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EXAMINING A CAUSAL RELATIONSHIP BETWEEN DUBAI-OMAN AVERAGE CRUDE OIL PRICE AND SOME MACROECONOMIC FACTORS

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Abstract *Most of the Asian countries are fulfilling their demand for crude oil by importing it on average of Dubai and Oman. It becomes interesting to investigate the macroeconomic variables showing the relationship and also to investigate the effect of these variables on average of Dubai and Oman. The present study examines such a relationship and effect of one macroeconomic variable on others. Study is based on secondary data collected from eia.gov (Energy Information Administration an Official Energy Statistics from the U.S. Government), gold.org (Official website of The World Gold Council which is the market development organisation for the gold industry), and fxtop.com (a website where we can convert one currency with other) for the study period of 11 years from April 2005 to March 2016. Total five variables have been considered in the study, namely, Dubai-Oman Average price of crude oil, WTI, Brent, Rupee-Dollar Exchange Rate, and Gold Price. The study has found a bi-directional causality between Dubai and Oman average crude oil price and Brent as well as gold price and exchange rate. Some other causal relationships have also been confirmed.*

Keywords: *Macroeconomic Variable, ADF Unit Root Test, Johanson's Co-integration, VAR Granger's Causality/Block Exogeniety Wald Test*

INTRODUCTION

In today's economic scenario, world economies have undergone significant changes which are continuous in nature. These changes have affected rising economies to a greater extent, especially with regard to the elimination of restrictions in trade and commerce among different economies of the world. With the development of the commodities markets, a surge has been noticed in the economic uses of different commodities especially crude oil and gold. Crude oil and gold can also be termed as strategic commodities in the commodities markets. Crude oil is the most commonly traded commodity in the commodities markets and its prices are most volatile compared to other traded commodities. Gold is considered the leader in the precious metal market and it is also an investment asset commonly known as 'safe heaven' to avoid increasing risk in financial markets (Jothi & Suresh, 2017). Investors often switch between oil and gold or include them together in their portfolios to diversify the risk (Soytas, Sari, Hammoudeh, & Hacihasanoglu, 2009). The Dubai-Oman average is considered as a benchmark for Middle-Eastern crude oil, particularly for sale in Asian markets and therefore it becomes a matter of investigation into the relationship between Dubai-Oman average and US dollar exchange rates as transactions related to crude oil are settled in US dollar. Prior to 2007, it was the belief of majority of economists that there exists a directly proportional relationship between prices of crude oil and US dollar exchange rates as prices of crude oil move up the dollar rates also show a considerable surge due to increase in demand for dollars. Such a relationship is not seen in recent years.

The demand for crude oil depends mainly on the sulphur content of the crude oil. Low-sulphur crude oil, also known as sweet crude, is preferred over high-sulphur crude oil, also known as sour crude oil, as gasoline and diesel fuels are easy to extract from sweet crude oil having lower density than sour crude oil. The refiners prefer low-density crude oils as they can reap high refinery margins from them.

Location of crude oil has been considered one of the important factors that affect the demand for crude oil. Less expensive delivery of crude oil fetches higher prices from the buyer's side. Keeping these points in view, buyers want

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an easy way to value a variety of crude oils and this purpose is being served best by the benchmark crude oils. Major benchmark crude oils are Brent Blend, WTI and Dubai-Oman. Brent is traditionally a European oil index, and oil is produced in the North Sea. Whereas, WTI (West Texas Intermediate) is a Texas-based US oil index. Both indices are used as international benchmarks of oil. Dubai-Oman is the average of Dubai and Oman crude oil price. At present, much of the global trading takes place on the futures market, with each contract tied to a certain category of oil. Demand and supply dynamics bring in continuous changes in the values of marker crude oil. It may happen in the long run that the marker crude oil which is traded at a premium at present may be traded at a discount in the future.

Therefore, keeping in view the above-mentioned long-run relationship between different markers (benchmarks), it becomes the area of investigation into such a relationship. As far as gold is concerned, it also has an insight relationship with crude oil. The investments in crude oil shift to gold when gold is bullish compared to crude and vice versa. Exchange rate (rupee/dollar) has also shown long-run relationship with the major benchmark crude oil under some specific global economic conditions (sub-prime crises). Hence, this variable has also undertaken in this study to examine whether such relationship does still exists or not. Further, an attempt has also been made to investigate the existence of a causal relationship between these macroeconomic variables.

Other than the introductory part, the rest of the paper is organized as follows: Section 2 presents a literature review related to the macroeconomic variables taken in the study. Section 3 presents methodology, followed by the results and discussion in Section 4. Finally, Section 5 concludes the study with its implication and scope for further research.

LITERATURE REVIEW

Siliverstovs, Hegaret, Neumann and Hirschhausen (2005) investigated the degree of integration of natural gas markets. Their relation to the oil price were explored through principal components analysis and Johansen likelihood-based co-integration procedure for Europe, North America and Japan markets for the period between the early 1990s and 2004. In both of their analysis, they found a very high integration in the prices of natural gas within the European market; between the European an Japanese Market; as well as within the North American market. At the same time, the obtained results suggested that the European and the North American as well as the Japanese and North American markets were not integrated, confirming with the earlier studies that the gas markets were not integrated across continents.

