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Exploring Causal Relationship Between Security Of Demand For Crude Oil And Economic Well-Being: The Case Of Five Mena Oil Exporting Countries

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Relationship between Oil Security and Economic Well-Being

It is opined that interest in energy security, for crude oil importers, is based on the notion that an uninterrupted supply of energy is critical for the functioning of an economy.[1] An exact definition of energy (including oil) security is hard to give as it has different meanings to different people at different points of time. Definitions of energy security have widened over time; however, the first and most dominant element of availability of energy to an economy still remains.[2] For big economies, oil supply security primarily means adequate volume, uninterrupted supply, at reasonable price.[3] Elaborating on the risks of disruption of supply, Conant and Gold (1978)[4] stated that failure to obtain any one of the three has a disastrous consequence for the economic well-being of citizens, political stability and national security of the consuming country. Further, Buzan and Waever (1998)[5] of the Copenhagen school of thought pointed out that the term security includes five separate aspects including economic security. They emphasised the need to construct a conceptualisation of security that means something much more specific than just any threat or problem. According to them the concept of securitisation entails a degree of interdependence between actors (states) within a regional energy security subsystem. Keohane and Nye (1975)[6] stated that each energy dependency case could be perceived as a mutually beneficial (positive dependency), or as an unequal and threatening energy dependency (negative dependency). While giving an example of positive interdependency within the Asian energy security subsystem, Shiv Kumar Verma (2007) states that if oil importers need flow of oil from the Middle East, it is also in interest of the Middle East to have a stable market for sustainable demand for its oil.

Oil security, for importers of crude oil, has traditionally been associated with the securing of access to oil supplies. Similarly, from the perspective of oil exporters, D. Von Hippel *et.al.* (2011),[7] state that the cornerstone of their security is in maintaining a steady market for exports of their (oil) production. The clearest definition of energy (oil) security in the context of this research is probably that was given by the Working Group of Asian Energy and Security in Massachusetts Institute of Technology's Centre for International Studies. The MIT working group defined three distinct goals of energy security. One of them is physical supply of energy (oil) for a nation's security and economic welfare.

As most of the Middle East oil exporting countries are dependent on the revenues generated from oil exports, their economic welfare is presumably associated with the security of oil demand, because physical supply disruption caused from demand imbalances affects the price of oil and consequently their revenue generations from exports. Oil exporting nations, whose citizens' economic welfare is overtly dependent on crude oil imports or revenues from crude oil exports, face a multitude of problems from oil demand disruptions. Lesbirel (2004)[8] pointed out that imbalances in supply or (demand) of crude oil may occur as a result of political, market and accidental/natural events or a combination of them. Dorian et.al. (2006),[9] state that oil security can be generally understood as an insurance measure taken by oil importers and exporters against the risk of harmful energy import and export disruption. Oil security can be seen from a short or long-term perspective. In the short term, the concern is with the disruptive impact of an unanticipated cut in demand or fall in price. In the long-term, the concern of the oil exporters is more on the availability of sufficient oil demand, which allows stable and sustainable economic development. The subject of causal relationship between primary energy consumption (including all forms of energy, i.e., oil, gas, coal, etc.) and GDP has been a subject of intense research in the past three decades using the concept of Granger causality. In 1978 J Kraft and A Kraft[10] examined an existing causal relationship between (primary) energy consumption and economic growth in their seminal paper. The paper was a pioneering work in the study of causal relationship between energy consumption and income of United States over the 1947-74 period. Their paper opened the floodgates of research on the topic. Since then, energy researchers have used dynamic modelling through modern econometric tools to establish an energy and economic growth nexus and for explaining causal relationship between different parameters in the area of energy security. Most of the recent energy related research with econometric analysis on Middle East oil exporting countries has been focussed on the causal relationship between primary energy consumption (EC) and economic growth (GDP). Survey of existing literature on similar relationships between the variables shows that causality has been examined under two categories for some Middle East oil exporting countries: one, which are country specific and others, which have taken a multi-country approach in their analysis.

Country Studies

In his research, Mehrzad Zamani (2007)[11] has confirmed that Iran's total energy consumption is responsive to its overall Gross Domestic Product using Vector Error Correction Model (VECM). Mahadevan and Asafu-Adjaye (2007)[12] uses panel error correction methodology to find the causality between GDP and EC for 20 oil exporting countries, including the five largest suppliers from the Middle East, namely Saudi Arabia, Iran, Iraq, UAE and Kuwait. They found bi-directional causality running from GDP→EC and EC→GDP in the cases of Saudi Arabia, Kuwait and UAE, and unidirectional (short-run causality) running from EC→GDP for Iran and Iraq.

Mehrara (2007)[13] has used panel co-integration to find the causality between energy consumption and economic growth for 11 oil-exporting countries (Iran, Kuwait, UAE, Saudi Arabia, Bahrain, Oman, Algeria, Nigeria, Mexico, Ecuador and Venezuela). His research used per capita GDP as a proxy variable for economic growth and per capita primary energy consumption as a proxy for energy consumption (EC). The research found causality from GDP→EC. Various other researchers have contributed to energy consumption and growth causality literature on single or a group of countries. These studies have focussed on several countries and time frames, and have used different proxy variables in order to find whether there exists a causal relationship between those variables with different results at different points in time, as the series and methodology differed. Therefore, no consensus was reached from these empirical researches on the causal relationship between energy consumption and growth. However, noteworthy is that none of them except Sajal Ghosh (2009)[14] have tested the causality of GDP with import quantity of crude oil, using import quantity of oil as a proxy to oil security. Similarly, Mehrara (2007) was amongst the few to use GDP per capita as a proxy variable for economic growth. Moreover, research done on oil exporting countries by Mehrara (2007), and Mahadevan and Asafu-Adjaye (2007) by using panel co-integration and panel error correction method do not give a country-specific view and instead give a holistic causality output for all the countries in the panel. Such a result does not help in country-specific policy making. The following table gives a detailed view of some of the relevant literature in energy related journals, which has examined the GDP and EC nexus of Saudi Arabia, Iran, Iraq, UAE and Kuwait:

Table 1: Country study on the relationship between GDP and energy consumption

Authors	Period	Country	Methodology	Causality relationship
Mehrzad Zamani, 2007	1967-2003	Iran	Granger causality, Co-integration, VECM	GDP-->Total energy
Mahadevan and Asafu-Adjaye, 2007	1971-2002	20 energy importers and exporters (including Saudi Arabia, Iran, UAE, Iraq and Kuwait)	Panel VECM	EC-->GDP, GDP-->EC (for developed countries); EC-->GDP (for developing countries)
Mehrara, 2007	1971-2001	11 Oil exporting countries (including Saudi Arabia, Iran, UAE, Iraq and Kuwait)	Panel Co-integration	GDP-->EC

Research Questions

This study focuses on filling what some might call a gap in literature, or more appropriately expand upon prior work on geopolitical strategies for oil security. While economic interdependence and oil security has been identified as an important concept in international relations and geopolitical literature, and have been addressed independently, mainly from the importers' perspective, this researcher has not found any studies that empirically tests the influence of oil export quantity on the economic well-being of citizens of the exporting countries head to head. Do they have any dynamic influence on each other (bi-directional), or is the influence uni-directional, or is it that they do not influence each other at all? Do they behave differently with different countries? Is the influence short-term or long-term in nature? The research seeks to understand the dynamic relationship of the influence of security of total export quantity (IT_i) on GDP per capita (GDP_i), of the oil exporting countries.

A case-to-case analysis is done of the top five crude oil exporters from the Middle East. The proposed study intends to raise the following questions that need to be investigated:

1. Do total exports quantity of oil (IT_i) of oil exporting countries from MENA countries like Saudi Arabia, Kuwait, Iraq, Iran and UAE have any influence on per capita GDP (GDP_i) of these countries, signifying security of demand is required for economic well-being of their respective country's citizens?
2. Which of these top five exporters of oil show causality, running from IT_i to GDP_i and what are its implications?

Key Assumptions

If the economic welfare of the citizens of a country is overtly dependent on the revenues generated from the exports of oil, any disruptions in demand will adversely affect the well-being of the citizens; researchers like Zamani (2007), Mahadevan and Asafu-Adjaye (2007) and Mehrara (2007) have used sophisticated econometric tools to find the dynamic relationship between primary energy consumption and overall GDP or GDP growth of oil exporting nations like Saudi Arabia, UAE, Kuwait, Iraq, Iran, etc.

This paper hypothecates that oil security (IT_i) has a dynamic relationship with per capita Gross Domestic Product (GDP_i), which promulgates it to secure the demand for its total export quantity of crude oil. Therefore, if the causality flows from IT_i to GDP_i, the research hypothecates that any disruption in demand for oil from oil importing countries will affect the per capita GDP of the oil exporting countries from MENA region, therefore signifying the need for security of demand for its exports.

The assumptions that underlie the above are:

- That the economic well-being of citizens of some oil exporting countries from MENA depends on the quantity of exports of crude oil, since revenues generated from crude oil exports helps in their economic development. Therefore, there is a necessity for security of demand of crude oil exports.
- That the significant dynamic relationship between the variables and the direction of their influence on each other can be framed as a dynamic model using modern econometric tools such as co-integration, vector auto regression (VAR) model vector error correction model (VECM) and Granger causality test.

The variables used in the research are as follows:

1. Year wise GDP per capita (GDP_i) of the oil exporting countries (proxy for economic well-being or economic security).
2. Total year wise quantity export of crude oil (IT_i) (proxy for oil demand security).

Apart from the above, the research hypothesises that the causality should flow from IT_i to GDP_i for each oil exporter in consideration. However, if the causality flows in the reverse direction, that is from GDP_i to IT_i, we can assume that the export quantity has no influence on per capita GDP of the oil exporting country. Hence, to conclude we can say that a supplier of crude oil will be considered to be dependent on oil exports if there is empirical evidence of a dynamic influence of IT_i and GDP_i in the right direction, i.e.: IT_i->GDP_i, here i denote the oil exporting country.

This research tries to attend to the following literature gaps. First, the implications of oil exports on the economic well-being of the citizens of top five oil producing and exporting nations of the MENA have not been studied in detail. Secondly, the research will add to the existing literature by providing possible reasons for consolidating the empirical results, which contradicts the general hypothesis. The following hypotheses have been framed for the research.

Framed Hypothesis

Hypothesis A:

Saudi Arabia: The total crude oil export quantity ($IT_{\text{Saudi Arabia}}$) of Saudi Arabia influences the per capita GDP ($GDP_{\text{Saudi Arabia}}$) of the country.

