



TESTING THE JOINT STOCK MARKET EFFICIENCY OF OPEC COUNTRIES

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ABSTRACT

The study investigates the joint market efficiency hypothesis of the OPEC countries by obtaining monthly stock price data from seven OPEC countries from January, 2005 to April, 2016. The study confirms the risk-return tradeoff in the OPEC stock markets. While most relationships are positive only a pair of country shows strong negative association. Results of both parametric and nonparametric tests indicate that all OPEC members' monthly stock return, except Qatar, are not weak-efficient. This implies that not all OPEC stock markets are efficient. Meanwhile, the study finds that current monthly stock return of one country member can be predicted using the historical monthly price movement of another OPEC member. As a whole, the monthly stock price of OPEC countries are not jointly weak efficient. Recommendations were offered based on these important discoveries.

Keywords: market efficiency, nonparametric tests, oil-rich countries, parametric tests, time series model

JEL Classification: G14, Q39, C14, C22



1. INTRODUCTION

The world market has witnessed progressive growth in the recent time. This is evidenced in the world GDP growth rising from 2.0 in 2015 to 2.4 in 2016 and then to 3.0 in 2017 with estimated growth to increase further to 3.1 in 2018 (WORLD BANK, 2018). Consequently, the business environment has been showing many signs of motivation for investors which invariably has resulted to the listing of new, productive and profitable companies. The World Bank alluded to the fact that the economic upturn was driven by investment in equity, manufacturing and trade. The improvement in economic activity has facilitated investment in the stock market both at local regional or offshore levels.

However, the motivation for purchasing more and new stocks may have implication for market efficiency. Market is efficient when the prices of stocks reflect their fundamentals so that current price is irrelevant to influence future price (PANDEY, 2010).¹ In this case, the market is said to be weak efficient and the price follows a random walk. Notwithstanding the proposition of weak form efficiency, real world experiences have shown that some investors have been able to use past information to determine the future price and by doing so they have opportunities to earn supernormal profit (DARRAT; ZHONG, 2009).

This study seeks to test the individual and joint weak form efficiency hypothesis of the OPEC country members' stock markets by employing a battery of tests, such as Augmented Dickey Fuller (ADF), Phillips-Perron (PP), the Kwiatkowski Phillips Schmidt Shin (KPSS) Variance Ratio and cointegration tests. There are studies that have employed some of these tests but none has considered the case of the OPEC countries. What informs the use of series of tests is based on the argument surrounding the use of one or a few tests. In the case of unit root tests, it has been argued that the result only provides necessary condition for weak form efficiency (random walk) but not sufficient condition because the units can possess predictable elements whereas a random walk for stock price suggests that returns must be uncorrelated with the error term (GILMORE; MCMANUS, 2003).

Variance ratio (and multiple variance ratio by Cho and Denning (1993)) was proposed to provide sufficient condition for random walk. But the basic variance ratio pioneered by Lo and Mackinlay (1988) and the extended version, that is, the multiple variance ratio pioneered by Cho and Denning (1993) have come under serious attack because first, the tests are only

¹ Faini (1994) modified the earlier work by re-categorizing efficient market into tests for return predictability, event studies and test for private information



useful when series are normally distributed. Specifically, the result of variance ratio tests for which its series is not normally distributed should be interpreted with caution because of the statistical errors carried along with it (KIM & SHAMSUDDIN, 2008). Consequently, the use of variance ratio could lead researcher to reject the null hypothesis when in fact it should be accepted. Second, the test is useful under asymptotic condition, that is, it works well with large sample size.

These shortcomings lead to the development of a random walk test that is compatible with small sample size. Unlike the previous variance ratio tests that are parametric in nature, Wright (2000) is a non-parametric test that allows for small sample size and also compatible with non-normality condition. Therefore even when there is large observation but the series are not normal, the relevant variance ratio test should be Wright (2000) non-parametric test. Hence, to appreciate the improvement so far in the test for weak efficient form, it is pertinent to perform all these tests

Meanwhile, many researchers have engaged most of these tests for many countries and regions. Uquhart and McGroarty (2016) investigated the case of what they claimed as the four largest stock markets (US, UK, Japan and China) in the world. Guidi and Gupta (2013) utilized most of these tests to investigate the efficiency of the ASEAN market. Also, Jamaani and Roca (2015) employed these tests to investigate the case of the Gulf Corporation Council (GCC). Although some countries that feature in the Jamaani and Roca (2015) also appear in the present study, data update and the focus on some countries that are not part of GCC but are major oil marketers differentiate the present study from the past.

Oil sector has been linked with economic performance of the oil producing nations. Hence, improvement in the oil sector, can lead to increase in economic activity which will in turn, increase confidence in equity investment (WORLD BANK, 2018). This action certainly have implication for the stock market of the country. What is not clear is whether the improvement in the economy of a particular oil producing country, which will influence the equity market of such country will also lead to a change in the stock price of one or other oil producing countries.