Svetlana and Smyth (2009) studied co-integration between oil spot and futures prices of the same and different grade in the presence of structural change. The purpose of the study was to examine whether crude oil spot and futures prices of the same and different grades were co-integrated using a residual-based co-integration test that allows for one structural break in the co-integrating vector and high-frequency data. For the analysis, U.S. WTI (West Texas Intermediate) and UK Brent were chosen as the representative crudes since these two crudes have well-established spot and futures markets. The results revealed that spot and futures prices of the same grade, as well as spot and future prices of different grades, were co-integrated. They (Svetlana & Smyth, 2009) further examined whether crude oil spot and futures prices of the same and different grades were co-integrated using a residual-based co-integration test that allowed for one structural break in the co-integrating vector and high-frequency data. They used daily spot and futures prices at 1 and 3 months to maturity for the two benchmark crudes over the period spanning January 1991 to November 2008. They chose the U.S. WTI traded at NYMEX and the UK Brent traded at ICE as the representative crude oil for this analysis. The source for the spot prices was the Energy Information Administration (EIA), while future prices were taken from NYMEX and ICE. They found that spot and future prices of the same grade, as well as spot and future prices of different grade, were co-integrated.

Matthew, Jian and Kuan (2009) examined whether Dubai crude oil and Brent crude oil futures prices were stationary as well as whether there exists a long-run equilibrium relationship in the oil markets. Further, they investigated the dynamic process of the endogenous variables and future periods through Vector Error Correction Model (VECM). They found that Brent crude oil prices lead Dubai crude oil prices, and in the long term, however, both Dubai and Brent crude oil prices will reach an equilibrium. Their co-integration and VECM results were consistent with the one-great-pool concept advocated by Adelman (1984).

Almadi and Zhang (2011) examined whether the world's crude oil benchmarks (West Texas Intermediate in North America, Brent crude in Europe, and Dubai and Oman crude oil prices in Asia) were stationary as well as whether there exists a long-run equilibrium relationship between these markets. They found that the prices of the four main crude oil benchmarks were co-integrated and indicating that in the long run, the world oil market was unified rather than regionalized. They also found that Western oil markets (WTI and Brent) lead East-of-Suez (EOS) markets (Dubai and Oman). Specifically, this study found that WTI significantly leads to Brent, Dubai and Oman crude oil prices; Brent significantly leads Dubai and Oman crude oil prices; and Oman moderately leads Dubai crude oil prices. They concluded that in the long-run prices of the four (WTI, Brent, Dubai and Oman) crude oil main markets will reach an equilibrium.

Le and Chang (2011) had investigated the relationships between the prices of gold and oil in terms of index of the US Dollar, where monthly data has been examined by applying the econometric model. They found that there is a long-run relationship between the prices of oil and gold. They further stated that gold price can be predicted based on the oil price.

While studying co-movements of selected macro-variables (gold price, stock price, real exchange rate, and crude oil price), using econometric models, Samanta and Zadeh (2012) investigated that there is a co-integration between the selected variables. They further stated that stock price and gold price are more likely to move on their own while oil price and exchange rates likely to be influenced by other variables.

Bhunia and Pakira (2014) had investigated the affiliation between three financial variables of gold price, exchange rates, and Sensex between 1991 and 2013. For the purpose, they used econometrics models, namely, unit root test, Granger causality test, and Johansen co-integration test. They found that there exists a long-term relationship among the selected variables.

Benhabib, Kamel and Maliki (2014) investigated the relationship between oil price and the nominal US Dollar/Algerian Dinar exchange rate through an empirical analysis using a VAR Model (Vector Autoregressive Model) upon monthly data for the period 2003–2013. Results show that a co-integration relationship is not detected between the oil and exchange rate in Algeria. However, the estimation of a VAR model indicates that a 1% increase in oil price would tend to depreciate Algerian Dinar against the US Dollar by nearly 0.35%.

Above studies, conducted in India or abroad, however, investigate integration and relationship between some macroeconomic variables. But no study has been undertaken on the variables taken in this study. This study is an attempt to bridge this gap.

OBJECTIVES OF THE STUDY

Following are the major objectives of this study:

- To examine causal relationship between Dubai and Oman average crude oil price and WTI.
- To examine causal relationship between Dubai and Oman average crude oil price and Brent.
- To examine causal relationship between Dubai and Oman average crude oil price and Exchange rate in context to the Indian rupee and US Dollar.
- To examine causal relationship between Dubai and Oman average crude oil price and international gold price.

HYPOTHESES

To attain the above set objectives, following null hypotheses have been formulated and tested:

H_{01}: "WTI does not Granger cause to Dubai and Oman average crude oil price."

H_{02}: "Dubai and Oman average crude oil price does not Granger cause to WTI."

H_{03}: "Brent does not Granger cause to Dubai and Oman average crude oil price."

H_{04}: "Dubai and Oman average crude oil price does not Granger cause to Brent."

H_{05}: Indian rupee and U.S. Dollar Exchange rate does not Granger cause to Dubai and Oman average crude oil price."

H_{06}: "Dubai and Oman average crude oil price does not Granger cause to Indian rupee and U.S. Dollar Exchange rate."

H_{07}: International Gold Price does not Granger cause to Dubai and Oman average crude oil price."

H_{08}: "Dubai and Oman average crude oil price does not Granger cause to International Gold Price."

H_{09}: Exogenous variables in model do not Granger cause to dependent variable."

