ARE STOCK PRICE BEHAVIOURS OF OPEC COUNTRIES INTERDEPENDENT?

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ABSTRACT

This paper explores the dependence of stock markets among selected OPEC members. It investigates the risk-return tradeoff and linear correlation among the stock returns. Then it explores the dependence and volatility spillover effect of the Nigerian stock market and other OPEC members. Utilizing the DCC(1,1)-GARCH(1,1) with monthly stock price indices of selected OPEC countries between January, 2005 to March, 2018, we observe that risk-return tradeoff did not hold for some country pairs. Strong correlation occurred between some pairs of countries' monthly annual stock returns. The stock market dependence of OPEC is time-varying and it is the case that a unidirectional dependence of Nigeria stock market on other OPEC members exists, except in Saudi Arabia where bidirectional dependence was observed. When innovations arising from any OPEC members in our study is positive (encouraging), the stock returns of Nigeria will improve. However, this positive spillover exists from all the countries except in Kuwait. Based on these results, it is recommended that Nigeria investors can purchase the stock of some OPEC countries except Saudi Arabia during the period of downturn in Nigeria. Also, the concerned authorizes such as the Securities and Exchange Commission, Nigeria Stock Exchange and the Federal Government should ensure that credible policies that will positively affect the stock market should be of highest priority.

Keywords: stock market, spillover, dynamic conditional correlation, generalized autoregressive conditional heteroskedasticity.

JEL Classification: G14, Q39, C14, C22

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1. Introduction

Stock market dependence is certainly not a new phenomenon in the financial literature. However, the debate on the nature and pattern of dependence is becoming more and more intense. The major debate centers on whether the dependence is linear, or nonlinear. A well-articulated seminal work of Makowitz (1958) demonstrated that the behaviour of one stock could affect the other and so, investors will do well by diversifying their portfolio in order to minimize risk. To do this effectively, they should be equipped with adequate information about the dependence of stock returns. Grubel (1968) further proposes that for investors to maximize profits, decision on portfolio diversification should not be based on within-country stock market butalso between-country stock market. This proposition is made stronger by the technological breakthrough in communication and telecommunication sector, which has made economies of the world, and particularly the capital markets more integrated. This development produces both good news and bad news. The good news is that investors now find it easy to invest in various markets across the world in order to hedge risk. The bad news is that due to possible interdependence among stock markets, the potential to diversify could be reduced owing to possible contagion effect of political instability or financial crisis in one country. The highly dependent stock markets of advanced countries led to near collapse of the global stock market during the recent global financial crisis. Further, if stock markets among countries are dependent, then any unexpected change in the stock market index at the international level could lead to market instability across other markets. Until date, received evidence point to the fact that capital market integration is increasing and the end is not in sight. The implication is that investors and policy makers must be equipped with the extent and nature of dependence of stock markets so as to enable them take appropriate decisions.

Researchers have utilized various methods to investigate the extent and pattern of between-country stock market dependence and have come up with diverse results. The first set of the methods was based on the assumption that the dependence is time-invariant. In this regard, linear correlation, extreme correlation, partial correlation and partial transfer entropy were employed (Junior et al, 2015). The second set of methods rely on the assumption of nonlinear dependence. The estimation techniques include vector autoregression (VAR), cointegration analysis (see Rehnaan and Hazazi, 2014),Granger causality (Bhunia and Yaman, 2017), Stochastic Gradient Boosting (Kuchina and Pikola, 2016), Markov Regime Switching (Naifer and Al-Dohaiman, 2013), Quintile-on-quintile approach (Shahzad et al, 2017),Gray relation network analysis (Jia and An, 2015), Copulas and its variants (Mensah and Alagidede, 2017; Yang et al, 2015; Pastpupatkal et al, 2015; Boubaker and Sghaier, 2016; and Boubaker and Raza 2016) and dynamic/constant conditional correlation-generalized autoregressive conditional heteroskedasticity (DCC-/CCC-GARCH) (Cho and Parhizgari, 2008; Dajcman and Festia, 2012).These array of methods have been employed in one form or the other, depending on the researcher's objective and nature of data, mostly for developed and emerging markets, with a few exceptions such as Mensah and Alagidede (2017) whose focus was on African emerging markets versus advanced countries. Unfortunately, none of these methods was used to investigate Organization of Petroleum Exporting Countries (OPEC).

The OPEC member countries constitute a cartel that influence global oil price or oil supply. Reasons why attention should be shifted to the stock markets of OPEC members is that oil sector in each of the member countries is the engine of economic performance as an average share of oil in GDP of any country member is around 38 percent OPEC, 2016). Consequently, any distortion in oil price or oil supply usually have strong effect on these economies. By implication, any distortion in the oil market that changes the volume or price should influence the economy and this could affect the confidence of investors (World Bank, 2018). What is unclear is whether the distortion in the economy of a particular oil producing country, which will influence the equities market of such country, will also lead to a change in the equities markets of one or other oil producing countries. In addition, attention should be paid to the stock market of OPEC member countries as the cartel set a target of 40 million barrels per day (40mb/d) in 2040, up from 32mb/d in 2018 and a growth prospect estimated at 2.3 percent in 2019 from the 1.8 percent in 2017 (see www.momr.opec.org for this information).Further, many OPEC members have been identified as emerging markets in their respective region while the market capitalization of oil companies in each of these markets was on average of 44 percent (OPEC, 2016). All these could be good news for investors if they are equipped with the nature of dependence among the stock markets. However, the bad news is that most of these OPEC members are facing different type of business-based factors such as political instability, internal conflicts and financial crisis (Guidi, 2006). If the stock markets of the OPEC member countries are dependent, then any financial crisis or country-specific business distortion could transmit to other member countries and reduce their ability to hedge risk. Hence, investors need to know whether such dependence is negative or positive, time-dependent or time-invariant. Such information will enable investor to make informed decisions.