Hypothesis B:

Iran: The total crude oil export quantity (IT_{Iran}) of Iran influences the per capita GDP (GDP_{Iran}) of the country.

Hypothesis C:

UAE: The total crude oil export quantity (IT_{UAE}) of the UAE influences the per capita GDP (GDP_{UAE}) of the country.

Hypothesis D:

Iraq: The total crude oil export quantity (IT_{Iraq}) influences the per capita GDP (GDP_{Iraq}) of the country.

Hypothesis E:

Kuwait: The total crude oil export quantity (IT_{Kuwait}) influences the per capita GDP (GDP_{Kuwait}) of the country.

In short, the framed hypotheses tries to examine the relationship between quantified proxy variables to establish the assumed relationships between variables i.e. IT_i and GDP_i. In other words it is an effort to prove the relationship between capita GDP_i (economic well-being) and IT_i total quantity of oil exports (oil demand security) of top five oil exporting countries from the MENA region.

Data Collection and Methodology

The assumed bivariate relationship of economic security and oil security for top five oil exporters of the MENA region were examined empirically by using Vector Auto Regression (VAR) and Vector Error Correction Model (VECM).

This research paper uses secondary data of the quantity of crude exports and per capita Gross Domestic Product (GDP) of the oil exporting countries in consideration. Most of the data pertaining to total crude oil export from year 1980 to 2008 has been acquired through the UN Energy Statistics Department. The GDP per capita data was downloaded from the UN statistics data bank on country's accounts, which is available online.

The robustness of the data was ascertained by checking the stationarity of the time series data of 29 years (from 1980 to 2008) through the Augmented Dickey Fuller (ADF) test. Based on the results of stationarity, the variables were modeled as unrestricted VAR or VECM. Subsequently, the hypothesis was tested through the Granger Causality or Block Exogeneity Test. Further, the residual test of the error terms i.e., test for Heteroscedasticity, Normality of Residual and Serial auto correlation was tested.

To test our hypothesis the logarithms of the variable has been taken for further empirical examination i.e., LIT_i (log of IT_i) and $LGDP_i$ (log of GDP_i) has been used.

Traditionally to test for any causal relationship between variables, Granger (1969)[15] causality test is employed. Here in our research the Granger Causality tests whether the past values of the variable, say $LGDP_{i(t-1)}$, significantly influence the value of variable $LIT_{i(t)}$ then $LGDP_i$ is said to Granger Cause LIT_i and vice versa as the case may be. Here in order to find the Granger's causality between LIT_i and $LGDP_i$, we have to follow the steps as given below:

i. First check the stationarity of original variables time series (i.e., whether it has a unit root)
ii. Check co-integration between the non-stationary series.
iii. Check Long-term causality for co-integrating series through VECM and short-term dynamics by Granger Causality test
iv. In case of absence of co-integration of I (1) series, check the short-term dynamics by the block Exogeneity test or Granger causality test.

Augmented Dickey Fuller (ADF) Unit Root Test

Empirical studies have shown that in order to avoid spurious regression situation the variables must be stationary or co-integrated (Engle and Granger, 1987).[16] It is well known that most of economic time series data might have a unit root and dominated by stochastic trend. The presence of a unit root in any time series means that the mean and variance are not independent of time. Conventional regressions techniques, based on non-stationary time series, produce spurious regression and statistics may simply indicate only correlated trend rather than a true relationship.

In order to address the integration properties of the variables and avoid spurious regression, we construct a stationary test using Augmented Dickey Fuller (ADF) test proposed by Dickey and Fuller (1979).[17] Augmented Dickey Fuller test represent by,

$$\Delta y_t = \delta_0 + \delta_1 t + \gamma y_{t-1} + \sum_{i=1}^{k} \varphi_i \Delta y_{t-1} + \mu_t \text{---}1$$

Where, $\Delta y_t = y_t - y_{t-1}$ and Δ is the first difference operator, δ_0 is the constant or drift term, t is linear time trend, $\gamma = \rho - 1$ and μ_t is the serially uncorrelated, random disturbance. Under the null hypothesis, $\mathrm{H}_0: \gamma = 0$ and alternative hypothesis, $\mathrm{H}_1 : \gamma < 0$. If the null hypothesis is accepted, we conclude that unit root is present. While the series contain stochastic trend rather than deterministic trend, we use F test, under F test the null hypothesis, $H_1 : \delta_1 = \gamma = 0$ and alternative hypothesis, $H_1 : \delta_1 \neq \gamma \neq 0$. If the null hypothesis is rejected, we conclude that the series contain a time trend, if the null hypothesis is accepted we conclude that series does not contain a time trend. An important practical issue for the implementation of the ADF test is the specification of the lag length, we have used the Schwarz Bayesian Criterion (SBC) to determine the appropriate lag lengths for LIT_i and $LGDP_i$. The tests suggest that a model with the least value of SBC should be chosen

Since, correct information depends on the stationarity of data, it is necessary to determine the integration properties of the variables used in this study. In our research we have used the Augmented Dickey Fuller Test (ADF) to test the stationarity of the LIT_i and $LGDP_i$ of all the top five crude oil exporters from MENA region. During the testing of the individual time series of the variables LIT_i and $LGDP_i$ of oil exporting countries, three different assumption can be included in the test equation for testing ADF at level, 1st difference or 2nd difference of the variable time series (2nd difference has not been used in this empirical research). The test equation of the variables can be represented by the following equations:

$$\Delta LIT_{i_t} = \lambda LIT_{i_{t-1}} + \sum_{r=1}^{k} \chi_i \Delta LIT_{i_{t-r}} + \varepsilon_t \text{(} LIT_i \text{ is a random walk)-------------------------------------}2$$

$$\Delta LIT_{i_t} = \alpha_0 + \lambda LIT_{i_{t-1}} + \sum_{r=1}^{k} \chi_i \Delta LIT_{i_{t-r}} + \varepsilon_t \text{(} LIT_i \text{ is a random walk with drift)----------------}3$$

$$\Delta LIT_{i_t} = \alpha_0 + \alpha_1 t + \lambda LIT_{i_{t-1}} + \sum_{r=1}^{k} \chi_i \Delta LIT_{i_{t-r}} + \varepsilon_t \text{(} LIT_i \text{ is a random walk with drift around a}$$

stochastic trend)--4

Here error term ε_t are considered uncorrelated

Null Hypothesis

$H_0 : \lambda = 0$(Unit root is present)

$H_1 : \lambda < 0$(No unit root)

Here, k is the pre selected order of lags for the residuals and ε_t is the white noise with Δ as the first difference operator, i.e. $\Delta IT_{it} = IT_{it} - IT_{i(t-1)}$. Similar test equations estimation for ADF tests of $LGDP_i$ can be given as below:

Similarly,

$$\Delta LGDPi_t = \lambda LGDPi_{t-1} + \sum_{r=1}^{k} \chi_i \Delta LGDPi_{t-r} + \varepsilon_t (\ LGDP_i \text{ is a random walk})\text{------------------------}5$$

$$\Delta LGDPi_t = \alpha_0 + \lambda LGDPi_{t-1} + \sum_{r=1}^{k} \chi_i \Delta LGDPi_{t-r} + \varepsilon_t (\ LGDP_i \text{ is a random walk with drift})\text{------}6$$

$$\Delta LGDPi_t = \alpha_0 + \alpha_1 t + \lambda LGDPi_{t-1} + \sum_{r=1}^{k} \chi_i \Delta LGDPi_{t-r} + \varepsilon_t (LGDP_i \text{ is a random walk with drift around a stochastic trend})\text{---}7$$

Here error term ε_t are considered uncorrelated

Null Hypothesis

$H_o : \lambda = 0$(Unit root is present)

$H_1 : \lambda < 0$(No unit root)

In this paper pure random walk has been ignored while testing stationarity of the series using ADF test. Test equation with intercepts and trend with intercept has been assumed.

Johansen Co-integration

The first step in the empirical estimation is the univariate characteristic, which shows that the variables are stationary or non-stationary. If the variables are non-stationary, their order of integration is tested. This study uses Augmented Dickey-Fuller (ADF) statistics to test the stationarity of the variables and their order of integration. If the variables are I (1), the next step is to test whether they are co-integrated. Engle and Granger (1987) pointed out that a linear combination of two or more non-stationary time series may be stationary. If such a stationary linear combination exists, the non-stationary time series is said to be co-integrated. The stationary linear combination is called the co-integration equation and may be interpreted as a long-run equilibrium relationship amongst the variables. The purpose of the co-integration test is to determine whether group of non-stationary series are co-integrated or not. The test is done by using the Johansen (1991)[18] full information maximum likelihood test. In Johansen procedure defining a vector X_t of n potentially endogenous variables, it is possible to specify the data generating process and model X_t as an unrestricted Vector Auto-Regression (VAR) involving up to k- lags of X_t specified as:

$$X_t = \mu + A_1 X_{t-1} + \cdots\cdots\cdots\cdots\cdots\cdots + A_{t-k} X_{t-k} + \varepsilon_t \text{---}8$$

Where μ is a constant term which can be divided into two parts, the intercept in the co-integration relation and the trend terms, X_t is (n x l) matrix of non-stationary I (1) variables and A_i is an (n×n) matrix of coefficients. This is a system in reduced form and each variable in X_t is regressed on the lagged values of itself and all the other variables in the system. Equation (8) can be re-specified into a Vector Error Correction Model (VECM) as:

$$\Delta X_t = \mu + \Gamma_1 \Delta X_{t-1} + \ldots\ldots\ldots\ldots\ldots\ldots + \Gamma_{k-1} \Delta X_{t-k+1} + \Pi X_{t-k} + \varepsilon_t \text{-------------------------}9$$

In this research $LITi$ and $LGDP_i$ series are co-integrating for all the oil exporting countries considered in this research, therefore VECM is possible and our empirical work can be represented as:

$$\Delta LITi_t = \mu + \Gamma_1 \Delta LITi_{t-1} + \ldots\ldots\ldots\ldots\ldots\ldots + \Gamma_{k-1} \Delta LITi_{t-k+1} + \Pi LITi_{t-k} + \varepsilon_t ------------------10$$

Similarly,

$$\Delta LGDPi_t = \mu + \Gamma_1 \Delta LGDPi_{t-1} + \ldots\ldots\ldots\ldots\ldots\ldots + \Gamma_{k-1} \Delta LGDPi_{t-k+1} + \Pi LGDPi_{t-k} + \varepsilon_t ------------11$$