RESEARCH METHODOLOGY

The present empirical study is based on the secondary data collected from he official websites of Energy Information Administration an Official Energy Statistics of the U.S. Government, The World Gold Council which is the market development organization for the gold industry, and www.fxtop.com (a website where we can convert one currency with other) for the study period of 11 years from April 2005 to March 2016. Total five variables have been taken in the study, namely, Dubai, Oman, Average price of crude oil, WTI, Brent, Rupee-Dollar Exchange Rate and Gold Price.

Testing Stationarity

To run a particular model in econometrics, it needs the variable included in the model to be stationary. To check such stationarity, Augmented Dickey-Fuller (ADF) Unit Root test (Dickey & Fuller 1979) with intercept has been conducted for all the variables taken in the study at the level and at first difference using following regression equation:

$$\Delta x_t = \alpha_0 + \alpha_{t-1} + \sum_{i=1}^{n} {}^{2}{}_{\mathrm{i}}" x_{t-1} + u \qquad \text{(i)}$$

Where x_t is natural log price of the series of the selected variable for time t, α_0 is the constant, α_{t-1} is the coefficient of lagged log prices, β_i is the coefficient for lagged returns on the variable, Δ is the first difference operator, and ε_t is the white noise process (error term). Data has been processed and analysed using EVIEWS.

ADF unit root test hypothesize that the series is non-stationary (α = 0). We only infer that the series is stationary when the null the rejected (α ≠ 0). It has been found that all prices are non-stationary at a level except prices of WTC, but stationary at first differences.

Co-Integration Test

To find whether a long-run relationship exists between the variables included in the model, Johansen's co-integration test has been conducted. To find whether Π = 0, in Johansen's co-integration test, it has been hypothesized that there is no Co-integrated Eigenvalues in the model. Acceptance of the null motivates us to use VAR. VAR in level with constant is written as:

$$x_t = \sum_{i=1}^{k} A_i x_{t-1} + u_t \qquad \text{(ii)}$$

For k > 1, this VAR in the level is written as:

$$\Delta x_t = \Pi x_{t-1} + \sum_{i=1}^{k-1} \Pi_i \Delta x_{t-1} + u_t \qquad \text{(iii)}$$

For the simpler case k = 1, it is simply as;

$$\Delta x_t = \Pi x_{t-1} + u_t \qquad \text{(iv)}$$

The matrix Π can be written in terms of the vector or matrix of adjustment parameter α and the vector or matrix of co-integrating vector β as:

$$\Pi = \alpha\beta^T \qquad \text{(v)}$$

The number of Π in the above equation (ii) determines how many co-integrations are there in the model. If the matrix Π equals a matrix of zeroes, that is, Π = 0, then the variables are not co-integrated and the relationship reduces to the Vector Auto Regression in the first differences. It is written as:

$$\Delta x_t = \sum_{i=1}^{k-1} \Pi_i \Delta x_{t-1} + u_t \qquad \text{(vi)}$$

Acceptance or rejection is based on the basis of Trace statistics and Maximum Eigen Value.

GRANGER'S CAUSALITY TEST

The Granger causality test (Granger, 1988) has been applied to explore the existence of the causality pattern between the dependent and independent variables of the study. To test the causality, the following equations are involved:

$$\Delta AvgDO_t = \beta_0 + \sum_{i=1}^{k} \beta_{1i} \Delta \text{AvgDO}_{t-1} + \sum_{i=1}^{k} \beta_{2i} \Delta Brent_{t-1} + u_{1t} \qquad \text{(vii)}$$

$$\Delta Brent_t = \lambda_0 + \sum_{i=1}^{k} \lambda_{1i} \Delta Brent_{t-1} + \sum_{i=1}^{k} \lambda_{2i} \Delta \text{AvgDO}_{t-1} + + u_{2t} \qquad \text{(viii)}$$

$$\Delta AvgDO_t = \varphi_0 + \sum_{i=1}^{k} \varphi_{1i} \Delta \text{AvgDO}_{t-1} + \sum_{i=1}^{k} \varphi_{2i} \Delta \text{ExR}_{t-1} + u_{3t} \qquad \text{(ix)}$$

$$\Delta \text{ExR}_t = \pi_0 + \sum_{i=1}^{k} \pi_{1i} \Delta \text{ExR}_{t-1} + \sum_{i=1}^{k} \pi_{2i} \Delta \text{AvgDO}_{t-1} + + u_{4t} \qquad \text{(x)}$$

$$\Delta AvgDO_t = \psi_0 + \sum_{i=1}^{k} \psi_{1i} \Delta \text{AvgDO}_{t-1} + \sum_{i=1}^{k} \psi_{2i} \Delta \text{Gold}_{t-1} + u_{5t} \qquad \text{(xi)}$$

$$\Delta \text{Gold}_t = \omega_0 + \sum_{i=1}^{k} \omega_{1i} \Delta \text{Gold}_{t-1} + \sum_{i=1}^{k} \omega_{2i} \Delta \text{AvgDO}_{t-1} + + u_{6t} \qquad \text{(xii)}$$

$$\Delta AvgDO_t = \phi_0 + \sum_{i=1}^{k} \phi_{1i} \Delta \text{AvgDO}_{t-1} + \sum_{i=1}^{k} \phi_{2i} \Delta \text{WTI}_{t-1} + u_{7t} \qquad \text{(xiii)}$$

$$\Delta \text{WTI}_t = \gamma_0 + \sum_{i=1}^{k} \gamma_{1i} \Delta \text{WTI}_{t-1} + \sum_{i=1}^{k} \gamma_{2i} \Delta \text{AvgDO}_{t-1} + u_{8t} \qquad \text{(xiv)}$$