Preliminary analysis arising from the stock market data employed for this work show that there appears to be strong dependence among stock returns of some OPEC members. The reason for this co-movement could be informed by similar economic characteristic. Hence, it is important to closely investigate this dependency for the purpose of providing useful information for investors interested in the stock markets of OPEC member countries.

This study seeks to employ the DCC-GARCH approach to investigate the dependence because experience shows that investors interested in foreign equities are concerned about the co-movement and spillover among equities. The traditional linear approach will not provide adequate and reliable information because it may show that no dependence exists even when there is one. The reason for the absence of dependency in the case of linear approach is that it assumes that the series are time independent(Cho and Parhizgari, 2008). Hence, a time-dependent association between stocks are effectively analyzed with the aid of DCC-GARCH. The advantage of this approach above others is that it parameterizes the correlation and so, it is possible to quantify the size of the dependence.

2. Literature Review

Empirical literature of market dependence is vast. Some researchers focus on the dependence of stock market on oil market and or gold market (Naifer and Al-Dohaiman, 2013; Shahzad et al, 2017). Acomprehensive review of cross country stock market dependence can be found in Boubaker and Raza (2016). Consequently, this section

presents recent evidence on the subject matter with particular focus on various methods utilized and the coverage areas. The work of Dajcman and Festic (2012) focused on the dependence of Slovenian stock market and five advanced stock markets in Europe, that is, Austria, Czech Republic, France, Hungary, and the United Kingdom. They obtained daily data for all the stock market indices from April 1 1997 to May 12, 2010. The authors specifically examinedthe presence of co-movement of stock returns in these markets and analyzed whether they were time-dependent. They were also interested in investigating the role of financial crises on the dependence. Utilizing DCC-GARCH model, the data showed that the Slovenian stock market index and the European stock market indices are interdependent. Also, a spillover effect was observed across the markets while the presence of financial crises magnifies the dependence. The authors also noted that the dependence is strong and increasing over time.

Nader et al (2013) studied the dependence of stock market returns on oil price under regime shifts in the Gulf Cooperation Council (GCC). They employed a Markov-shift regime-switching model to generate regional probabilities for all oil market variables. They focused on the crisis and non-crisis regimes. The result showed that the stock market returns and OPEC oil volatility is regime dependent. In addition, there was a significant and symmetric dependence between inflation rate and crude oil.

Dasgupta (2014) investigated stock market dependence among the BRICcountries (Brazil, Russia, India and China). They utilized Engle& Granger and Johansson & Joselius cointegration to investigate the short- and long-run dependence. They also employed vector autoregression (VAR) and variance decomposition as robustness check. Collecting daily data on the stock market indices of the countries from January 1, 2003 to December 31, 2012, and converting them to stock returns, they found a significant short- and long-run bidirectional Granger causality. In particular, the movement of Chinese stock market affects Brazilian stock market and this in turn, affects the Russian stock market. Indian stock market has strong impact on the stock market of Brazil and Russia. Rehman and Hazazi (2014) examined the integration of Saudi Arabia stock market and the stock markets of advanced countries, namely, United States, United Kingdom and Japan. They also examined the integration of selected GCC (Gulf Copperation Council) markets - United Arab Emirate, Oman, Bahrain, Kuwait, and Qatar – with Saudi capital market. Weekly stock market indices data starting from July 1, 2009 to July 30, 2013 were obtained for the sample countries and various tests such as correlation, unit root and stationarity, Johansson cointegration and pairwise causality were performed. Results indicated that co-movement increased among the stock indices and that level of dependence increased. Inparticular, Saudi's stock market and the GCC stock market showed evidence of integration.

Abbra and Zevallos (2014) focused on the linkages and possible contagion among six stock markets from three regions and the European stock markets (UK and Germany). The three regions are Latin America, North America and Asia markets. Three countries: Argentina, Brazil and Mexico were selected from Latin America; two countries: Singapore and Japan were selected from Asia while the US was selected from North America. Utlizing bivariate SIC time-varying copulas approach for daily and weekly data between September 61995 and April 19, 2013, it was found that these markets are asymmetrically dependent. There is also evidence of contagion among Latin America stock markets.

However, when the third market was introduced, the contagion disappeared. For the European markets, contagion was present and this was traced to the internet bubble and Euro crisis in 2011. The US stock market did not show evidence of contagion transfer to other markets, suggesting that the former cannot explain full losses of German and UK stock markets. But the US stock markets had strong influence on the losses of Latin America stock markets.

Junior et al (2015) considered 83 stock markets indices across the world. They computed partial correlation to develop dependency network and employed this to compute the partial transfer entropy and then used the result to investigate any indirect effect that one stock market could have on the other. This model was claimed to be an efficient way of quantifying the flow of information between stock returns. Data were collected on the stock market indices of the said countries between January 2003 and December 2014. Some OPEC member countries showed evidence of dependence. In particular, dependency was observed between Saudi Arabia-India. India stock market depended on Oman stock market which also depended on the stock market of Qatar. Also, UAE stock market depended on Qatar which depended on |Oman, and then Saudi Arabia in that order.

Bein and Tuna (2015) examined the impact of the sovereign debt crisis on 3 Central and Eastern Europe (CEE) emerging markets, that is, Czech, Hungary and Poland with special attention on the volatility and conditional correlation changes after the financial challenges facing Greece, Ireland, Portugal, Spain and Italy (GIPSI). Obtaining daily data from May 32004 to November 22 2003 and utilizing multivariate DCC model of Engle (2002), found a spillover effect from the GIPSI and 3 EUs on the CEE stock markets. The stock market of Poland showed significant level of conditional correlation. Pastpipatkul, Yamaka and Sriboonchina (2015) investigated the co-movement and dependence of 3 largest stock markets in the world, that is, the US Dow Jones, London Stock Exchange (LSE) and Japan Nikkei 225 index. They employed the C-vine and D-vine copulas and the result showed that the C-vine copulas is more appropriate. They observed positive dependence between LSE and the other markets. Kuchina and Pikola (2006) analyzed the impact of different stock market indices on the Czech stock market between 2 trading days. They employed the stochastic gradient boostrap approach and the result showed that changes in Czech stock market returns index are influenced by some European countries' stock markets.