Where $\Gamma_i = -(I - A_1 - A_2 \cdots\cdots A_i), (i = 1,\ldots\ldots\ldots, k-1)$ and $\Pi = -(I - A_i - \ldots\ldots - A_k)$, I is a unit matrix, $A_i (i = 1\ldots\ldots\ldots p)$ are the coefficient vectors, k is the number of lags included in the system, ε_t is the vector of residual which represents the unexplained changes in the variable or influenced of exogenous shocks, or ε_t is independently and identically distributed with mean zero and variance δ^2 and Δ represents variables in differenced form which are I (0) and stationary. In the analysis of VAR, Π is a vector, which represents a matrix of long-run coefficients. The long-run coefficient are defined as a multiple of two matrices, i.e., if α and β' are of dimension (n×r) and (r×n) respectively and $\Pi = \alpha\beta'$, where α is a vector of the loading matrix and denotes the speed of adjustment from the disequilibrium, while β' is a matrix of long-run coefficient so that the term $\beta' LITi_{t-1}$ in equation (10) or $\beta' LGDPi_{t-1}$ in equation (11) represents up to (n-1) co-integration relationship in the co-integration model. It is responsible for making sure that $LITi_t$ and $LGDPi_{t-1}$ converges to their long-run steady-state values. If rank of Π in equation (9) is equal to 'n' then vector of X_t is stationary. In the other extreme, when rank of Π is equal to zero then the matrix is null and X_t vector is a non-stationary process. If rank of Π is equal to one, there is single co-integrating vector. When rank of Π is within the range, 0<r<n, then there are r co-integrating vectors. It is assumed that $LITi_t$ is a vector of non-stationary variables I(1), then all terms in equation (10) which involves $\Delta LITi_{t-i}$ are I(0), and $\Pi LITi_{t-k}$ must be stationary for ε_t I(0) to be white noise, similar assumption were also made for $LGDP_i$. Two tests statistics are suggested to determine the number of co-integration vectors based on likelihood ratio test (LR): the trace test and maximum eigenvalue test statistics.

The trace test (λ_{trace}) is defined as:

$$trace(r_0 \mid k) = -T \sum_{i=r_0+1}^{n} \log(1-\hat{\lambda}_i)$$

$$or,\ \lambda_{\text{trace}}(r_0) = = -T \sum_{i=r_0+1}^{n} \log(1-\hat{\lambda}_i)$$

Where $\hat{\lambda}_i$ are the ordered (estimated) eigenvalues

$\lambda_1 > \lambda_2 > \ldots\ldots > \lambda_k$ and r_0 ranges from 0 to k-1

Null Hypothesis

H_0:r $\leq r_0$

H_1:r $\geq r_0$+1

The null hypothesis is that the number of co-integration vectors is $\leq r$ (at most r co-integrating vectors $0 \leq r \leq n$) where r = 0, 1, or 2 against the alternative hypothesis that the number of co-integration vectors = r or (n-r, Co-integration vectors) where $\hat{\lambda}_i$' is define as the estimated value of characteristics roots obtained from the estimated Π matrix and T is the number of observations.

The maximum eigenvalue test ($\lambda_{\max}$) is defined as:

$$\lambda \max (r_0) = = -T \sum_{i=r_0+1}^{n} \log(1-\hat{\lambda}_i)$$

Where $i = r_0 + 1$

Where $\hat{\lambda}_i$ are the ordered (estimated) eigenvalues

$\lambda_1 > \lambda_2 > \ldots\ldots > \lambda_k$ and r_0 ranges from 0 to k-1

Null Hypothesis

H_0:r $\leq r_0$

H_1:r=r_0+1

The null hypothesis tests the number of co-integration vectors = r against the alternative that there are r+1 co-integrating vectors, the null hypothesis, r = 0 is tested against the alternative that r = 1, and r = 0 is tested against the alternative r = 2, when the two tests produced conflicting results, the maximum eigenvalue test is considered since the alternative hypothesis is an equality. Co-integrated variables share common stochastic and deterministic trends and tend to move together through time in a stationary manner even though the two variables in this study may be non-stationary. It is important to note that there are three possibilities; *first* rank of Π can be zero. This takes place when all elements in the matrix Π are zero. This means that the sequences are unit root processes and there is no co-integration. The variables do not share common trends or move together over time. In this case, the appropriate model is a VAR in first differences involving no long-run elements. *Second*, the rank of Π could be full (in this study, rank= 2). In this case, the system is stationary and the two variables can be modelled by VAR in levels. It represents a convergent system of equations, with all variables being stationary. *Finally*, the rank of Π can be a reduced (in this study, rank=1). In this case, even if all variables were individually I (1), the level-based long-run component would be stationary. In this case, there are n-1 cointegrating vectors. The appropriate modelling methodology here is a VECM.

The maximum eigenvalue test statistic and trace statistic will allow us to determine whether there is any cointegration between the series. If the total crude export $LITi$ and the per capita Gross Domestic Product $LGDP_i$ series are co-integrated, we can use error correction representation to test causality between the two series. VECM has been primarily used in the empirical analysis to examine the relationship between $LGDP_i$ and $LITi$ as the time series data of the considered oil exporting countries are co-integrating.

In implementing the Johansen co-integration procedure, a number of crucial empirical decisions have to be made. The first decision concerns the lag-length in the VAR model, for which we use the information provided by the Akaike Information Criteria (AIC), Schwarz Bayesian Criteria (SBC) and the Hannan-Quinn (HQC) statistic. Generally in the research we have taken the SBC for determining the lag length.

Engle and Granger (1987) showed that if two series X and Y are individually integrated to the order one I (1) and co-integrated then there would be a causal relationship in at least one direction i.e., either X will cause Y or Y will cause X. Even though co-integration indicates the presence of Granger Causality, it does not indicate in which direction the causality runs i.e. does X →Y or Y→X. This direction of Granger's causality can be detected through the Vector Error Correction Model (VECM) of long run co-integrating vectors. Furthermore, Granger's representation theorem demonstrates how to model a co-integrated I (1) series in vector auto regression (VAR) format. VAR can be constructed either in terms of the level of the data or in terms of their first difference, i.e., I (0) variables, with the addition of an error correction term to capture the short run dynamics.

Vector Error Correction Model (VECM) and Causality Test

The traditional Granger causality test uses the simple F-test statistics. Several study such as Chow (1987),[19] have used the traditional (F-test) to test for causality are not sufficient if variables are nonstationarity 1(1) and co-integrated.

Many economic time-series are 1(1), and when they are co-integrated, the simple F-test statistic does not have a standard distribution. If $LITi$ and $LGDP_i$ are co-integrated, then causality must exist at least in one direction. During our empirical work, where we have examined the relationship of per capita $LGDP_i$ of oil exporting countries with crude export quantity $LITi$, most of the variable time series were found to be non-stationary at level but co-integrating (assuming a deterministic linear trend) by Johansen co-integration. If time series included in the analysis are 1(1) and co-integrated, the traditional Granger causality test should not be used, and proper statistical inference can be obtained by analysing the causality relationship on the basis of the VECM.

The error correction coefficients, term serve two purposes. They are (i) to identify the direction of causality between $LGDP_i$ and $LITi$, and, (ii) to measure the speed with which deviations from the long-run relationship are corrected by changes in $LGDP_i$ and $LITi$.

If the variables are 1(1) and co-integrated, Granger causality should be done in the VECM. We have used VECM in our empirical work for finding dynamic relationship between $LITi$ and $LGDP_i$ time series, the same can be expressed as:

$$\Delta LGDP_{i_t} = C_1 + \sum_{j=1}^{q} \alpha_{1j} \Delta LGDP_{i_{(t-j)}} + \sum_{k=1}^{n} \beta_{1i} \Delta LIT_{i_{(t-k)}} + \phi_{1t} EC_{t-1} + \mu_t \text{-----------} 12$$

$$\Delta LIT_{i_t} = C_2 + \sum_{j=1}^{p} \alpha_{2j} \Delta LIT_{i_{(t-j)}} + \sum_{p=1}^{r} \beta_{2i} \Delta LGDP_{i_{(t-p)}} + \phi_{2t} EC_{t-1} + \gamma \text{------------} 13$$

Where μ_t and v_t are uncorrelated error terms and $E(\mu_t, \mu_{st}) = 0$, $E(v_t, v_{st}) = 0$, ΔLIT_i and $\Delta LGDP_i$ first difference stationary and co-integrated variables and EC_{t-1} the lagged values of the error term derived from the following co-integration regressions equation given by equation (14) and (15). The optimal lag-length can be derived on the basis of SBC, AIC and HQC statistic. The coefficient of error correction term will capture the speed of the short-run adjustment towards the long-run equilibrium. In our empirical work on relationship between $LITi$ and $LGDP_i$ it can be represented as:

$$LGDP_{i_{(t)}} = \delta + \phi LIT_{i_{(t)}} + \varepsilon_{1t} \text{--} 14$$

$$LIT_{i_{(t)}} = \alpha + \psi \, LGDP_{i_{(t)}} + \varepsilon_{2t} \text{--} 15$$

Using equation (12) and equation (13), long and short-run Granger causality can be tested. Granger causality in the long run is tested by checking the significant of the parameter estimates of lag error correction term, (standard t-test), where the null hypothesis stated as $H_0 : \phi_{1t} = 0$ (i.e., per capita GDP does not Granger cause export quantity of crude oil in the long run) in equation (12). If the coefficient ϕ_{1t} is significant, then the null hypothesis of no long-run equilibrium relationship can be rejected, it shows that per capita GDP causes export quantity of crude oil, therefore not supporting our $LITi$ influences $LGDP_i$ hypothesis. Similarly, for $H_0 : \phi_{2t} = 0$ (i.e., export quantity of crude oil does not Granger cause per capita GDP in the long run) in equation (13), if the coefficient ϕ_{2t} is significant, than the null hypothesis of no long-run equilibrium relationship can be rejected, it shows that total export quantity of crude oil causes per capita GDP of that country, supporting our $LITi$ influences $LGDP_i$ hypothesis. Negative and statically significant value of the coefficient of error correction terms indicates the existence of long-run causality. Granger causality in the short-run is tested jointly. This is performed using the WALD parameter restriction test, in which the null hypothesis is $H_0 : \sum_{i=1}^{p} \beta_{1i} = 0$ (i.e., export Quantity of crude oil does not Granger cause per capita GDP in the short-run) in equation (12). If the null hypothesis is rejected, it shows that export quantity of crude oil influences per capita GDP, supporting our $LITi$ influences $LGDP_i$ hypothesis. Similarly the null hypothesis is $H_0 : \sum_{i=1}^{p} \alpha_{2i} = 0$ (i.e., per Capita GDP does not Granger does not cause export quantity of crude oil in the short-run) in equation (13). If the null hypothesis is rejected, it shows that per capita GDP causes per capita GDP, thus not supporting $LITi$ influences $LGDP_i$ hypothesis. There will be bi-directional causality between $LITi$ and $LGDP_i$, if both of the null hypothesis $H_0 : \sum_{i=1}^{p} \beta_{1i} = 0$ and $H_0 : \sum_{i=1}^{p} \alpha_{2i} = 0$ are subject to rejection. Total oil export quantity and per capita GDP will be determined independently if none of the null hypothesis $H_0 : \sum_{i=1}^{p} \beta_{1i} = 0$ and $H_0 : \sum_{i=1}^{p} \alpha_{2i} = 0$ are rejected, that indicate there is no causal link between these two variables. The estimation comes of three steps. First, the study tests stationary of the two variables using Augmented Dickey-Fuller (ADF) unit root test. When the null hypothesis of nonstationarity is not rejected by these two tests, it moves to the second step, the co-integration test in Johansen's (1991) framework. If the first two steps indicate that the two variables are nonstationarity and cointegrated, the third step is taken: estimating equations (12) and (13) using the vector error correction technique and testing short and long-run Granger causality between $LITi$ and $LGDP_i$.