Where; $\Delta AvgDO_t$, $\Delta Brent_t$, ΔExR_t, ΔWTI_t, and $\Delta Gold_t$ are stationary time series at first difference; β_0, λ_0, …….γ_0 are intercepts; β_1, λ_1, …….γ_1 and β_2, λ_2, …….γ_2 are coefficients of the….; u_{1t}, u_{2t} ……….. u_{8t} are respective error terms of equation (vii) to equation (xiv); and k is the maximum lag length used in each time series which is taken in the basis of Akaike Information Criterion (AIC) of optimum lag selection. Variables $\Delta Brent_{t-1}$, ΔExR_{t-1}, ΔWTI_{t-1}, and $\Delta Gold_{t-1}$ in above equations, vii to xiv, are said to Granger cause $\Delta AvgDO_t$ if the coefficients of these equations are jointly significantly different from zero. Similarly, $\Delta AvgDO_t$

is said to Granger cause $\Delta Brent_{t-1}$, ΔExR_{t-1}, ΔWTI_{t-1}, and $\Delta Gold_{t-1}$ if the corresponding coefficients of related equations are jointly significantly different from zero.

Results of ADF

ADF test has been conducted on log prices of the variables and the first difference with intercept only, is used in the model. The test period is 12 years, from April 2004 to March 2016. T-statistics and corresponding p-values are Mackinnon's (1996) one-sided p-values and Schwartz Information Criteria (SIC) has been used to determine the lag length. Results of ADF have been given in Table 1 below. Results show that all series in their first difference are stationary at 1% level of significance.

Table 1: Augmented Dickey-Fuller Unit Root Test Statistic

Variables	t-Statistic	Prob.
At Level		
Average of Dubai-Oman (AvgDO)	-2.447	0.131
Exchange Rate (ExR)	-0.751	0.829
Gold Price (GoldPr)	-2.696	0.077
Brent Price (Brt)	-2.324	0.166
WTC	-2.914	0.047
At First Difference		
Average of Dubai-Oman (AvgDO)	-7.133	0.000
Exchange Rate (ExR)	-3.857	0.003
Gold Price (Gold)	-12.957	0.000
Brent Price (Brent)	-7.613	0.000
WTC	-5.871	0.000

Note: The critical values for 1, 5, and 10% level of significance are -3.481, -2.883, and -2.578, respectively. All first, differenced series are stationary at 1% level of significance.

Source: Author's Own Calculation

Results of Co-Integration Test

Outcomes of the Johansen's co-integration test have been depicted in Table 3. The table shows that variables are not co-integrated. The the null hypothesis of no co-integration among time series variables has been accepted at the five percent level of significance with trace statistic = 69.313 < critical value = 69.819 (p-value = 0.0548); and maximal Eigen value statistic = 27.556 < critical value = 33.976 (p-value: 0.2347).

Fig. 1: Graphical Presentation of Time Series (Variables) at Level

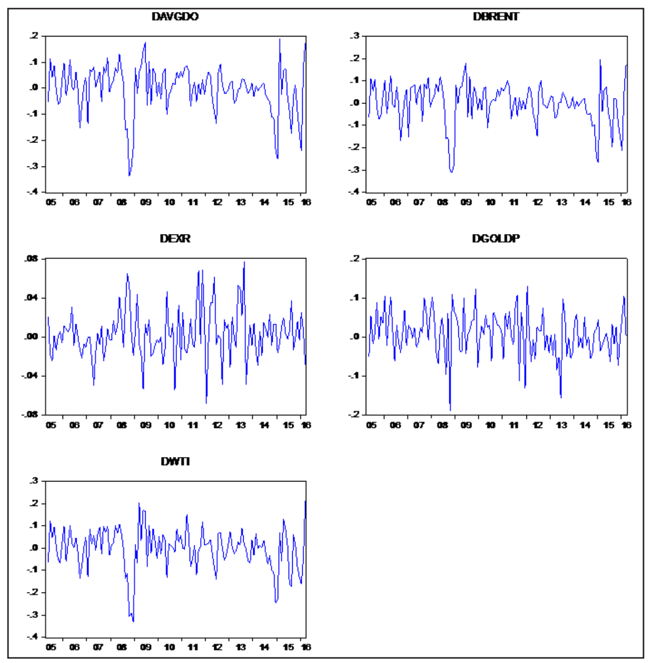

Fig. 2: Graphical Presentation of Time Series (Variables) at First Difference

This has shown that there is no long-run relationship between the variables taken in the study. Absence of co-integrating equations in the model leads us to the use of VAR model rather than VECM. As a co-integration procedure needs to include optimal lags in the model, it is important to find optimal lags that have to be included in the VAR model. Therefore, optimal lags have been obtained through lag selection criteria given in EVIEWS. Results have been given in Table 2. Results of lag selection criteria show different criteria i.e. HQ, FPE, AIC, SC and LR. Akaike Information Criteria (AIC) is considered as robust to select optimal lags. This study includes two lags in the co-integration procedure as indicated by AIC.