Boubaker and Raza (2016) evaluated the time-varying and asymmetric co-movement of CEE equity market with the US stock market during the subprime crisis and the global financial crisis. They employed time-varying copulas that allowed for memory in both marginal and joint distribution. The result showed strong evidence of co-movement between the CEE and the US equity markets. The movement exhibited large time-variations and asymmetry in tails of their distribution. Boubaker and Sghaier (2016) explored into regime change in the time-varying dependence of oil price and GCC stock markets by developing a Markov-switching copulas model. Clearly, the authors are interested in the presence of long memory effect on dependence. The result indicated that regime changes, that is, pre-financial crisis, period of financial crisis and post-financial crisis have diverse dependency influence on GCC stock markets. In the pre- and post-financial crisis, the dependence is weak unlike in the period of financial crisis

when the dependence is strong and notable. The result for OPEC member countries indicated a lower tail dependence but in the non-OPEC members, there was presence of upper tail dependence. Among the time-varying copulas and Markov-switching copulas, the latter performed better. The result, therefore, indicated that dependency of oil market and stock market is more pronounced in the non-OPEC stock markets than in OPEC member stock markets.

Mata and Mora (2016) analysed the dependence of Chinese and Latin America Integrated Market (MILA). They adjust the multivariate probability distribution variance gamma to find a robust estimator for the correlation matrix of returns. The result indicated that stock market dependence exists among China, Peru, Mexico, Colombia and Chile. Ferreiraa and Donisio (2017) argued that even if there is absence of linear autocorrelation in the stock returns, there could be long range dependence. The argument was investigated for the G-7 stock markets by applying 2 methods that allowed nonlinear behavior of returns, that is, mutual information and correlation coefficients. It was found that the stock markets have long-term dependence among returns in the G-7. The causal relationship between financial markets in Asia and the US was investigated by Bhunia and Yaman (2017). They analysed daily time series data for 9 Asian stock markets from 2 January 1991-31 March 2016. They employed tests such as cointegration, unit root, correlation and error corrections. The results showed a positive correlation between Asia stock markets and the US except for Vietnam. Further, a long run and short run bi-causality among the markets was detected.

Jebran et al (2017) investigated volatility spillover on selected Asian stock markets in the pre and post 2007 financial crisis. The countries in the sample are China, Hong Kong, Pakistan, India and Sri Lanka. Utilizing exponential GARCH (EGARCH), a bidirectional volatility spillover exists between India and Sri Lanka stock markets. The bidirectional volatility spillover that was observed in Hong Kong and India; and Pakistan and India occurred during the pre-crisis period. The general result is that these markets exhibit a relatively **high** degree of integration. Shahzad et al (2017) examined the dependence of gold and benchmark border price of 10 stock markets, including five developed markets, namely, the US, UK, Japan, Canada and Germany with 5 Eurozone periphery countries (Greece, Ireland, Portugal, Spain and Iceland). They utilized a novel quintile-on-quintile approach to construct the dependence between the entire distributions of financial assets and uncovered some novel features of relationship. First, it was discovered that Gold can be used as hedging strategy for stock portfolio. Second, gold may not be a good hedging strategy when the stock and bond markets are bearish. Third, bonds act as safe havens for the stock portfolio and finally, there exist strong dependence between stock-gold, stock-bond even though the dependence are not uniform.

Bala and Takimoto (2017) paid attention to the spillover effect of some financial crisis around the world such as the Mexico financial crisis of 1994, currency crisis in Brazil in 1999, the financial crisis that occurred in some Asia emerging markets between 1997 and 1998 and the US financial crisis alongside Greek debt crisis of 2007-2009 and 2010, respectively on the stock returns of emerging and developed markets using the MGARCH approach (CCC, VAR, EGARCH,, BEKK-GARCH and DCC). They found that these series of crisis contagion affected many countries. The result of the paper indicated that correlation in

emerging markets are lower compared with that of the developed markets. This suggests that there is greater interaction in the developed market than in the emerging markets. They also found that the correlation and unconditional covariance matrix of stock returns are time-dependent. This implies that neglecting time dependence in the stock market behaviours will magnify the persistence of conditional variance and correlation. Comparing results from the various models, DCC-MGARCH show the best performance.

Gamba-Santamaria et al (2017) studied the stock market spillover effect of the US on the Latin America stock market. Utilizing the DCC-GARCH, they constructed volatility spillover indices directly from the stock returns. The result indicated that the volatility transmission was more from Brazil than any other Latin America markets while Mexico, Colombia and Chile were most affected by the spillover. The volatility transmission from the US to Latin America stock markets was notable during the episode of Lehman Brothers. Santilan-Salgado, Roldan and Miranda (2017) opined that cross-country stock market interdependence can reduce potential to diversify portfolio and so, it is imperative to study the degree of interdependence of stock markets among the Latin America Integrated Markets (MILA). They employed correlation, cointegration and nonlinear Granger causality as techniques of analysis. The result indicated that linear dependence across the MILA markets is on the high side. They also detected strong integration among the markets. This implies that investors in these countries will find little incentive in venturing into any of the stock market if any crisis strikes in any of the markets.

The empirical evidence provided indicate that stock markets around the world exhibit varying dependency. More dependence exist among the developed markets than the emerging markets. Further, the dependence is time-varying both in the correlation and variance. However, the study of stock market dependence of the OPEC members is absent despite their active involvement in determining world oil price and oil volume. To the extent that oil is an important determinant of the economic activity of these countries and that changes in the oil price affects the respective stock markets of the OPEC (Salisu and Oloko, 2013b), it is important to investigate the dependence of these stock markets so as to analyse how any shock could be transmitted to the markets.