Granger Causality Analysis

Granger developed the Granger causality test in 1969.[20] According to Granger a variable is said to be Granger causes another Variable if past and present value of one variable help to predict the other.

Following Oxley and Greasley (1998),[21] a three-stage procedure has been used to test the direction of causality. The first step tests for the order of integration of the natural logarithm of the variables using Augmented Dickey Fuller (ADF). Conditional on the outcome of the tests, the second step involves investigating bivariate co-integration using VAR approach of Johansen (1991) and Johansen and Juselius (1990).[22] The third stage, involves constructing standard Granger-type causality tests, augmented where appropriate with a lagged error correction term.

The three-stage procedure for testing causality leads to three alternative approaches (S. Ghosh, 2000),[23] which has been used in this research to test causality between $LITi$ and $LGDP_i$. If the series $LITi$ and $LGDP_i$ of individual countries are individually I (1) and co-integrated then Granger causality tests may use I (1) data because of super consistency properties of estimation. Here the variables $LITi$ and $LGDP_i$ can be represented as:

$$LITi_t = \alpha + \sum_{p=1}^{m} \beta_i LITi_{(t-p)} + \sum_{j=1}^{n} \gamma_j LGDPi_{(t-j)} + u_t \text{------------------------------} 16$$

$$LGDPi_t = a + \sum_{p=1}^{q} b_i LGDPi_{(t-p)} + \sum_{j=1}^{r} c_j LITi_{(t-j)} + \varepsilon_t \text{----------------------------} 17$$

Now, for Equations 16 and 17, $LGDPi$ Granger causes (GC) $LITi$ if

Ho: $\gamma_1 = \gamma_2 = ... = \gamma_n = 0$ is rejected against

H1: $\gamma_j \neq 0, j = 1....n$ (at least one is not equal to 0)

Here, $LITi$ Granger Cause $LGDPi$ if,

H0: $c_1 = c_2 = ... = c_n = 0$ is rejected against

H1: $c_j \neq 0, j = 1....r$

Here in the above equations u_t and ε_t are serially uncorrelated, random disturbances. Secondly, Granger causality tests with co-integrated variable may utilise the I(0) data with an Error Correction Term (ECT) i.e.

$$\Delta LITi_t = \alpha + \sum_{p=1}^{m} \beta_i \Delta LITi_{(t-p)} + \sum_{j=1}^{n} \gamma_j \Delta GDPi_{(t-j)} + \delta ECM_{t-1} + u_t \text{-------------------} 18$$

$$\Delta LGDPi_t = a + \sum_{p=1}^{q} b_i \Delta LGDPi_{(t-p)} + \sum_{j=1}^{r} c_j \Delta LITi_{(t-j)} + dECM_{t-1} + \varepsilon_t \text{----------------} 19$$

Hypothesis

Now, for Equations 18 and 19,

Δ $LGDPi$ Granger causes (GC) Δ $LITi$ if

Ho: $\gamma_1 = \gamma_2 = ... = \gamma_n = 0$ is rejected against

H1: $\gamma_j \neq 0, j = 1....n$ (at least one is not equal to 0)

Here, Δ $LITi$ Granger Cause Δ $LGDPi$ if,

H0: $c_1 = c_2 = ... = c_n = 0$ is rejected against

H1: $c_j \neq 0, j = 1....r$

Thirdly, if the data are I (1) but not co integrated valid Granger type tests require transformation to make them I (0). So, in this case the equations become

$$\Delta LITi_t = a + \sum_{p=1}^{m} b_i \Delta LITi_{(t-p)} + \sum_{j=1}^{n} c_j \Delta LGDPi_{(t-j)} + \varepsilon_t \text{-------------------------} 20$$

$$\Delta GDPi_t = \alpha + \sum_{p=1}^{q} \beta_i \Delta GDPi_{(t-p)} + \sum_{j=1}^{r} \gamma_j \Delta LITi_{(t-j)} + u \text{------------------------}21$$

The optimum lag length q, r, m and n are determined by the basis of Schwarz Bayesian Criterion (SBC).

Here, $\Delta\ LGDPi$ Granger Cause $\Delta\ LITi$ if,

H_0: $c_1 = c_2 = ... = c_n = 0$ is rejected against

H_1: $c_j \neq 0, j = 1....n$

$\Delta\ LITi$ Granger causes (GC) $\Delta\ LGDPi$ if

Ho: $\gamma_1 = \gamma_2 = ... = \gamma_n = 0$ is rejected against

H_1: $\gamma_j \neq 0, j = 1....r$ (at least one is not equal to 0)

This test will help to determine whether there is any influence of $LITi$ on $LGDP_i$, or vice versa. As noted above, all figures of imports and exports have been taken from the United Nations Energy Statistics.

Empirical Results and Analysis

Table 2: Results of unit root test for oil exporting countries

Supplier Country/ /region	LIT_i (level)	(p) Value	$LGDP_i$ (Level)	(p) Value	LIT_i (1st diff.)	(p) Value	$LGDP_i$ (1st diff)	(p) Value
Saudi Arabia (with intercept)	-2.628	0.10	-0.733	0.82	-2.383	0.15	-2.2279	0.18
Saudi Arabia (with trend and intercept)	-2.961	0.18	-1.209	0.88	-4.761	0.00	-4.3500	0.01
Iran (with intercept)	-2.504	0.12	-0.286	0.91	-6.224	0.00	-4.0100	0.00
Iran (with trend and intercept)	-3.136	0.11	-0.439	0.98	-5.126	0.00	-4.4700	0.00
UAE (with intercept)	-0.650	0.84	-1.192	0.99	-3.275	0.02	-2.8560	0.06
UAE (with intercept and trend)	-2.322	0.49	-0.071	0.99	-3.728	0.02	-5.1380	0.00
Kuwait (with intercept)	-2.570	0.15	-0.013	0.94	-6.158	0.00	-4.5630	0.00
Kuwait (with trend and intercept)	-2.641	0.24	-1.656	0.74	-5.992	0.00	-5.2930	0.00
Iraq (with intercept)	-1.189	0.36	-1.004	0.73	-4.619	0.00	-4.9870	0.00
Iraq (with intercept and trend)	-1.889	0.63	-1.850	0.65	-4.518	0.00	-4.9880	0.00

Table 3: Johansen co-integration results of $LGDP_i$ and $LITi$ of the oil exporting countries

Cointegration	**Saudi Arabia**				
Trace	Eigenvalue	Trace-Stat	Critical val	p value	Results
None	0.606	26.907	15.494	0.00	Reject null hypothesis
Atmost 1	0.061	1.709	3.841	0.19	Accept null hypothesis
Maximum Eigenvalue	Eigenvalue	Max-Eigen	Critical val	p value	
None	0.606	25.198	14.264	0.00	Reject null hypothesis
Atmost 1	0.061	1.709	3.841	0.19	Accept null hypothesis
Cointegration	**Iran**				
Trace	Eigenvalue	Trace-Stat	Critical val	p value	Results
None	0.705	34.020	15.494	0.00	Reject null hypothesis
Atmost 1	0.038	1.046	3.841	0.30	Accept null hypothesis
Maximum Eigenvalue	Eigenvalue	Max-Eigen	Critical val	p value	
None	0.705	32.973	14.264	0.00	Reject null hypothesis
Atmost 1	0.038	1.046	3.841	0.30	Accept null hypothesis
Cointegration	**UAE**				
Trace	Eigenvalue	Trace-Stat	Critical val	p value	
None	0.542	20.529	15.494	0.00	Reject null hypothesis
Atmost 1	0.008	0.221	3.841	0.63	Accept null hypothesis
Maximum Eigenvalue	Eigenvalue	Max-Eigen	Critical val	p value	
None	0.542	20.308	14.264	0.00	Reject null hypothesis
Atmost 1	0.008	0.221	3.841	0.63	Accept null hypothesis
Cointegration	**Kuwait**				
Trace	Eigenvalue	Trace-Stat	Critical val	p value	
None	0.508	19.192	15.494	0.00	Reject null hypothesis
Atmost 1	0.001	0.033	3.841	0.63	Accept null hypothesis
Maximum Eigenvalue	Eigenvalue	Max-Eigen	Critical val	p value	
None	0.508	19.158	14.264	0.00	Reject null hypothesis
Atmost 1	0.001	0.033	3.841	0.85	Accept null hypothesis
Cointegration	**Iraq**				
Trace	Eigenvalue	Trace-Stat	Critical val	p value	
None	0.296	11.873	15.494	0.16	Accept null hypothesis
Atmost 1	0.084	2.386	3.841	0.12	Accept null hypothesis
Maximum Eigenvalue	Eigenvalue	Max-Eigen	Critical val	p value	
None	0.296	9.486	14.264	0.24	Accept null hypothesis
Atmost 1	0.084	3.386	3.841	0.12	Accept null hypothesis

Table 4: Granger causality test of $LGDP_i$ and $LITi$ of the oil exporting countries

Granger Causality	Country	Chi-Square	d.f.	Prob. (p)	Results
DLGDP-->DLIT	Saudi Arabia	15.605	3	0.00	Reject null hypothesis
DLIT-->DLGDP	Saudi Arabia	4.066	3	0.25	Accept null hypothesis
DLGDP-->DLIT	Iran	10.073	1	0.00	Reject null hypothesis
DLIT-->DLGDP	Iran	1.232	1	0.26	Accept null hypothesis
DLGDP-->DLIT	UAE	5.823	1	0.04	Reject null hypothesis
DLIT-->DLGDP	UAE	4.010	1	0.13	Accept null hypothesis
DLGDP-->DLIT	Kuwait	8.537	1	0.00	Reject null hypothesis
DLIT-->DLGDP	Kuwait	0.348	1	0.55	Accept null hypothesis
DLGDP-->DLIT	Iraq	0.226	2	0.89	Accept null hypothesis
DLIT-->DLGDP	Iraq	8.364	2	0.01	Reject null hypothesis