Table 2 : VAR Lag Order Selection Criteria

Lag	Log L	LR	FPE	AIC	SC	HQ
0	1181.2	NA	3.40E-15	-19.1252	-19.01089*	-19.07877*
1	1218.214	70.4157	2.80E-15	-19.3206	-18.6347	-19.0419
2	1244.347	47.59331	2.75e-15*	-19.33898*	-18.0815	-18.8282
3	1268.429	41.89828*	2.81E-15	-19.3241	-17.495	-18.5811
4	1280.067	19.30263	3.52E-15	-19.1068	-16.7061	-18.1317
5	1297.939	28.1877	4.02E-15	-18.9909	-16.0187	-17.7836
6	1315.646	26.48823	4.63E-15	-18.8723	-15.3285	-17.4328
7	1328.895	18.74258	5.79E-15	-18.6812	-14.5658	-17.0096
8	1341.483	16.78469	7.41E-15	-18.4794	-13.7924	-16.5756

Endogenous variables: DAVDO, DBRTE, DEXR, DGOLD and DWTC
Exogenous variables: C
* Indicates lag order selected by the criterion
LR: Sequential modified LR test statistic (each test at 5% level), FPE: Final Prediction Error
AIC: Akaike Information Criterion, SC: Schwarz Information Criterion, HQ: Hannan-Quinn Information Criterion

Table 3: Unrestricted Co-integration Test

Unrestricted Co-integration Rank Test (Trace)				
Hypothesized No. of CE(s)	**Eigen Value**	**Trace Statistic**	**0.05 Critical Value**	**Prob.****
None	0.195057	69.31324	69.81889	0.0548
At most 1	0.127484	41.75628	47.85613	0.1657
At most 2	0.108602	24.43678	29.79707	0.1826
At most 3	0.066533	9.836299	15.49471	0.2935
At most 4	0.008564	1.092342	3.841466	0.296
Trace test indicates no co-integration at the 0.05 level				
* Denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				
Unrestricted Co-integration Rank Test (Maximum Eigen Value)				
Hypothesized No. of CE(s)	**Eigen Value**	**Max-Eigen Statistic**	**0.05 Critical Value**	**Prob.****
None	0.195057	27.55696	33.87687	0.2347
At most 1	0.127484	17.3195	27.58434	0.5526
At most 2	0.108602	14.60048	21.13162	0.3179
At most 3	0.066533	8.743956	14.2646	0.3081
At most 4	0.008564	1.092342	3.841466	0.296
Max-Eigen value test indicates no co-integration at the 0.05 level				
* Denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				

Outcome of Vector Auto Regression

In the VAR model, a time series is said to be integrated with others, if the critical value (t statistics at 5% level of significance) is more than 1.96. Table 4 shows that Dubai and Oman average crude oil price at lag 1 has an influence on Brent (t = 2.66284) and WTI (t = 2.79771). However, at lag 2, it has no influence on any of the variables included in the model. Brent at lag 1 has also influence on Dubai-Oman (t = -2.14973) and WTI (t = -2.23096). No such influence of Brent has been observed at lag 2 on any of the variable. The exchange rate at lag 1 has shown influence on Dubai-Oman (t = -2.23252), Brent (t = -2.20493) and Gold price (t = -2.01757). However, it has no such influence on any of the variable at lag 2. Gold Price at lag 1 has no influence on any of the variable. However, exchange rate has been found to be influenced by gold price at lag 2 (t = 2.10079). No variable in the model was found to be influenced by WTI at lag l and lag 2.

Table 4: Vector Auto Regression Estimates

	DAVDO	DBRTE	DEXR	DGOLD	DWTI
DAVDO(-1)	1.565598	1.677365	-0.0933	-0.62415	1.787814
	(-0.61728)	(-0.62991)	(-0.18848)	(-0.42359)	(-0.63903)
	[2.53627]	**[2.66284]**	[-0.49501]	[-1.47349]	**[2.79771]**
DAVDO(-2)	0.707495	1.08246	0.351512	-0.08961	0.788156
	-0.64339	-0.65655	-0.19645	-0.4415	-0.66605
	[1.09964]	[1.64871]	[1.78934]	[-0.20297]	[1.18333]
DBRTE(-1)	-1.37143	-1.49748	0.059917	0.833132	-1.47338
	-0.63795	-0.65101	-0.19479	-0.43777	-0.66043
	[-2.14973]	[-2.30026]	[0.30760]	[1.90312]	**[-2.23096]**
DBRTE(-2)	-0.64389	-0.95924	-0.23302	-0.0599	-0.47276
	-0.6532	-0.66657	-0.19945	-0.44823	-0.67621
	[-0.98574]	[-1.43907]	[-1.16835]	[-0.13364]	[-0.69913]
DEXR(-1)	-0.67811	-0.68343	0.132348	-0.42052	-0.31816
	-0.30374	-0.30995	-0.09274	-0.20843	-0.31444
	[-2.23252]	**[-2.20493]**	[1.42705]	**[-2.01757]**	[-1.01182]
DEXR(-2)	0.139325	0.115782	-0.13368	0.22475	0.317425
	-0.32039	-0.32694	-0.09782	-0.21985	-0.33167
	[0.43487]	[0.35414]	[-1.36654]	[1.02228]	[0.95705]
DGOLD(-1)	0.184758	0.176988	0.014232	-0.12999	0.084628
	-0.14378	-0.14672	-0.0439	-0.09866	-0.14884
	[1.28503]	[1.20631]	[0.32420]	[-1.31754]	[0.56858]
DGOLD(-2)	0.165064	0.147507	-0.08938	-0.02749	0.08631
	-0.13934	-0.14219	-0.04255	-0.09562	-0.14425
	[1.18461]	[1.03739]	**[-2.10079]**	[-0.28748]	[0.59834]
DWTI(-1)	0.172679	0.168044	0.01274	-0.26646	0.075234
	-0.21652	-0.22095	-0.06611	-0.14858	-0.22415
	[0.79751]	[0.76055]	[0.19270]	[-1.79338]	[0.33565]
DWTI(-2)	-0.05675	-0.113	-0.10823	0.145138	-0.21248
	-0.21399	-0.21836	-0.06534	-0.14684	-0.22152
	[-0.26521]	[-0.51747]	[-1.65639]	[0.98841]	[-0.95918]
C	-0.00222	-0.00171	0.003625	0.009435	-0.00228
	-0.00755	-0.00771	-0.00231	-0.00518	-0.00782
	[-0.29384]	[-0.22179]	[1.57191]	[1.82020]	[-0.29184]