3. Methodology

There are several approaches to investigating stock market dependence. The DCC-GARCH is one of the most commonly used because of its simplicity, reliability and appropriateness. Papers that have utilized DCC-GARCH in the recent time include Ferreira and Dionisio (2017) and Bala and Takimoto (2017). The DCC-GARCH is therefore employed for this work. The DCC-GARCH assume that conditional correlation between variance of the series (stock returns) could be nonlinear and time-varying. The DCC-GARCH is a variant of multivariate GARCH (MGARCH) where GARCH is modelled to predict future volatility of stock returns. A simple MGARCH is given in equation 1:

$$r_1 = \varsigma_t + a_t \quad \text{.....1}$$

$$a_t = H_t^{1/2} z_t \quad \text{.....2}$$

That is, *n*-asset returns r_t is nx1 vector and the nx1 vector of mean-corrected return of the asset is a_t. The term ς_t is the nx1 vector of expected value of r_t. H_t is nxn matrix of conditional variance of a_t at time *t*. z_t is the nx1 vector of the error term that is assumed to be independently and identically distributed. In equation 2, the conditional variance depends on time. By implication, the time dependence has to be investigated at each iteration, a task that is burdensome. To get out of this challenge, the conditional correlation and conditional variance can be modelled. That is, the time dependence conditional variance is assumed to have two components, namely, conditional standard deviation and correlation matrix. This is the basis for DCC-GARCH aspect of the MGARCH. If A is the conditional standard deviation and M is the correlation covariance, then H_t can be summarized in equation 3

$$H_t = A_t M_t A_t \quad \text{.....3}$$

$$A_t = diag\left[\sqrt{h_{1t}} \text{.....} \sqrt{h_{nt}}\right]$$

Equation 3 is a general form of the behaviour of H_t. The reduced form will be when the correlation is constant, in which case, the subscript *t* will not be included in M_t. When the correlation is time-varying, then equation three holds. According to Engle and Sheppard (2001), the DCC-GARCH, which have a component of time varying conditional standard deviation A_t and time varying correlation matrix M_t implies that the two are time-dependent. Hence, equations 1 to 3 indicate the DCC-GARCH version. The standard deviation of the univariate GARCH, that is, $h_{1t}^{1/2}$, is the elements in the diagonal of A_t and

$$h_t = \zeta_t + \sum_{q=1}^{Q_i} \gamma_{iq} r_{i,t-q}^2 + \sum_{p=1}^{P_i} \beta_{ip} h_{ij-p} \quad \text{.....4}$$

In equation 4, ζ_t is nxn vector and γ_{ij} and β_{ij} are diagonal nxn matrix. Next is the second part, that is, the conditional correlation matrix, which is an asymmetric matrix. Any form of A_t should satisfy two conditions. First, for H_t to be positive definite, A_t must be positive definite. The second condition is that all elements in the correlation should be ≤ 1. One method usually employed to ensure these conditions are met is to break down A_t into unconditional covariance and the diagonal elements, that is,

$$A_t = Q_t^{*-1} Q_t Q_t^{*-1}$$

$$Q_t = (1 - \sum_{m=1}^{M} \gamma_m - \sum_{n=1}^{N} \beta_n)\overline{Q} + \sum_{m=1}^{M} \gamma_m (\tau_{t-m} \tau_{t-m}^T) + \sum_{n=1}^{N} \beta Q_{t-n} \quad \text{.....5}$$

$\overline{Q}$ is the unconditional covariance of the standardized error, τ_t and $Q*$ is the diagonal matrix used to rescale the elements Q so that the requirement that $\left|\theta_{ij}\right| \leq 1$ is satisfied.

Where θ_{ij} is the positive definite of the conditional correlation. M and N are length of new information term and length of correlation matrices in the DCC estimation respectively. Also, to guarantee positive de-fitness of H_t, parameters γ and β are scalarsand ≥ 0 but the sum should less than 1. Further, the starting point of Q_t, Q_0 should be positive (Orskaug, 2009).

Equation 5 assumes that the DCC-GARCH model is of the form DCC(1,1)-GARCH(1,1) version, which is the most commonly used in empirical model (Engle, 2002; Egert and Kocenda, 2010). The first step in empirical estimation of equation 5 is to estimate a VAR model specified in equation 5

$$r_{1.t} = \zeta_1 + \sum_{m=1}^{M} \gamma_{1,i} r_{1,t-i} + \sum_{n=1}^{N} \beta_1 r_{2,t-i} + \tau_{1,t}$$
$$r_{2,t} = \zeta_2 + \sum_{m=1}^{M} \gamma_{2,i} r_{2,t-i} + \sum_{n=1}^{N} \beta_2 r_{2,t-i} + \tau_{2,t} \quad \text{.....6}$$

Where $r_{1.t}$ and $r_{2.t}$ are returns on stocks ofany two markets. Relating this to this study, it means the returns on Nigeria stock market index and any other OPEC stock returns respectively. We then use the residuals of the VAR to estimate the DCC(1,1)-GARCH(1,1) model specified in equations 7 and 8.

$$h_{it} = \zeta_i + \gamma_{i1} r_{it-1}^2 + \beta_{i1} h_{it-1} \text{.....7}$$

$$Q_t = (1-\gamma_i - \beta_i)\overline{Q} + \gamma_i(\tau_{t-1}\tau_{t-1}^T) + \beta Q_{t-1} \text{.....8}$$

The stock returns is computed from the log of difference of stock price index of each country of interest. Working with stock return will remove the problem of unit of measurement (Brooks, 2014). The stock return is computed by taking the log of difference of stock prices, that is,

$$p_t = 100 * \ln\left(\frac{P_t}{P_{t-1}}\right) = 100 * \left(\ln(P_t) - \ln(P_{t-1})\right) \text{.....9}$$

Before estimating the DCC-GARCH model specified in equations 7 and 8, it is important to provide information about the characteristic of the series. Three tests, the augmented Dickey-Fuller (ADF), Phillip-Perron (PP) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS). The ADF test was proposed to check the presence of unit root. If the ADF test validates the existence of unit root, then the price return is nonstationary, and this implies that the stock return is time-varying.