The direction of causal relationship between crude oil export quantity $LITi$ and per capita GDP, $LGDP_i$ can be classified into four types as a causal relation between energy consumption and economic growth has been classified as (Yoo, 2005; Jumbe, 2004, Mozumder and Marathe, 2007)[24 25 26]:

1. No causality between $LGDP_i$ and $LITi$ is referred to as 'neutrality hypothesis'. It and it implies that there is no relation between export quantity of crude oil and per capita GDP of the oil exporting country. This means that change in export quantity will not have any effect on the per capita GDP of the citizens of the oil exporting country as the case may be.
2. The uni-directional causality running from $LGDP_i$ to $LITi$ shows that policy to increase or decrease exports quantity may be implemented with little or no effect on the per capita GDP of the country. It may be called a 'conservative hypothesis'.
3. The uni-directional causality running from $LITi$ to $LGDP_i$ shows that policy to decrease exports quantity (ITi) may adversely affect per capita GDP (GDP_i) of the citizens of the country (i); whereas increase in quantity of ITi will contribute of the growth of per capita GDP (GDP_i). This is also called the 'growth hypothesis'.
4. Bi-directional causality between $LGDP_i$ and $LITi$ may also exist. This is called the 'feedback hypothesis'. It implies that crude oil exports quantity and per capita GDP are jointly determined and affected at the same time.

Results of Saudi Arabia Data (crude oil exporter)

Step 1: Unit Root Test

Null Hypotheses:

1. $H_0 : \alpha = 0$
2. $H_1 : \alpha < 0$

The individual series of the variable of (log) crude oil export quantity $LITi$ here (i) is the supplying country (Saudi Arabia) and (log) per capita GDP, $LGDP_i$ and is tested for stationarity by using the Augmented Dickey Fuller (ADF) test. Here, both the series are stationary at the first difference level, i.e., the series are I (1). The Tau (τ) value of $LITi$ and $LGDP_i$ with a trend and intercept are −4.761 and −4.150, respectively, from the ADF test, which is < than the ADF critical value (-ve) of t-statistics at 1%, 5% and 10%; hence, the null hypothesis of unit root was rejected for both the series. The results of ADF unit root tests are as given below:

Table 5: Augmented Dickey Fuller unit root test of Saudi Arabia (99% level of confidence)

Supplier Country/ /region	LIT_i (level)	(p) Value	$LGDP_i$ (Level)	(p) Value	LIT_i (1st diff.)	(p) Value	$LGDP_i$ (1st diff)	(p) Value
Saudi Arabia (with intercept)	-2.628	0.10	-0.733	0.82	-2.383	0.15	-2.227	0.18
Saudi Arabia (with trend and intercept)	-2.961	0.18	-1.209	0.88	-4.761	0.00	-4.350	0.01

Note: 99% critical value of ADF statistic with (trend and constant) is −4.3239

Step 2: Co-integration

Null Hypotheses:

Maximal Eigenvalue Test:

$$1. H_0 : r = 0, r \leq 1$$

$$2. H_1 : r = 1, r = 2$$

Trace Test:

$$1. H_0 : r = 0, r \leq 1$$

$$2. H_1 : r \geq 1, r = 2$$

Starting with the null hypothesis of no co-integration, among the variables, i.e. r=0, the maximal Eigenvalue statistic is 25.198, which is more than the 95% critical value of 14.264. Hence, the null hypothesis of r=0 is rejected at 5% level of significance. The rejection of the first null hypothesis means that there are (1) co-integrating vectors, i.e., (r = 1).

Similarly, in the Trace Test, the null hypothesis of no co-integration was rejected at 5% level of significance for the first hypothesis. Hence, both Eigenvalue and Trace Test indicate there is co-integration relationship between $LITi$ and $LGDP_i$. Therefore, short-run and long-run causality can be tested using a vector error correction model with the first difference of endogenous variables $LITi$ and $LGDP_i$. While estimating the Eigen and

Trace statistic values of the co-integration test, a linear deterministic trend was assumed. The Johansen co-integration test and null hypotheses tests results are as follows:

Table 6: Johansen co-integration test (Saudi Arabia)

Co-integration	Saudi Arabia				
Trace	Eigenvalue	Trace-Stat	Critical val	p value	Results
None	0.606	26.907	15.494	0.00	Reject null hypothesis
At most 1	0.061	1.709	3.841	0.19	Accept null hypothesis
Maximum Eigenvalue	Eigenvalue	Max-Eigen	Critical val	p value	
None	0.606	25.198	14.264	0.00	Reject null hypothesis
At most 1	0.061	1.709	3.841	0.19	Accept null hypothesis

Step 3: VECM

The co-integrated bivariate system $LITi$and $LGDP_i$ can be modelled as a VECM. On the basis of Schwarz Bayesian Criteria (SBC), the optimal lag order of the VAR is chosen as 3. The test results show that the t-statistics of the coefficients of the lagged variables $LITi$ and $LGDP_i$ in VECM model are statistically significant (with proper sign) when $LITi$is the dependent variable. The estimated output from VECM is given below:

Table 7: Vector Error Correction Estimates (Saudi Arabia)

Standard errors in ( ) & t-statistics in [ ] Estimated Output from VECM (Saudi Arabia)		
Cointegrating Eq:	CointEq1	
LGDP (-1)	1.000000	
LIT (-1)	1.104348	
	(0.23059)	
	[4.78917]	
C	-15.20802	
Error Correction:	D (LGDP)	D (LIT)
CointEq1	0.049262	-0.529135
	(0.09407)	(0.11565)
	[0.52366]	[-4.57521]

The ECT term shows that there exists long-run causality between $LITi$and $LGDP_i$, with causality flowing from $\Delta LGDP_i$ to $\Delta LITi$.

VAR Model (Saudi Arabia):

================================

D(GDP) = A(1,1)*(B(1,1)*GDP(-1) + B(1,2)*IT(-1) + B(1,3)) + C(1,1)*D(GDP(-1)) + C(1,2)*D(GDP(-2)) + C(1,3)*D(GDP(-3)) + C(1,4)*D(IT(-1)) + C(1,5)*D(IT(-2)) + C(1,6)*D(IT(-3)) + C(1,7)

D(IT) = A(2,1)*(B(1,1)*GDP(-1) + B(1,2)*IT(-1) + B(1,3)) + C(2,1)*D(GDP(-1)) + C(2,2)*D(GDP(-2)) + C(2,3)*D(GDP(-3)) + C(2,4)*D(IT(-1)) + C(2,5)*D(IT(-2)) + C(2,6)*D(IT(-3)) + C(2,7)

VAR Model - Substituted Coefficients:

==============================

D(GDP) = 0.0492620939244*(GDP(-1) + 1.1043476857*IT(-1) - 15.208016466) + 0.480315768801*D(GDP(-1)) - 0.478250740086*D(GDP(-2)) + 0.314651656217*D(GDP(-3)) + 0.225703817707*D(IT(-1)) + 0.165732482689*D(IT(-2)) - 0.0482934072462*D(IT(-3)) + 0.0175489353031

D(IT) = - 0.529135096007*(GDP(-1) + 1.1043476857*IT(-1) - 15.208016466) + 1.36407176227*D(GDP(-1)) + 0.681047105792*D(GDP(-2)) + 0.989116572726*D(GDP(-3)) - 0.427549277354*D(IT(-1)) - 0.111115372799*D(IT(-2)) - 0.0757685910839*D(IT(-3)) + 0.0350210839529

Step 4: Granger Causality Test:

Null Hypotheses:

$H_0 : \gamma_i = \psi i$ for all i's
$H_1 : \gamma i \neq 0$ and $\psi i \neq 0$ for at least some i's

1. $\Delta LGDP_i$ Does not cause $\Delta LITi$
2. $\Delta LITi \, \Delta LIT$ Does not cause $\Delta LGDP_i$

From the co-integration process, we have come to know that r=1, in such a case, the VEC model can be run with the first difference operator of the variables $\Delta LITi$ and $LGDP_i$. The Granger causality to test for short-term dynamics of the bivariate VECM model has been examined. In the non-causality of per capita GDP, $\Delta LGDP_i$ in the total imports/exports of crude oil $\Delta LITi$ equation, the observed LR statistics (which follows Chi-square distribution with 3 degree of freedom) 15.603 is found to be statistically significant. While testing the non-causality of import/export quantity of crude $\Delta LITi$ in per capita GDP, $\Delta LGDP_i$ equation, the Chi-square variate, with three degrees of freedom is 4.066, which is statistically insignificant. The 1[st] hypothesis of $\Delta LGDP_i$ does not cause $\Delta LITi$ and can be rejected; however the second hypothesis of $\Delta LITi$ that does not cause $\Delta LGDP_i$ cannot be rejected. This proves that there is unidirectional causality flowing from $\Delta LGDP_i$ to $\Delta LITi$. The results of the Granger causality test are given below:

Table 8: Granger causality test (Saudi Arabia)

Granger Causality	Country	Chi-Square	d.f.	Prob (p)	Results
DLGDPi-->DLITi	Saudi Arabia	15.605	3	0.00	Reject null hypothesis
DLITi-->DLGDPi	Saudi Arabia	4.066	3	0.25	Accept null hypothesis

Step 5: Residual Testing

The test for normality of the residual did not give any significant evidence of departures from standard assumptions.

