policy, 43(22), 213-217.

Arfaoui, M., Rejeb, A.B. (2017), Oil, gold, us dollar and stock market ınterdependencies: A global analytical insight. European Journal of Management and Business Economics, 23(11), 1-20.

Basnet, H.C., Upadhyaya, K.P. (2015), Impact of oil price shocks on output, inflation and the real exchange rate: Evidence from selected ASEAN countries. Applied Economics, 47(29), 3078-3091.

Bhat, J.A., Ganaie, A.A., Sharma, N.K. (2018), Macro-economic response to oil and food price shocks: A structural VAR approach to the Indian economy. International Economic Journal, 46(05), 1-25.

BP. (2019), BP Statistical Review of World Energy. United Kingdom: BP Statistics.

Gupta, V., Sharma, P. (2018), The impact of oil prices on stock prices and other macro-economic variables in India: Pre-and post-2008 crises.

OPEC Energy Review, 23(10), 1-20.
Katircioglu, S.T. (2010), International tourism, higher education and economic growth: In the case of North Cyprus. The World Economy, 33(12), 1955-1972.
Koh, W.C. (2016), How do oil supply and demand shocks affect Asian stock markets? Macro-Economics and Finance in Emerging Market Economies, 15(2), 1-18.
Malik, K.Z., Ajmal, H., Zahid, M.U. (2017), Oil price shock and its ımpact on the macro-economic variables of Pakistan: A structural vector autoregressive approach. International Journal of Energy Economics and Policy, 25(15), 1583-1592.
Mensi, W., Hkiri, B., Al-Yahyaee, K.H., Kang, S.H. (2017), Analyzing time-frequency co-movements across gold and Oil prices with BRICS stock markets: A VaR based on the wavelet approach. International Review of Economics and Finance, 40(3), 1-29.
Narayan, P.K. (2005), The saving and investment nexus for China: Evidence from cointegration tests. Applied Economics, 18(5), 1979-1990.
Negi, P. (2015), Impact of oil price on economic growth: A study Of BRIC nations. Indian Journal of Accounting, 116(5), 44-155.
Omolade, A., Ngalawa, H., Kutu, A. (2019), Crude oil price shocks and macro-economic performance in Africa's oil-producing countries. Cogent Economics and Finance, 15(6), 1-17.
Ratti, R.A., Vespignani, J.L. (2016), Oil prices and global factor macro-economic variables. Energy Economics, 22(1), 198-212.
Raza, N., Shahzad, S.J., Tiwari, A.K., Shahbaz, M. (2016), Asymmetric impact of gold, oil prices and their volatilities on stock prices of emerging markets. Resources Policy, 18(8), 290-301.
Salami, M.A., Haron, R. (2018), Long-term relationship of crude palm oil commodity pricing under structural break. Journal of Capital Markets Studies, 25(6), 1-19.
Singh Tomar, R., and Singh, H. (2016), The causal relationship between stock market indices, gold prices, Crude oil prices, and exchange rates. Research Gate, 17(7), 53-65.
Sreenu, N. (2019), The effects of oil price shock on the ındian economy-a study. The Indian Economic Journal, 26(9), 25-40.
Tang, K., Xiong, W. (2012), Index ınvestment and the financialization of commodities. Financial Analysis Journal, 15(8), 54-74.
Yıldırım, D.C., Yıldırım, S. (2019), Investigating energy consumption and economic growth for BRICS-T countries. World Journal of Science, Technology and Sustainable Development, 16(6), 1-25.
Zahran, M.S. (2019), The response of remittances inflows to asymmetric oil price shocks in Egypt. Review of Economics and Political, 6(3), 1-20.