The Phillip Perron proposes long run variance, using Newey-Wester estimation. The PP is different from ADF in the way the heteroskedasticity and autocorrelation are dealt with. Unlike the ADF, PP uses non-ADF regression and make adjustment for the existence of biasedness owing to possible correlations in innovation terms. Unlike the ADF and PP tests, the KPSS is specifically designed for testing the presence of stationarity, that is, the absence of random walk. The KPSS proceed in two steps. The first step is to estimate an OLS regression where the regressor is an exogenous variable (usually a constant or

constant and trend) and the regressand is the stock return. The second step is to compute an LM statistics then use it to test the presence of stationarity.

Data for the stock prices were extracted for all the OPEC members from the International Monetary Fund's International Financial Statistics (IFS) on stock prices between January 2005 and March 2018, making 159 observations for each country. The stock markets of Iran, Kuwait, Nigeria, Saudi Arabia, Qatar, UAE and Venezuela are correspondingly TEDPIX, KWSEIDX, ASI, TASI, QEI, ADX and IBVC. The stock market price of each market is measured as the index of prices of stocks of all companies traded in each of the markets.

4. Presentation of result and discussions

The properties of the stock price returns of the OPEC countries for which data are available is presented in Table 1. The expected returns on stocks range between 0.006% in Iran to 0.99% in Saudi. Hence, Saudi Arabia stock market posted the highest expected stock returns among the OPEC countries under study. The second highest expected returns was observed in Kuwait (0.95%) while the stock market of Venezuela was the third highest expected returns with 0.91%. Nigeria's expected stock return was about 0.57% while that of UAE was 0.11%. Iran had the lowest expected stock returns, posting only 0.006% within the period of investigation.

Table 1: Descriptive Statistics of the series

STATISTICS	TEDPIX	KWSEIDX	ASI	TASI	QEI	ADX	IBVC
MEAN	0.006	0.948	0.569	0.996	0.749	0.105	0.902
MIN	0.003	0.451	0.180	0.634	0.084	0.059	0.001
MAX	0.011	1.369	0.835	1.976	1.648	0.163	3.381
SD	0.001	0.231	0.185	0.227	0.334	0.028	0.947
SKEWNESS	-0.006	- 0..459	-0.399	-1.068	0.468	0.372	0.768
KURTOSIS	5.871	2.306	2.190	5.096	3.065	1.647	2.662
SHAPIRO-WILK	0.928	0.954	0.939	0.940	0.935	0.897	0.853
PROB>Z	0.000	0.000	0.000	0.000	0.000	0.000	0.000
OBS	159	159	159	159	159	159	159

Source: Author's computation

Note: TEDPIX , KWSEIDX, ASI, TASI, QEI, ADX and IBVC is the returns of the stock market index of Iran, Kuwait, Nigeria, Saudi Arabia, Qatar, United Arab Emirate, and Venezuela respectively

The standard deviation, which measures the extent of risk incurred in investing in any of the stocks reveals that Venezuela's stock was the riskiest with standard deviation posting

0.95%, followed by Qatar with 0.33%. Nigeria's stock return's standard deviation was 0.19% while Iran's stock had the lowest risk (0.001%).

The literature predicts that stocks that have high expected returns will be associated with high risk, so that investors that are willing to earn higher return should be ready for more risk. This proposition appear not to hold for some stock markets under consideration. In particular, Saudi Arabia's stock returns was the highest but also had one of the lowest risks among the markets considered. The stock market with highest risk, that is, Venezuela's return, posted the third highest returns. The expected returns on Qatar's stock was lower than Kuwait's but the risk attached to it was higher. It is only Iran's risk-return where tradeoff holds. This suggests that there are other factors that may affect decision to purchase equity apart from risk.

The skewness of returns was positive in Saudi Arabia, UAE and Venezuela while it was negative in Iran, Kuwait, Nigeria and Qatar. This suggests that the first set of countries exhibited asymmetric tail that extend further towards positive monthly returns than negative. Countries in the second category exhibited asymmetry tail extend further towards negative monthly return than positive. The monthly Kurtosis are higher than 3 in three countries (Iran, Qatar and Saudi Arabia), indicating that the monthly return distribution of these countries have fatter tails. All the series are not normally distributed given the values of the Shapiro-Wilk normality probabilities.

Table 2: Pairwise Correlation Matrix

	TEDPIX	ASI	TEDPIX	QEI	TASI	ADX	IBVC
TEDPIX	1						
ASI	**0.640**						
TEDPIX	0.134	0.545	1				
QEI	-0.099	0.102	0.317	1			
TASI	0.438	0.360	0.038	0.631	1		
ADX	0.392	0.400	0.230	**0.735**	**0.764**	1	
IBVC	**-0.688**	-0.132	0.216	0.310	-0.208	0.051	1

Source: Author's computation

Note: TEDPIX , KWSEIDX, ASI, TASI, QEI, ADX and IBVC is the returns of the stock market index of Iran, Kuwait, Nigeria, Saudi Arabia, Qatar, United Arab Emirate, and Venezuela respectively

The relationship between stock returns across selected OPEC members is provided in Table 2. The Table shows that there is relatively strong and positive relationship inKuwait-Nigeria; Kuwait-Venezuela, UAE-Qatar and UAE-Saudi Arabia. However, the relationship between the stock returns of Kuwait and Venezuela is negative.

4.2 Results of the Unit root tests

The presence of unit root in the OPEC countries stock returns are investigated using the ADF, PP and KPSS by considering both the constant and constant and trend. The ADF, PP and KPSS are tested at level and so, if the value of any of the first two exceeds the 5% critical value, the series are assumed to be stationary and in the case of stock returns, it means that present price depends on previous price. In the case of KPSS, the critical value must be less than the KPSS computed.