Results of Iran Data (crude oil exporter)

Step 1: Unit Root Test

Null Hypotheses:

$1. H_0 : \alpha = 0$

$2. H_1 : \alpha < 0$

The individual series of the variable of (log) crude oil export quantity $LITi$ here (i) is the supplying country (Iran) and (log) per capita GDP, $LGDP_i$ are tested for stationarity by using the Augmented Dickey Fuller (ADF) test. Here, both the series are stationary at the first difference level, i.e., the series are I (1). The Tau (τ) value of $LITi$ and $LGDP_i$ with a trend and intercept are –5.126 and –4.470, respectively, from the ADF test, which is < than the ADF critical value (-ve) of t-statistics at 1%, 5% and 10%; hence, the null hypothesis of unit root was rejected for both the series. The results of ADF unit root tests are given below:

Table 9: Augmented Dickey Fuller unit root test of Iran (99% level of confidence)

Supplier Country/ /region	LITi (level)	(p) Value	$LGDP_i$ (Level)	(p) Value	LITi (1st diff.)	(p) Value	$LGDP_i$ (1st diff)	(p) Value
Iran (with intercept)	-2.504	0.12	-0.286	0.91	-6.224	0.00	-4.010	0.00
Iran (with trend and intercept)	-3.136	0.11	-0.439	0.98	-5.126	0.00	-4.470	0.00

Note: 99% critical value of ADF statistic with (trend and constant) is –4.3393

Step 2: Co-integration

Null Hypotheses:

Maximal Eigenvalue Test:

$1. H_0 : r = 0, r \leq 1$

$2. H_1 : r = 1, r = 2$

Trace Test:

$1. H_0 : r = 0, r \leq 1$

$2. H_1 : r \geq 1, r = 2$

Starting with the null hypothesis of no co-integration, among the variables, i.e., r=0, the maximal Eigenvalue statistic is 32.973, which is more than the 95% critical value of 14.264. Hence the null hypothesis of r=0 is rejected at 5 per cent level of significance. The rejection of the first null hypothesis means that there are (1) co-integrating vectors, i.e. (r = 1).

Similarly, in the Trace Test, the null hypothesis of no co-integration was rejected at 5% level of significance for the first hypothesis. Hence, both Eigenvalue and Trace Test indicate there is co-integration relationship between $LITi$ and $LGDP_i$. Therefore, short-run and long-run causality can be tested using a vector error correction model with the first difference of endogenous variables $LITi$ and $LGDP_i$. While estimating the Eigen and Trace statistic values of the co-integration test, a linear deterministic trend was assumed. The Johansen co-integration test and null hypotheses tests results are as follows:

Table 10: Johansen co-integration test (Iran)

Co-integration	Iran				
Trace	Eigenvalue	Trace-Stat	Critical val	p value	Results
None	0.705	34.020	15.494	0.00	Reject null hypothesis

At most 1	0.038	1.046	3.841	0.30	Accept null hypothesis
Maximum Eigenvalue	Eigenvalue	Max-Eigen	Critical val	p value	
None	0.705	32.973	14.264	0.00	Reject null hypothesis
At most 1	0.038	1.046	3.841	0.30	Accept null hypothesis

Step 3: VECM

Null Hypothesis:

1. $\Delta LGDP_i$ Does not cause $\Delta LITi$
2. $\Delta LITi$ Does not cause $\Delta LGDP_i$

The co-integrated bivariate system $LITi$ and $LGDP_i$ can be modelled as a VECM. On the basis of Schwarz Bayesian Criteria (SBC), the optimal lag order of the VAR is chosen as 1. The test results show that the t-statistics of the coefficients of the lagged variables $LITi$ and $LGDP_i$ in VECM model are statistically significant (with proper sign) when LIT_i is the dependent variable. The ECT term shows that there exists long run causality between $LITi$ and $LGDP_i$, flowing from $\Delta LGDP_i$ to $LITi$. The estimated output from VECM is given below:

Table 11: Vector Error Correction Estimates (Iran)

Standard errors in ( ) & t-statistics in [ ] Estimated Output from VECM (Iran)		
Cointegrating Eq:	CointEq1	
IT (-1)	1.000000	
GDP (-1)	0.273688	
	(0.12601)	
	[2.17195]	

C	-6.683933	
Error Correction:	D (IT)	D (GDP)
CointEq1	-0.579047	-0.011550
	(0.08975)	(0.15276)
	[-6.45145]	[-0.07561]

VAR Model (Iran):

===============================

D (IT) = A (1,1)*(B(1,1)*IT(-1) + B(1,2)*GDP(-1) + B(1,3)) + C(1,1)*D(IT(-1)) + C(1,2)*D(GDP(-1)) + C(1,3)

D (GDP) = A (2,1)*(B(1,1)*IT(-1) + B(1,2)*GDP(-1) + B(1,3)) + C(2,1)*D(IT(-1)) + C(2,2)*D(GDP(-1)) + C(2,3)

VAR Model - Substituted Coefficients:

===============================

D (IT) = - 0.579046513218*(IT (-1)) + 0.273688068532*GDP(-1) - 6.68393285076) - 0.0588856266335*D(IT(-1)) + 0.435393249023*D(GDP(-1)) + 0.031817107843

D (GDP) = - 0.0115498953979*(IT (-1))+ 0.273688068532*GDP (-1) - 6.68393285076) + 0.250623471454*D(IT(-1)) + 0.13571369322*D(GDP(-1)) + 0.0132256245584

Step 4: Granger Causality Test:

Null Hypotheses:

$H_0 : \gamma_i = \psi i$ for all i's

$H_1 : \gamma i \neq 0$ and $\psi i \neq 0$ for at least some i's

1. $\Delta LGDP_i$ Does not cause $\Delta LITi$
2. $\Delta LITi$ Does not cause $\Delta LGDP_i$

From the co-integration process, we have come to know that r=1, in such a case, the VEC model can be run with the first difference operator of the variables $LITi$ and $LGDP_i$. Granger causality test for short-term dynamics of the bivariate VECM model has been examined. While testing the non-causality of per capita GDP, $\Delta LGDP_i$ in the total exports of crude oil $\Delta LITi$ equation, the observed LR statistics (which follows Chi-square distribution with 1 degree of freedom) 10.073 is found to be statistically significant. While testing the non-causality of export quantity of crude $\Delta LITi$ in per capita GDP, $\Delta LGDP_i$ equation, the Chi-square variate, with 1 degree of freedom, is 1.232, which is statistically insignificant. The 1st hypothesis of $\Delta LGDP_i$ does not cause $\Delta LITi$ can be rejected; however, the second hypothesis that $\Delta LITi$ does not cause $\Delta LGDP_i$ cannot be rejected. This proves that in there is unidirectional causality flowing from $\Delta LGDP_i$ to $\Delta LITi$. The results of the Granger causality test are given below:

Table 12: Granger causality test (Iran)

Granger Causality	Country	Chi-Square	d.f.	Prob (p)	Results
DLGDPi-->DLITi	Iran	10.073	1	0.00	Reject null hypothesis
DLITi-->DLGDPi	Iran	1.232	1	0.26	Accept null hypothesis

Step 5: Residual Testing

The test for normality of the residual did not give any significant evidence of departures from standard assumptions.

Results of United Arab Emirates Data (crude oil exporter)

Step 1: Unit Root Test

Null Hypotheses:

1. $H_0 : \alpha = 0$

2. $H_1 : \alpha < 0$

The individual series of the variable of (log) crude oil export quantity $LITi$ here (i) is the supplying country (UAE) and (log) per capita GDP, $LGDP_i$ are tested for stationarity by using the Augmented Dickey Fuller (ADF) test. Here, both the series are stationary at the first difference level, i.e., the series are I (1). The Tau (τ) value of $LITi$ and $LGDP_i$, with a trend and intercept are −4.761 and −4.150, respectively, from the ADF test, which is < than the ADF critical value (-ve) of t-statistics at 1%, 5% and 10%; hence, the null hypothesis of unit root was rejected for both the series. The results of ADF unit root tests are as given below:

Table 13: Augmented Dickey Fuller unit root test of UAE (99% level of confidence)

Supplier Country/ /region	LIT_i (level)	(p) Value	$LGDP_i$ (Level)	(p) Value	LIT_i (1st diff.)	(p) Value	$LGDP_i$ (1st diff)	(p) Value
UAE (with intercept)	-0.650	0.84	-1.192	0.99	-3.275	0.02	-2.8560	0.06
UAE (with intercept and trend)	-2.322	0.49	-0.071	0.99	-3.728	0.02	-5.1380	0.00

Note: 95% critical value of ADF statistic with (constant) is –3.6999 and –4.3393 with (trend and constant)

Step 2: Co-integration

Null Hypotheses:

Maximal Eigenvalue Test:

1. $H_0 : r = 0, r \leq 1$

2. $H_1 : r = 1, r = 2$

Trace Test:

1. $H_0 : r = 0, r \leq 1$

2. $H_1 : r \geq 1, r = 2$

Starting with the null hypothesis of no co-integration, among the variables, i.e. r=0, the maximal Eigenvalue statistic is 20.308, which is more than the 95 per cent critical value of 15.494. Hence, the null hypothesis of r=0 is rejected at 5 per cent level of significance. The acceptance of the first null hypothesis means that there is (1) cointegrating vectors, i.e. (r = 1).

Similarly, in the Trace Test, the null hypothesis of no co-integration was rejected at 5 per cent level of significance for the first hypothesis. Hence, both Eigenvalue and Trace Test indicate there is co-integration relationship between $LITi$ and $LGDP_i$. Therefore, short-run and long run causality can be tested using a vector error correction model, with the first difference of endogenous variables $LITi$ and $LGDP_i$. While estimating the Eigen and Trace statistic values of the co-integration test, a linear deterministic trend was assumed. The Johansen co-integration test and null hypotheses tests results are as follows:

Table 14: Johansen co-integration test (UAE)

Co-integration	UAE				
Trace	Eigenvalue	Trace-Stat	Critical val	p value	
None	0.542	20.529	15.494	0.00	Reject null hypothesis

At most 1	0.008	0.221	3.841	0.63	Accept null hypothesis
Maximum Eigenvalue	Eigenvalue	Max-Eigen	Critical val	p value	
None	0.542	20.308	14.264	0.00	Reject null hypothesis
At most 1	0.008	0.221	3.841	0.63	Accept null hypothesis

Step 4: VECM

Null Hypothesis:

1. $\Delta LGDP_i$ Does not cause $\Delta LITi$
2. $\Delta LITi$ Does not cause $\Delta LGDP_i$

The co-integrated bivariate system $LITi$ and $LGDP_i$ can be modelled as a VECM. On the basis of Schwarz Bayesian Criteria (SBC), the optimal lag order of the VAR is chosen as 1. The test results show that the t-statistics of the coefficients of the lagged variables $LITi$ and $LGDP_i$ in VECM model are statistically significant (with proper sign) when LIT_i is the dependent variable. The ECT term shows that there exists long-run causality between $LITi$ and $LGDP_i$, with causality flowing from $\Delta LGDP_i$ to $\Delta LITi$. The estimated output from VECM is given below:

Table 15: Vector Error Correction Estimates (UAE)

Standard errors in ( ) & t-statistics in [ ] Estimated Output from VECM (UAE)		
Cointegrating Eq:	CointEq1	
IT (-1)	1.000000	
GDP (-1)	0.400092	
	(0.14688)	
	[2.72398]	
C	-8.371412	
Error Correction:	D(IT)	D(GDP)