	DAVDO	DBRTE	DEXR	DGOLD	DWTI
R-squared	0.281799	0.277632	0.102526	0.101773	0.259961
Adj. R-squared	0.220935	0.216415	0.026469	0.025652	0.197245
Sum sq. residuals	0.778836	0.811032	0.07261	0.366742	0.83467
S.E. equation	0.081242	0.082904	0.024806	0.055749	0.084104
F-statistic	4.629944	4.535175	1.348013	1.336995	4.145099
Log likelihood	146.5369	143.9242	299.5757	195.1145	142.0712
Akaike AIC	-2.10135	-2.06084	-4.47404	-2.85449	-2.03211
Schwarz SC	-1.85749	-1.81698	-4.23018	-2.61063	-1.78825
Mean dependent	-0.00287	-0.00273	0.002987	0.008064	-0.00315
S.D. dependent	0.092044	0.093656	0.025141	0.056478	0.09387
Determinant residuals covariance (dof adj.)		1.57E-15			
Determinant residuals covariance		1.01E-15			
Log-likelihood		1312.128			
Akaike information criterion		-19.4904			
Schwarz criterion		-18.2711			

Note: Estimates in first row of column, Standard errors in ( ) & t-statistics in [ ]

The estimated integration of variables (VAR Models with Substituted Coefficients) is given below in equations form:

DAVGDO = 1.565*DAVGDO(-1) + 0.707*DAVGDO(-2) - 1.371*DBRENT(-1) - 0.643*DBRENT(-2) - 0.678*DEXR(-1) + 0.139*DEXR(-2) + 0.185*DGOLDP(-1) + 0.165*DGOLDP(-2) + 0.173*DWTI(-1) - 0.057*DWTI(-2) - 0.0022

DBRENT = 1.677*DAVGDO(-1) + 1.082*DAVGDO(-2) - 1.497*DBRENT(-1) - 0.959*DBRENT(-2) - 0.683*DEXR(-1) + 0.116*DEXR(-2) + 0.176*DGOLDP(-1) + 0.147*DGOLDP(-2) + 0.168*DWTI(-1) - 0.113*DWTI(-2) - 0.002

DEXR = - 0.093*DAVGDO(-1) + 0.351*DAVGDO(-2) + 0.059*DBRENT(-1) - 0.233*DBRENT(-2) + 0.132*DEXR(-1) - 0.134*DEXR(-2) + 0.014*DGOLDP(-1) - 0.089*DGOLDP(-2) + 0.013*DWTI(-1) - 0.108*DWTI(-2) + 0.004

DGOLDP = - 0.624*DAVGDO(-1) - 0.089*DAVGDO(-2) + 0.833*DBRENT(-1) - 0.059*DBRENT(-2) - 0.420*DEXR(-1) + 0.224*DEXR(-2) - 0.130*DGOLDP(-1) - 0.027*DGOLDP(-2) - 0.266*DWTI(-1) + 0.145*DWTI(-2) + 0.009

DWTI = 1.787*DAVGDO(-1) + 0.788*DAVGDO(-2) - 1.473*DBRENT(-1) - 0.473*DBRENT(-2) - 0.318*DEXR(-1) + 0.317*DEXR(-2) + 0.085*DGOLDP(-1) + 0.086*DGOLDP(-2) + 0.075*DWTI(-1) - 0.212*DWTI(-2) - 0.002

Outcomes of Var Granger Causality/ Block Exogeneity Wald Test

VAR Granger's causality/Block Exogeneity Wald test has been depicted in Table 5. Independent variables and their Chi-Square (χ^2) values with corresponding p-values have been given in columns and dependent variables are given in rows. All variables are taken in the model at their first difference. Results have shown that Brent ($\chi^2 = 5.601$, p = 0.06) and exchange rate ($\chi^2 = 5.092$, p = 0.078) Granger cause to Dubai-Oman average crude oil price in model 1. All independent variables together in the model also Granger cause to Dubai-Oman average crude oil price ($\chi^2 = 17.343$, p = 0.026). Findings have rejected our null hypothesis that *"exogenous variable in the model together do not Granger cause to Dubai-Oman average crude oil price"*.

Outcomes of model 2, given in Table 3, have revealed that Dubai and Oman average crude oil price ($\chi^2 = 9.967$, p = 0.007, significant at 1 %) and rupee-dollar exchange rate ($\chi^2 = 4.923$, p = 0.085, significant at 10 %) Granger causes Brent. Findings rejected to our null hypothesis that *"Dubai and Oman average crude oil price and exchange rate do not Granger cause to Brent"*. Outcomes on other independent variables in model 2 could not reject our null hypothesis. That means they do not granger cause to Brent. All exogenous variables in the model 2, together, Granger cause to Brent ($\chi^2 = 23.041$, p = 0.003) at 1% level of significance. Further, in this study, it has been found that there is bi-directional causality between Dubai and Oman average crude oil price and Brent.