The result from the ADF, PP and KPSS are mixed across countries in OPEC. The result of the monthly ADF and PP test show that all the stock returns of OPEC countries, except Iran, accept the null hypothesis of the presence of a unit root, at 1% and 5% significant levels both at constant and constant and trend. When KPSS was utilized, the result is slightly different. As can be observed, the monthly KPSS test show that Nigeria and Iran stock returns reject the null hypothesis of stationarity, at 1% and 5% significant levels both at constant and constant and trend. Therefore, out of the seven OPEC countries, the stock price return of five countries are time-dependent.

Table 3: Result of Augmented Dickey-Fuller (ADF) test for Random Walk

Countries	KWSEIDX			ASI			TEDPIX			QEI			TASI			ADX			IBVC		
Model	ADF test	Critical values		ADF test	Critical values		ADF test	Critical values		ADF test	Critical values		ADF test	Critical values		ADF test	Critical values		ADF test	Critical values	
		1%	5%		1%	5%		1%	5%		1%	5%		1%	5%		1%	5%		1%	5%
Constant	-0.75	-3.48	-2.88	-1.11	-3.48	-2.88	-3.25**	-3.48	-2.88	-2.32	-3.48	-2.88	-2.12	-3.48	-2.88	-1.83	-3.48	-2.88	-0.95	-3.48	-2.88
Constant and Trend	-1.68	-4.03	-3.44	-1.56	-4.03	-3.44	-3.20	-4.03	-3.44	-2.48	-4.03	-3.44	-2.22	-4.03	-3.44	-1.82	-4.03	-3.44	-3.07	-4.03	-3.44

Result of Phillips-Perron (PP) test for Random Walk

Countries	KWSEIDX			ASI			TEDPIX			QEI			TASI			ADX			IBVC		
Model	PP test	Critical values		PP test	Critical values		PP test	Critical values		PP test	Critical values		PP test	Critical values		PP test	Critical values		PP test	Critical values	
		1%	5%		1%	5%		1%	5%		1%	5%		1%	5%		1%	5%		1%	5%
Constant	-0.7	-3.48	-2.88	-1.2	-3.48	-2.88	-4***	-3.5	-2.9	-2.6	-3.5	-2.9	-2.4	-3.5	-2.9	-1.7	-3.5	-2.9	-1.9	-3.5	-2.9
Constant and Trend	-2	-4.03	-3.44	**-1.6	-4.01	-3.44	-3.7**	-4.1	-3.4	-2.8	-4.1	-3.4	-2.2	-4,1	-3.4	-1.6	-4.1	-3.4	-3.3	-4.1	-3.4

Result of Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test for Random Walk

countries	KWSEIDX			ASI			TEDPIX			QEI			TASI			ADX			IBVC		
Model	KPSS test	Critical values		KPSS test	Critical values		KPSS test	Critical values		KPSS test	Critical values		KPSS test	Critical values		KPSS test	Critical values		KPSS test	Critical values	
		1%	5%		1%	5%		1%	5%		1%	5%		1%	5%		1%	5%		1%	5%
Constant	1.08***	0.74	0.46	0.30	0.74	0.46	0.22	0.74	0.46	0.46**	0.74	0.45	0.34	0.74	0.46	0.28	0.74	0.46	1.21***	0.74	0.46
Constant and Trend	0.17**	0.22	0.15	0.10	0.22	0.15	0.13	0.22	0.15	0.18**	0.22	0.15	0.25***	0.22	0.15	0.28***	0.22	0.15	0.10	0.22	0.15

Source: Author's computation

Note: TEDPIX , KWSEIDX, ASI, TASI, QEI, ADX and IBVC is the returns of the stock market index of Iran, Kuwait, Nigeria, Saudi Arabia, Qatar, United Arab Emirate, and Venezuela respectively

4.3 Result of the DCC-GARCH estimates

The estimation of the DCC-GARCH is predicated on the result of the VAR. The VAR is necessary because the residual obtained from it will be used as independent variable in the DCC-GARCH models. The VAR model also require the appropriate lag lengths that will enter the model. Using the SIC lag length criteria, the first lag is appropriate. Invoking equation 6, Table 4, presents the VAR result. The lag of Nigeria stock index significantly affects current stock market returns. This result corroborates the outcome of the unit root and stationarity tests.

Table 4: VAR Results of the stock market indices of Nigeria and other OPEC members

	ASI-TEDPIX	ASI-KWSEIDX	ASI-QEI	ASI-TASI	ASI-ADX	ASI-IBVC
γ	1.049***	0.966***	1.081***	1.112***	1.058***	1.103***
	(12.57)	(11.46)	(13.16)	(14.18)	(13.07)	(13.94)
β	19.02*	0.262***	0.0255	0.0700**	1.041**	-1.115**
	(1.71)	(3.57)	(0.68)	(2.32)	(2.05)	(-2.19)
ζ	0.026	-0.000	0.032*	0.003	0.021	0.021
	(1.29)	(-0.03)	(1.78)	(0.23)	(1.41)	(1.61)
γ	-0.000240	-0.0140	0.235	-0.000188	-0.0138	0.00799
	(-0.39)	(-0.15)	(1.34)	(-0.00)	(-1.11)	(0.04)
β	1.150***	1.346***	0.986***	0.924***	1.308***	1.301***
	(14.17)	(16.55)	(12.29)	(11.57)	(16.82)	(17.13)
ζ	0.001***	0.027*	0.098***	0.085**	0.004*	0.023
	(4.49)	(1.83)	(2.59)	(2.30)	(1.77)	(0.76)
N	157	157	157	157	157	157

Source: Author's computation

*Note: TEDPIX , KWSEIDX, ASI, TASI, QEI, ADX and IBVC is the returns of the stock market index of Iran, Kuwait, Nigeria, Saudi Arabia, Qatar, United Arab Emirate, and Venezuela respectively. tstatistics in parentheses; *p< 0.1, **p< 0.05, ***p< 0.01*

Further, information from the VAR is that Nigeria stock market depend significantly on the past returns of the OPEC members under review, except Qatar (QEI). The feedback process is not observed because the behaviour in the Nigeria stock market does not significantly explain any of the OPEC members' returns. It follows therefore that stock market spillover exists among the OPEC stock returns but the dependence is unidirectional. Specifically, the result indicates that there is a unidirectional spillover of stock market returns, running from other OPEC members to Nigeria stock market.