CointEq1	-0.246943	0.354330
	(0.09108)	(0.14384)
	[-2.71113]	[2.46342]

VAR Model (UAE):

===============================

D(IT) = A(1,1)*(B(1,1)*IT(-1) + B(1,2)*GDP(-1) + B(1,3)) + C(1,1)*D(IT(-1)) + C(1,2)*D(IT(-2)) + C(1,3)*D(GDP(-1)) + C(1,4)*D(GDP(-2)) + C(1,5)

D(GDP) = A(2,1)*(B(1,1)*IT(-1) + B(1,2)*GDP(-1) + B(1,3)) + C(2,1)*D(IT(-1)) + C(2,2)*D(IT(-2)) + C(2,3)*D(GDP(-1)) + C(2,4)*D(GDP(-2)) + C(2,5)

VAR Model - Substituted Coefficients:

===============================

D(IT) = - 0.246942689164*(IT(-1) + 0.40009232628*GDP(-1) - 8.37141222051) + 0.237456028707*D(IT(-1)) + 0.141099449833*D(IT(-2)) + 0.299600672564*D(GDP(-1)) + 0.221129410619*D(GDP(-2)) + 0.0110961012357

D (GDP) = 0.354329536506*(IT (-1) + 0.40009232628*GDP (-1) - 8.37141222051) + 0.34307446101*D(IT(-1)) - 0.0302273172826*D(IT(-2)) - 0.0684999978428*D(GDP(-1)) - 0.308774982829*D(GDP(-2)) + 0.0303107561658

Step4: Granger Causality Test:

Null Hypotheses:

$H_0 : \gamma_i = \psi i$ for all i's
$H_1 : \gamma i \neq 0$ and $\psi i \neq 0$ for at least some i's

1. $\Delta LGDP_i$ Does not cause $\Delta LITi$

2. $\Delta LITi$ Does not cause $\Delta LGDP_i$

From the co-integration process, we have come to know that r=1, in such a case, the VEC model can be run with the first difference operator of the variables $LITi$ and $LGDP_i$. Granger causality test for short-term dynamics of the bivariate VECM model has been examined. In the non-causality of per capita GDP, $\Delta LGDP_i$ in the total imports/exports of crude oil $\Delta LITi$ equation, the observed LR statistics (which follows Chi-square distribution with 1 degree of freedom) 4.010 is found to be statistically insignificant. While testing the non-causality of export quantity of crude $\Delta LITi$ in per capita GDP, $\Delta LGDP_i$ equation, the Chi-square variate, with 1 degree of freedom, is 5.823, which is statistically significant. The 1st hypothesis of $\Delta LGDP_i$ does not cause $LITi$ can be rejected; however, the second hypothesis of $\Delta LITi$ does not cause $\Delta LGDP_i$ cannot be rejected. This proves that in there is unidirectional causality flowing from $\Delta LGDP_i$ to $\Delta LITi$. The results of the Granger causality test are given below:

Table 16: Granger causality test (UAE)

Granger Causality	Country	Chi-Square	d.f.	Prob (p)	Results
DLGDPi-->DLITi	UAE	5.823	1	0.04	Reject null hypothesis
DLITi-->DLGDPi	UAE	4.010	1	0.13	Accept null hypothesis

Step 5: Residual Testing

The test for normality of the residual did not give any significant evidence of departures from standard assumptions.

Results of Kuwait Data (crude oil exporter)

Step 1: Unit Root Test

Null Hypotheses:

1. $H_0 : \alpha = 0$
2. $H_1 : \alpha < 0$

The individual series of the variable of (log) crude oil export quantity $LITi$ here (i) is the supplying country (Kuwait) and (log) per capita GDP, $LGDP_i$ are tested for stationarity by using the Augmented Dickey Fuller (ADF) test. Here, both the series are stationary at the first difference level, i.e., the series are I (1). The Tau (τ) value of $LITi$ and $LGDP_i$ with a trend and intercept are –5.992 and –5.293, respectively, from the ADF test, which is < than the ADF critical value (-ve) of t-statistics at 1%, 5% and 10%; hence, the null hypothesis of unit root was rejected for both the series. The results of ADF unit root tests are as given below:

Table 17: Augmented Dickey Fuller unit root test of Kuwait (99% level of confidence)

Supplier Country/ /region	LIT_i (level)	(p) Value	$LGDP_i$ (Level)	(p) Value	LIT_i (1st diff.)	(p) Value	$LGDP_i$ (1st diff)	(p) Value
Kuwait (with intercept)	-2.570	0.15	-0.013	0.94	-6.158	0.00	-4.563	0.00
Kuwait (with trend and intercept)	-2.641	0.24	-1.656	0.74	-5.992	0.00	-5.293	0.00

Note: 99% critical value of ADF statistic with (trend and constant) is –4.3560

Step 2: Co-integration

Null Hypotheses:

Maximal Eigenvalue Test:

$$1. H_0 : r = 0, r \leq 1$$
$$2. H_1 : r = 1, r = 2$$

Trace Test:

$$1. H_0 : r = 0, r \leq 1$$
$$2. H_1 : r \geq 1, r = 2$$

Starting with the null hypothesis of no co-integration, among the variable i.e. r=0, the maximal eigenvalue statistic is 19.158, which is more than the 95% critical value of 15.494. Hence the null hypothesis of r=0 is rejected at 5% level of significance. The acceptance of the first null hypothesis means that there is one (1) cointegrating vector i.e. (r = 1).

Similarly, in the Trace Test, the null hypothesis of no co-integration was rejected at 5% level of significance for the first hypothesis. Hence, both Eigenvalue and Trace Test indicate there is co-integration relationship between $LITi$ and $LGDP_i$. Therefore, short-run and long run causality can be tested using a vector error correction model with the first difference of endogenous variables $LITi$ and $LGDP_i$. While estimating the Eigen and Trace statistic values of the co-integration test, a linear deterministic trend was assumed. The Johansen co-integration test and null hypotheses tests results are as follows:

Table 18: Johansen co-integration test (Kuwait)

Co-integration	Kuwait				
Trace	Eigenvalue	Trace-Stat	Critical	p value	

			val		
None	0.508	19.192	15.494	0.00	Reject null hypothesis
At most 1	0.001	0.033	3.841	0.63	Accept null hypothesis
Maximum Eigenvalue	Eigenvalue	Max-Eigen	Critical val	p value	
None	0.508	19.158	14.264	0.00	Reject null hypothesis
At most 1	0.001	0.033	3.841	0.85	Accept null hypothesis

Step 3: VECM

Null Hypothesis:

1. $\Delta LGDP_i$ Does not cause $\Delta LITi$
2. $\Delta LITi$ Does not cause $\Delta LGDP_i$

The co-integrated bivariate system $LITi$ and $LGDP_i$ can be modelled as a VECM. On the basis of Schwarz Bayesian Criteria (SBC), the optimal lag order of the VAR is chosen as 1. The test results show that the t-statistics of the coefficients of the lagged variables $LITi$ and $LGDP_i$ in VECM model are statistically significant (with proper sign) when $LITi$ is the dependent variable. The ECT term shows that there exists long-run causality between $LITi$ and $LGDP_i$, with causality flowing from $\Delta LGDP_i$ to $\Delta LITi$. The estimated output from VECM is given below:

Table 19: Vector Error Correction Estimates (Kuwait)

Standard errors in ( ) & t-statistics in [ ] Estimated Output from VECM (Kuwait)		
Co-integrating Eq:	CointEq1	
IT(-1)	1.000000	
GDP(-1)	-0.267124	
	(0.20942)	
	[-1.27555]	

C	-1.222834	
Error Correction:	D(IT)	D(GDP)
CointEq1	-0.808039	-0.080735
	(0.22413)	(0.12180)
	[-3.60529]	[-0.66285]

VAR Model (Kuwait):

===============================

D(IT) = A(1,1)*(B(1,1)*IT(-1) + B(1,2)*GDP(-1) + B(1,3)) + C(1,1)*D(IT(-1)) + C(1,2)*D(GDP(-1)) + C(1,3)

D(GDP) = A(2,1)*(B(1,1)*IT(-1) + B(1,2)*GDP(-1) + B(1,3)) + C(2,1)*D(IT(-1)) + C(2,2)*D(GDP(-1)) + C(2,3)

VAR Model - Substituted Coefficients:

===============================

D(IT) = - 0.808038975607*(IT(-1) - 0.26712446871*GDP(-1) - 1.22283402769) - 0.299752142864*D(IT(-1)) + 1.60963224585*D(GDP(-1)) - 0.00869233869183

D(GDP) = - 0.0807349746353*(IT(-1) - 0.26712446871*GDP(-1) - 1.22283402769) - 0.0719670403986*D(IT(-1)) + 0.313113643134*D(GDP(-1)) + 0.0323194821871

Step4: Granger Causality Test:

Null Hypotheses:

$H_0 : \gamma_i = \psi i$ for all i's

$H_1 : \gamma i \neq 0$ and $\psi i \neq 0$ for at least some i's

1. $\Delta LGDP_i$ Does not cause $\Delta LITi$
2. $\Delta LITi$ Does not cause $\Delta LGDP_i$

From the co-integration process, we have come to know that r=1, in such a case, the VEC model can be run with the first difference operator of the variables $LITi$ and $LGDP_i$. The Granger causality test for short-term dynamics of the bivariate VECM model has been examined. In the non-causality of per capita GDP, $\Delta LGDP_i$ in the total imports/exports of crude oil $\Delta LITi$ equation, the observed LR statistics (which follows Chi-square distribution with 1 degree of freedom) 8.537 is found to be statistically significant. While testing the non-causality of import/export quantity of crude $\Delta LITi$ in per capita GDP, $\Delta LGDP_i$ equation, the Chi-square variate, with 1 degree of freedom, is 0.348, which is statistically insignificant. The 1st hypothesis of $\Delta LGDP_i$ does not cause $\Delta LITi$ can be rejected; however, the second hypothesis of $\Delta LITi$ does not cause $\Delta LGDP_i$ and cannot be rejected. This proves that there is unidirectional causality flowing from $\Delta LGDP_i$ to $\Delta LITi$. The results of the Granger causality test are given below:

Table 20: Granger causality test (Kuwait)

Granger Causality	Country	Chi-Square	d.f.	Prob (p)	Results
DLGDPi-->DLITi	Kuwait	8.537	1	0.00	Reject null hypothesis
DLITi-->DLGDPi	Kuwait	0.348	1	0.55	Accept null hypothesis

Step 5: Residual Testing

The test for normality of the residual did not give any significant evidence of departures from standard assumptions.