Results of model 3, depicted in Table 3, have shown that only exchange rate (χ^2 = 4.930, p = 0.085) Granger cause to gold price at 10% level of significance and rejected our null hypothesis that, exchange rate does not granger cause to the gold price. Other exogenous variables in the model do not cause to the dependent variable "gold price". All variables together (χ^2 = 10.896, p = 0.207) in the model also do not Granger cause to the gold price.

Outcomes of VAR Granger causality model 4 revealed that only gold price Granger cause to exchange rate (χ^2 = 4.852, p = 0.088). Hence, rejected to our null hypothesis that, "gold price does not Granger cause to exchange rate" at 10% level of significance. Other variables in the model could not reject our null hypothesis. All variables in the model, together, also could not reject our null hypothesis (χ^2 = 11.135, p = 0.194). Further, it has been found that there is bi-directional causality between exchange rate and gold price.

Outcomes of model 5 have shown that Dubai and Oman average crude oil price (χ^2 = 9.347, p = 0.009) and Brent price (χ^2 = 5.472, p = 0.064) Granger cause to WTI. Results have also shown that all variables, together, Granger cause to WTI (χ^2 = 17.7, p = 0.023) at 5% level of significance. However, gold price and exchange rate do not Granger cause to WTI but, these variables together with Brent price and Dubai and Oman average crude oil price cause for the change in WTI.

Table 5: VAR Granger Causality/Block Exogeneity Wald Tests

Model	Dependent Variables	Independent Variable					All
		D(AvgDO)	D(BRENT)	D(GOLDPR)	D(EXR)	D(WTI)	
1	D(AvgDO)		5.601*** (0.061)	2.640 (0.267)	5.092*** (0.078)	0.692 (0.707)	**17.343** (0.026)**
2	D(BRENT)	9.967* (0.007)		2.191 (0.3342)	4.923*** (0.085)	0.820 (0.663)	**23.041* (0.003)**
3	D(GOLDPR)	2.223 (0.329)	3.638 (0.162)		4.930*** (0.085)	4.078 (0.130)	**10.896 (0.207)**
4	D(EXR)	3.416 (0.181)	1.458 (0.482)	4.852*** (0.088)		2.762 (0.2513)	**11.135 (0.194)**
5	D(WTI)	9.347* (0.009)	5.472*** (0.064)	0.588 (0.745)	1.851 (0.396)		17.7 (0.023)**

Note: Values given in above columns are χ^2 statistics, values in parenthesis are corresponding p values, and *, **, & *** represents significance at 1%, 5 % and 10% level of significance respectively.

Table 6: Results of Hypotheses Testing at a Glance

Null Hypothesis	X^2-Statistic	P-value	Accepted or Rejected	Causality and its Direction
BRENT does not Granger Cause AvgDO	5.601***	0.061	Rejected	Bi-directional
AvgDO does not Granger Cause BRENT	9.967*	0.007	Rejected	
ExR does not Granger Cause AvgDO	5.092***	0.078	Rejected	Uni-directional
AvgDO does not Granger Cause EXR	3.416	0.181	Accepted	
GOLDPR does not Granger Cause AVDO	2.640	0.267	Accepted	No Causality
AvgDO does not Granger Cause GOLDPR	2.223	0.329	Accepted	
WTI does not Granger Cause AvgDO	0.692	0.707	Accepted	Uni-directional
AvgDO does not Granger Cause WTI	9.347*	0.009	Rejected	
ExR does not Granger Cause BRENT	4.923***	0.085	Rejected	Uni-directional
BRENT does not Granger Cause ExR	1.458	0.482	Accepted	
GOLDPr does not Granger Cause BRENT	2.191	0.3342	Accepted	No Causality
BRENT does not Granger Cause GOLDPr	3.638	0.162	Accepted	
WTI does not Granger Cause BRENT	0.820	0.663	Accepted	Uni-directional
BRENT does not Granger Cause WTI	5.472***	0.064	Rejected	

Null Hypothesis	X^2-Statistic	P-value	Accepted or Rejected	Causality and its Direction
GOLDPr does not Granger Cause ExR	4.852***	0.088	Rejected	Bi-directional
ExR does not Granger Cause GOLDPr	4.930***	0.085	Rejected	
WTI does not Granger Cause ExR	2.762	0.251	Accepted	No Causality
ExR does not Granger Cause WTI	1.851	0.396	Accepted	
WTI does not Granger Cause GOLDPr	4.078	0.130	Accepted	No Causality
GOLDPr does not Granger Cause WTI	0.588	0.745	Accepted	

Impulse Response Function

This study further provides an insight on the effect of lagged value of any one variable on others. This effect is captured by observing the impulse response function. Figure 3 depicts the impulse response function of the variables for their 10 periods (10 months) reaction to a unit shock in another variable's standard deviation (SD). Reaction of Dubai and Oman average crude oil price (AvgDO) to one standard deviation innovation (positive shock) in AvgDO itself is positive (0.08%) in first period (month), which goes down to 0.03% in second period. This downfall in the response continues further in the following months and becomes zero by sixth month. Brent and exchange rate do not show any reaction in the first month for one SD positive shock in AvgDO. This reaction is recorded to become small in second month but increases in the third and fourth month and becomes zero in fifth month. Reaction of gold and WTI with one SD innovation in AvgDO is zero in first month. This response increases in second month goes down in third month. After recovery in this response, in the fourth month, it is becoming zero in fifth month and shows no further response thereafter. Overall, it has been observed that reaction in the variables due to one SD innovation in the AvgDO only remains up to fifth month. Such an effect does not appear after fifth month in most of the variables undertaken in this study.