Meanwhile, each of the OPEC members' stock returns are affected by the previous innovation.

Table 5: Result for testing time-dependence between Nigeria stock index and each of the OPEC stock index

Test	NSE-TEDPIX	NSE-KWIDX	NSE-QEI	NSE-TASI	NSE-ADX	NSE-IBVC
χ2	3150.91***	545.94 ***	326.80***	12478***	701.67***	106735***
p-value	0.000	0.000	0.000	0.000	0.000	0.000

Source: Author's computation

Note: TEDPIX , KWSEIDX, ASI, TASI, QEI, ADX and IBVC is the returns of the stock market index of Iran, Kuwait, Nigeria, Saudi Arabia, Qatar, United Arab Emirate, and Venezuela respectively, $^{***}p< 0.01$

To determine whether dependence between Nigeria stock market index and other OPEC members are time dependent or not, a test of constant conditional correlation (CCC) was performed. The estimated DCC reported two lamdas (λ) (see Table 6). The null hypothesis for testing constant conditional correlation is that the magnitude of the λ are not significantly different from zero. Using Wald test as a guide, the result of the test is presented in Table 5. The chi-square values rejected the null hypothesis for each pair and so, it can be established that the stock market dependence between Nigeria's stock index and other OPEC in our sample are time varying and so, a GARCH-DCCis the reliable and appropriate model.

Table 6: Result showing the Dependence between Nigeria ASI and other OPEC stock market indices: DCC(1,1)-GARCH(1,1)

	ASI-TEDPIX	ASI-KWSEIDX	ASI-QEI	ASI-TASI	ASI-ADX	ASI-IBVC
$\zeta_{ASI-OTHERS}$	0.567***	0.586***	0.572***	0.086***	0.968***	0.619***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$\gamma_{ASI-OTHERS}$	0.856***	1.215***	0.846***	0.640***	0.752***	0.842***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$\beta_{ASI-OTHERS}$	0.473***	-0.035**	0.012	0.494***	0.185*	0.115
	(0.000)	(0.046)	(0.946)	(0.000)	(0.064)	(0.227)
Serial Corr	32.233	10.111	12.177	14.200	9.001	6.211
$\zeta_{OTHERS-ASI}$	0.007***	1.001***	1.027***	0.748***	1.066***	0.979***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

$\gamma_{OTHERS-ASI}$	1.592***	1.024***	0.730***	0.739***	0.842***	0.993***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$\beta_{OTHERS-ASI}$	0.007	0.075	0.306	0.426***	0.147	0.051
	(0.872)	(0.328)	(0.014)	(0.000)	(0.110)	(0.605)
Serial Corr	27.002	12.340	10.330	20.011	8.103	11.606
Γ	0.110**	0.011**	0.002	0.100**	0.192**	0.391***
	(0.003)	(0.004)	(0.031)	(0.002)	(0.004)	(0.000)
B	0.511***	0.771***	0.619	0.665***	0.551***	0.519***
	(0.000)	(0.000)	(0.012)	(0.000)	(0.000)	(0.000)
$CORR_{(ASI-OTHERS)}$	0.972***	0.884***	0.144	0.958***	-0.610***	-0.319
	(0.000)	(0.000)	(0.300)	(0.000)	(0.000)	(0.113)
	(0.000)	(0.000)	(0.300)	(0.000)	(0.000)	(0.113)
λ1	0.569***	0.598***	0.808***	0.299***	0.900***	0.749***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
λ2	0.393***	0.293***	0.001	0.654***	0.001	0.224***
	(0.000)	(0.000)	(0.812)	(0.000)	(0.760)	(0.001)
Loglikelihood	1159.496	305.891	250.790	595.136	76.806	94.425
N	157	157	157	157	157	157

Source: Author's computation

Note: TEDPIX , KWSEIDX, ASI, TASI, QEI, ADX and IBVC is the returns of the stock market index of Iran, Kuwait, Nigeria, Saudi Arabia, Qatar, United Arab Emirate, and Venezuela respectively. tstatistics in parentheses; $^{*}p<0.1$, $^{**}p<0.05$, $^{***}p<0.01$

Following the result of the VAR, a DCC(1,1)-GARCH(1,1) was estimated and the result is presented in Table 6. The Table is composed of six parts. Part one shows the GARCH(1,1) model when Nigeria stock returns is the dependent variable. The second part contains models when each of the OPEC members is a dependent variable while Nigeria stock

returns is the independent variable. These first and second parts are used to determine the nature of dependence whether unidirectional or bidirectional. The third part which shows the estimates of DCC gamma and beta provides information about the persistence of the volatility spillover, if there is any. The fourth and fifth parts are the pairwise correlation in the DCC-GARCH models and the values of λ used to test linear (dynamic) dependence respectively. The sixth part contains information about the relevant statistical properties.

Starting from the GARCH(1,1) model of the dependence of ASI returns on the behaviour of other OPEC members' stock market, all the parameters are significant. This implies that the conditional variance of ASI return is importantly affected by previous news in each of the other OPEC market returns in the pairs. The $\beta_{ASI\text{-}TEDPIX}$, $\beta_{ASI\text{-}KWEIDX}$, $\beta_{ASI\text{-}TASI}$ and $\beta_{ASI\text{-}ADX}$ are significant while it was insignificant in the case of $\beta_{ASI\text{-}QEI}$ and $\beta_{ASI\text{-}IBVC}$. What this suggests is that volatility transmission among the pairs are not uniform and more of unidirectional. It is only in ASI-ADX where bidirectional volatility transmission was observed. Therefore, the stock market of Nigeria and UAE are interdependent while in others, shocks in their stock market will be transmitted to Nigeria stock returns while these markets will not be affected by any shocks in the Nigeria stock market. In other words, the past news of the stock market of Iran, Kuwait, and UAE are transmitted into Nigeria stock market. Only the stock market of UAE and Nigeria are affected by innovation from both markets.