Results of Iraq Data (crude oil exporter)

Step 1: Unit Root Test

Null Hypotheses:

1.$H_0 : \alpha = 0$

2.$H_1 : \alpha < 0$

The individual series of the variable of (log) crude oil export quantity $LITi$ here (i) is the supplying country (Iraq) and (log) per capita GDP, $LGDP_i$ are tested for stationarity by using the Augmented Dickey Fuller (ADF) test. Here, both the series are stationary at the first difference level, i.e., the series are I (1). The Tau (τ) value of $LGDP_i$ with a trend and intercept are −4.518 and −4.988, respectively, from the ADF test, which is < than the ADF critical value (-ve) of t-statistics at 1%, 5% and 10%; hence, the null hypothesis of unit root was rejected for both the series. The results of ADF unit root tests are as given below:

Table 21: Augmented Dickey Fuller unit root test of Iraq (99% level of confidence)

Supplier Country/ /region	LITi (level)	(p) Value	$LGDP_i$ (Level)	(p) Value	LITi (1st diff.)	(p) Value	$LGDP_i$ (1st diff)	(p) Value
Iraq (with intercept)	-1.189	0.36	-1.004	0.73	-4.619	0.00	-4.987	0.00
Iraq (with intercept and trend)	-1.889	0.63	-1.850	0.65	-4.518	0.00	-4.988	0.00

Note: 99% critical value of ADF statistic with (trend and constant) is –4.3560

Step 2: Co-integration

Null Hypotheses:

Maximal Eigenvalue Test:

$1. H_0 : r = 0, r \le 1$

$2. H_1 : r = 1, r = 2$

Trace Test:

$1. H_0 : r = 0, r \le 1$

$2. H_1 : r \ge 1, r = 2$

Starting with the null hypothesis of no co-integration, among the variables, i.e. r=0, the maximal Eigenvalue statistic is 9.486, which is more than the 95% critical value of 15.494. Hence, the null hypothesis of r=0 is rejected at 5% level of significance. The acceptance of the first null hypothesis means that there is (1) co-integrating vectors, i.e., (r = 1).

Similarly, in the Trace Test, the null hypothesis of no co-integration was rejected at 5% level of significance for the first hypothesis. Hence, both Eigenvalue and Trace Test indicate there is no co-integration relationship between $LITi$ and $LGDP_i$. Therefore, short-run and long-run causality can be tested using an unrestricted VAR model with the first difference operator of endogenous variables $LITi$ and $LGDP_i$. While estimating the Eigen and Trace statistic values of the co-integration test, a linear deterministic trend was assumed. The Johansen co-integration test and null hypotheses tests results are as follows:

Table 22: Johansen co-integration test (Iraq)

Co-integration	Iraq				
Trace	Eigenvalue	Trace-Stat	Critical val	p value	
None	0.296	11.873	15.494	0.16	Accept null hypothesis

At most 1	0.084	2.386	3.841	0.12	Accept null hypothesis
Maximum Eigenvalue	Eigenvalue	Max-Eigen	Critical val	p value	
None	0.296	9.486	14.264	0.24	Accept null hypothesis
At most 1	0.084	3.386	3.841	0.12	Accept null hypothesis

Step4: VAR Model

The co-integrated bivariate system *LITi* and *LGDPi* can be modelled as an unrestricted VAR. On the basis of Schwarz Bayesian Criteria (SBC), the optimal lag order of the VAR is chosen as 2. The estimated output from VAR is given below:

Table 23: Vector Auto regression Estimates of Iraq

Standard errors in ( ) & t-statistics in [ ]		
Estimated Output from VECM (Iraq)		
	DGDP	DIT
DGDP(-1)	-0.055252	0.121318
	(0.20294)	(0.93545)
	[-0.27226]	[0.12969]
DGDP(-2)	-0.173735	0.432568
	(0.20283)	(0.93494)
	[-0.85657]	[0.46267]
DIT(-1)	0.011681	0.119682
	(0.05157)	(0.23772)
	[0.22651]	[0.50346]
DIT(-2)	0.143178	-0.024186
	(0.05009)	(0.23087)
	[2.85868]	[-0.10476]
C	0.038662	0.013388
	(0.04075)	(0.18786)

	[0.94864]	[0.07127]
R-squared	0.289971	0.029970
Adj. R-squared	0.154728	-0.154798

Step 4: Granger Causality Test:

Null Hypotheses:

$H_0 : \gamma_i = \psi i$ for all i's

$H_1 : \gamma i \neq 0$ and $\psi i \neq 0$ for at least some i's

1. $\Delta LGDP_i$ Does not cause $\Delta LITi$
2. $\Delta LITi$ Does not cause $\Delta LGDP_i$

From the co-integration process, we have come to know that r=0, in such a case, the VAR model can be run with the first difference operator of the variables $LITi$ and $LGDP_i$. The Granger causality test for short-term dynamics of the bivariate VAR model has been examined. In the non-causality of per capita GDP, $\Delta LGDP_i$ in the total imports/exports of crude oil $\Delta LITi$ equation, the observed LR statistics (which follows Chi-square distribution with 2 degree of freedom) 0.226 is found to be statistically not significant. While testing the non-causality of import/export quantity of crude ΔLIT_i in per capita GDP, $\Delta LGDP_i$ equation, the Chi-square variate, with 2 degree of freedom, is 8.364, which is statistically significant. The 1st hypothesis of $\Delta LGDP_i$ does not cause ΔLIT cannot be rejected; however, the second hypothesis of $\Delta LITi$ does not cause $\Delta LGDP_i$ can be rejected. This proves that there is unidirectional causality flowing from $\Delta LITi$ to $\Delta LGDP_i$. The results of the Granger causality test are given below:

Table 24: Granger causality test (Iraq)

Granger Causality	Country	Chi-Square	d.f.	Prob (p)	Results
DLGDPi-->DLITi	Iraq	0.226	2	0.89	Accept null hypothesis
DLITi-->DLGDPi	Iraq	8.364	2	0.01	Reject null hypothesis

Step5: Residual testing

The test for normality of the residual did not give any significant evidence of departures from standard assumptions.

Table 25: Summary results of causal relationship between IT_i and GDP_i between various oil importers and exporters

	Number	Assumptions	Results
Hypotheses	**A**	**Saudi Arabia:** The total crude oil export quantity ($IT_{\text{Saudi Arabia}}$) of Saudi Arabia influences the per capita GDP ($GDP_{\text{Saudi Arabia}}$) of the country.	Empirical test does not support the Hypothesis
	B	**Iran:** The total crude oil export quantity (IT_{Iran}) of Iran influences the per capita GDP (GDP_{Iran}) of the country.	Empirical test does not support the hypothesis
	C	**UAE:** The total crude oil export quantity (IT_{UAE}) of the UAE influences the per capita GDP (GDP_{UAE}) of the country.	Empirical test does not support the hypothesis
	D	**Iraq:** The total crude oil export quantity (IT_{Iraq}) influences the per capita GDP (GDP_{Iraq}) of the country.	Empirical test **supports the hypothesis** in the short-run
	E	**Kuwait:** The total crude oil export quantity (IT_{Kuwait}) influences the per capita GDP (GDP_{Kuwait}) of the country.	Empirical test does not support the hypothesis

Conclusion

It is observed that there is no long-term causality from $LITi$ (proxy for oil demand security from the exporter's perspective) to $LGDP_i$ (proxy for economic well-being or economic security) in the case of any of the top crude oil suppliers from MENA region i.e., Saudi Arabia, Kuwait, Iran, Iraq and UAE. However, short-term dynamics show causality running from $LITi$ to $LGDP_i$ in the case of Iraq. This indicates that in the long-run none of the oil exporting nations' per capita GDP or economic security is affected by the quantity of crude oil it exports, i.e., any reduction in crude oil exports will not adversely affect the per capita

GDP and hence no risk on economic well being from change in exports of oil in the long run. However, short-run dynamics show causality running from $LITi$ to $LGDP_i$ in the case of Iraq only.

According to a report published by the Arab Monetary Fund (AMF), in 2004 oil sector contributed 42%, 48%, 33% and 45% to the total GDP of Saudi Arabia, Kuwait, UAE and Iran. However, in case of Iraq oil sector contributes to more than 90% of the total GDP of the country, which partly explains the direction of the causality between $LITi$ and $LGDP_i$. Iraq is still heavily dependent on oil exports for economic development. Iraq's economy is dominated by the oil sector, 80% of the total foreign exchange earned comes from exports crude oil. According to a World Bank report in 2008, Iraq's non-oil economic activity remains very limited. However, on the contrary countries like Saudi Arabia, Kuwait, UAE and Iran have initiated huge investments for diversification of their economy, including tourism, financial services, education, and real estate, apart from petrochemicals. Consequently, the non-oil growth was about 6.5% a year from 2005 to 2008. Moreover, part of the revenues generated from oil exports by Saudi Arabia, Kuwait, UAE and Iran is transferred into the Sovereign Wealth Funds (SWF) of the respective countries for further investment in the domestic sectors and international markets. However, in case of Iraq though the Development Fund for Iraq (DFI) was created for investing in Iraqi, oil and non-oil development and reconstruction, the accountability of the spending is not very transparent and did not have the desired effect as in the other oil exporting countries considered in this research. Therefore, the short-term causality running from $LITi\text{-}>LGDP_i$ in case of Iraq, explains that the extend and effectiveness of the government spending and investments in non-oil sector has not been to an extend as seen in other oil exporting countries like Saudi Arabia, UAE, Kuwait and Iran in the short run. This has contributed to the dependence of economic well being of the Iraq on oil exports in the short run.

The absence of a causal relationship between the variable in the hypothesised direction is lacking for all the oil exporting countries in the long run because it is expected that even though the price of crude oil will remain high in the coming years, which will enable the oil exporting countries to generate high revenues instead of the global slowdown induced by the Euro-zone crisis, the non-oil GDP growth is expected to achieve an average of 4.5% in 2012, and will account for 75% of the GDP growth in 2013, in countries like Saudi Arabia, Kuwait and UAE. Therefore, in spite of high oil prices and higher revenues from oil exports, majority of the GDP growth will come from non-oil GDP growth in the MENA oil exporting countries. However, our empirical results fail to show causality between the variables in the hypothesised direction in the long run because all the oil exporting countries considered in this research has initiated major steps in augmenting non-oil investments in their countries so as to sustain a 6-7% GDP growth in real terms and sustain economic well being of its citizens even in case of fall of crude oil prices and dearth in demand for their available crude oil export quantity.

Notes

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