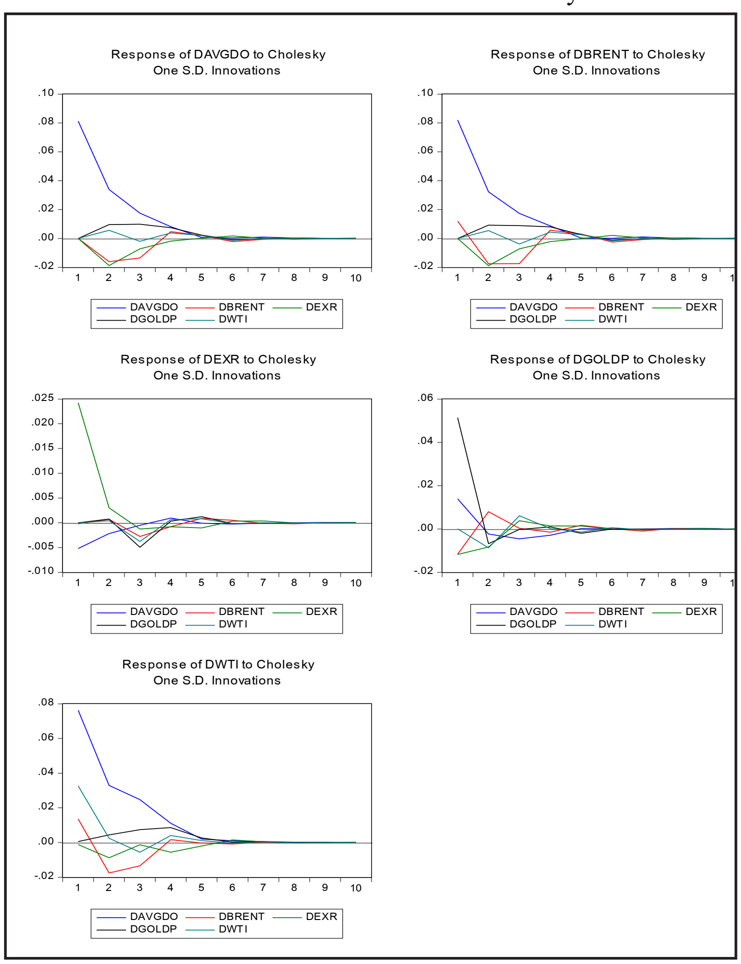

Fig. 3: Graphical Presentation of Impulse Response Function

CONCLUSION

This empirical study has been initiated to examine the causal relationship between Dubai and Oman average crude oil price and some international macroeconomic factors (variables), which are WTI, Brent, international gold spot price, rupee-dollar exchange rate, for the period of 11 years (April 2005 to March 2016). VAR Granger causality/Block Exoneinity Wald Test has been applied to explore the nature of the relationship (short/long run) between the selected variables.

The study has found a bi-directional causality between Dubai and Oman average crude oil price and Brent. Where, Dubai and Oman average crude oil price granger cause to Brent at 0.007 significance level but Brent Granger causes to Dubai and Oman average crude oil price at 0.061 level of significance. This finding also supports the findings of Jian and Kuan (2009) that Brent crude oil price leads to Dubai and Oman average crude oil price. However, findings do not show support for the existence of the long-run relationship. Findings of this study further support the findings of Almadi and Zhang (2011) that WTI leads to Dubai and Oman average crude oil price. Although, no co-integration has been captured. A bi-directional causality has been confirmed between gold price and exchange rate. Where, both variables Granger cause to each other at 0.088 and 0.085 significance level. In contrast to the findings of Bhunia and Pakira (2014), the present study found that gold price and exchange rate are not co-integrated. However, these variations in findings may exist as a result of taking different variables in the model. Also, it may be due to the time period of the study. Further, it has been searched that rupee/dollar exchange rate Granger causes Dubai and Oman average crude oil price at 0.078 significance level. Study has also found that such a uni-directional causality does exist between Dubai and Oman average crude oil price & WTI, Exchange rate & Brent, and Brent & WTI. Where, Dubai and Oman average crude oil price, Exchange rate and Brent were causing to change in WTI, Brent and WTI, respectively, at 0.009, 0.085 and 0.064 levels of significance.

IMPLICATION, LIMITATION AND SCOPE FOR FURTHER RESEARCH

Influenced by the Asian countries, Dubai and Oman average crude oil price is emerging as a more stable price and affecting to the price of well-established oil benchmark like WTI and Brent. The findings of this study further pave the way for establishing a new crude oil benchmark for Asian country that will help the Asian crude oil importer countries. Some of the Asian countries are developing rapidly and as a result, their demand for energy has also increased significantly. This phenomenon can help establish a new Asian benchmark that in turn can make this a dominant one. Once established, the new benchmark will help to discover the new price for other energy products such as coal, natural gas and many others that will further cut import cost on energy products of the Asian countries. However, few macroeconomic variables have been undertaken in this study. Further study could undergo taking some other macroeconomic variables such as FDI, major stock market indices, interest rate, and variables related to policy reforms.

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