The values of λ and β, that is, the parameters of the DCC are statistically significant for all the stock pairs except Qatar (QEI) stock index. A closer investigation into Table 6 shows that in all cases, the values of β is greater than λ. In this case, the behaviour of correlation variance is more affected by previous variance of each of the country-pairs. Further, the closer the value of beta to one, the more persistent the innovation from the OPEC stock market affect Nigeria stock market. Another insightful result from the Table is that the null hypothesis of constant conditional correlation is rejected, given the sum of the values of λ and β. The test is that if the sum is greater than zero, then the appropriate model should be DCC-GARCH. The closer the sum to one, the more persistence is the conditional variance. The values of the pairwise conditional variance correlation (CORR-OTHERS) is very close to one, thereby further establishing the persistence of the conditional variance.

5 Conclusion and recommendations

There is no doubt that the behavior of the stock markets has been attracting interest among investors, researchers and policy makers. Investors are interested in identifying investment opportunities in the stock markets, researchers are interested in obtaining current and valid information about the operation of the markets while the policymakers are interested in the alternative policy that will enhance the growth of the market as a tool for macroeconomic stability. One important information for these economic agents is market dependency. Market dependency is good during the period of good news (when shocks to the stock market is positive) but dependency could be worrisome, particularly during the period of bad news (when shocks to the stock market is negative).

This paper therefore provides information about the type and pattern of dependence among the OPEC stock markets. Data on stock market indices of Kuwait, Nigeria, Iran, Qatar, Saudi Arabia, UAE and Venezuela from January 2005 to March 2018 were developed. We explored into the risk-return trade-off in each of the country's stock returns and possible linear, time-invariant relationship between any pair. The risk-return tradeoff did not hold for some OPEC members. Venezuela stock returns posted the highest risk but had a lower returns than Saudi and Kuwait's stock returns. However, the risk-return tradeoff actually holds in Qatar. Further, strong relationship exists among the oil-rich Asian countries that are OPEC members. Specifically, stock returns in UAE and Qatar were strongly and positively related. The same strong and positive relationship also occurred between UAE and Saudi Arabia. However, Venezuela and Kuwait exhibit negative but strong stock returns relationship. As long as the relationship is so strong that the correlation is close to 1, the information provided therefore suggests that investors will minimize risk by mixing stocks from different countries in their portfolio. Of importance is investors interested in purchasing Kuwaiti and Venezuelan equities. Since the equities of the latter provide high risk and lower return and that it is negatively related with Kuwaiti stock return, more of Kuwait could be purchased while less of Venezuela should be purchased.

The cointegration result suggests that there is long run relationship among the monthly stock returns of OPEC countries. What this suggests is that current monthly stock price of one country in OPEC can be predicted using the previous monthly price movement of another country in the same OPEC. Thus, it can be concluded using monthly returns that stock price returns of the oil-rich OPEC are not weak-form either individually (except Qatar) or as a group. In addition, the study concludes that stock price movement of one of the OPEC member can be predicted using the previous price movement of the other. For instance, if the previous monthly price of stock in Nigeria increases, it can be conjectured that current stock price in Venezuela will necessarily increase. This result is consistent with the work of Jamaani (2015) and Urquhart and McGroarty (2016).The implication from this result is that the purchase of stocks in Venezuela and Kuwait should be done with caution while that of Nigeria and Kuwait appears to be more reliable.

The result also confirms the existence of dependence among stock markets of OPEC. Further, the dependency is time-varying. This result supports the findings of many researchers such as Boubaker and Raza (2016), Ferreiraa and Donisio (2017) and Shahzad et al (2017). However, the nature of dependence differ slightly. Our result show that spillover volatility runs from other OPEC stock markets to Nigeria while there is no feedback effect. That is, any shocks in any of the OPEC members in our sample will affect Nigeria stock market while any shock in Nigeria stock market will not affect these markets. The direction of spillover is positive except in Kuwait where negative spillover was observed. What this means is that periods of positive shock in any of the OPEC members in our sample will necessitate positive spillover on the Nigeria stock market while negative shock will also lead to negative spillover effect. But in the case of Kuwait, negative shock in their stock market will have a positive spillover on the Nigeria stock market.

Bidirectional spillover was observed between Nigeria and Saudi Arabia. This is an interesting but not surprising result. Saudi Arabia hosts Muslim pilgrimage and most Muslims from Nigeria do go to Saudi Arabia to observe various prayers. It is not impossible

for Nigeria Muslim investors to venture into the stock market of this country. Insofar as this investment is strong and given the frequency of travelling to and from this country, the two markets can experience strong interdependence. The good news from our result is that the spillover effect is positive, suggesting that Saudis Arabia stock market will experience positive spillover following good news in the Nigeria stock market. The bidirectional spillover effect observed in Nigeria and Saudi Arabia is consistent with the work of Dasgupta (2014).

The implication of the unidirectional spillover is that investors should be conscious of happenings in the oil-producing OPEC countries when engaging in equity investment in Nigeria. During the good times in these OPEC countries, investors can buy Nigeria stock because the good news will be transmitted to the Nigeria stock market and this could increase returns on equity. However, during the period of bad news, maybe during conflicts or political instability in any of these OPEC countries, insofar as this conflict inflicts injury on the stock market, Nigeria's stock market will be affected and so, investors should be conscious. Meanwhile, Nigerian investors can try to invest in the stocks of some OPEC members, except Saudi Arabia because of absence of feedback, that is, if there is any bad news in the Nigeria stock market, this cannot be transmitted to the stock markets of OPEC members under study. Hence, investors will do well by diversifying their portfolio between Nigeria stocks and these other OPEC markets.

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