It is important to understand how the current price of stocks in one oil producing country can be predicted by the previous stock price of another oil producing country. The literature argue that current price of one stock could be used to predict the future price of another stock



provided the two prices cointegrate (GUIDI; GUPTA, 2003). To this end, this study also test the long run relationship of the stock prices by utilizing the Johansen cointegration test

Also, it is not clear whether the stock market of the OPEC oil producing countries (as a whole and country-based) are weak-form efficient or not. Hence, the present paper differ from the previous one in at least two ways. First, the focus is on the OPEC countries which has not been examined before. Second, all available studies did not consider the panel result of any group of countries so as to establish the efficiency of the markets as a whole.

Hence, this study seeks to carry out various variance ratio tests alongside the necessary condition for random walk in order to show whether stock prices of OPEC oil producing countries are predictable on country-specific basis or not and to also show whether previous stock price in one OPEC oil producing country can predictably influence stock price in the other OPEC country member's stock market. The information can be useful for investors in equity market that are interested in the oil producing countries.

2. Literature Review

2.1. Theoretical Framework

The workhorse for investigating efficiency in the stock market is the efficient market hypothesis. This hypothesis was pioneered by Samuelson (1965) but was formally articulated and applied to the stock market by Fama (1970). They opine that stock market are so efficient that no matter how smart an investor is in accessing and using relevant information in the market, he/she cannot make any arbitrage profit through stock switching.

The reason is that information that could affect price changes are freely available and fully accessible to all participants in the market and by implication, it is difficult if not impossible for any investor to, on average, outsmart the market. There are two basic assumptions underlying the efficient market hypothesis. First, stock prices move randomly so that it is difficult to predict its time path. Second, the random behavior of one stock price does not influence or influenced by the randomness of another stock price movement.

Meanwhile, what could inform the randomness of stock price are historical price, internal factor and external or public factors. These three also help to describe the nature of efficiency in the market. If all information contained in the previous stock price have been fully absorbed by the current price, then the market exhibits weak-form efficiency. In addition to this, if the current price fully account for public information, then the market is said to be semi-strong form.



The public information here referred include (external) macroeconomic factors such as economic growth, exchange rate, inflation rate, unemployment, and (internal) firm-specific factors such as financial reports, dividend announcement, equity risk and so on. The market will exhibit strong-form efficiency if the current stock price also accounts for both internal and external information.

However, investors do engage in technical analysis to carefully read the perfect information available in order to make some profits, thereby casting doubt on the existence of weak-form efficiency. Also, since not all public information can be publicly accessible to all participants (as assumed by the semi-strong efficiency), or it could take some times before such information could be accessed by some, the semi-strong efficiency may not also hold. This implies that if the stock returns of OPEC are predictable, then it must be the case that Financial Analysts tend to utilize technical analysis to beat the market thereby making the stock returns predictable.

2.2. Empirical Literature

Empirical evidence on random walk hypothesis is large and increasing. Therefore, only the recent empirical papers are reviewed in this section. Zhang and Cheng (2005) use Gaussian mixture modeling to fit distributions of returns in order to detect random walks in capital markets. The study investigates the existence of the random walks hypothesis and showed that Gaussian mixture models can be used as an approximation of asset return distributions and that there are non-random walks in capital markets. Lagoarde-segot and Lucey (2006) developed dataset spanning January 1st 1998 to November 11th 2004 on the stock market prices of Morocco, Lebanon, Israel, Tunisia, Turkey and Jordan. The dataset were then utilized to test for the efficiency of the market using single efficiency index developed from aggregating results from technical trade analysis and random walk tests. The result shows that not all these countries operate efficient market. Some factors such as corporate governance and market depth significantly contribute to the inefficiencies in some of these markets.

Charles and Darne (2009) utilized daily data from 1992 to 2007 to investigate the existence of random walk in the two main markets in China, that is, the Shenzhen and Shanghai. The shares are classified into A and B. The result suggests that random walk hypothesis was rejected for shares in B class while in the case of A class, random walk was accepted. This implies that shares in A class are efficient while shares in B class are inefficient.



The study of Gimba (2012) focuses on the investigation of the weak-form efficiency for Nigeria stock market by employing both daily and weekly ASI and 5 most traded and oldest banks stock data from January 2007 to December 2009. Employing the variance ratio and runs tests, the presence of weak-form efficiency hypothesis was significantly rejected even under both homskedastic random walk hypothesis and matingale difference of sequence.

Nneji (2013) determine whether investors use historical data as a tool for predicting future security prices, to determine the speed of adjustment of stock price to stock information and to determine the relationship between stock market performance and economic growth of Nigeria. The results revealed that there is still room for improvement of the efficiency level of the Nigerian Capital Market.

The efficiency of the Gulf Cooperation Council (GCC) stock markets was examined by Jamaania and Roca (2014) in other to discover the nature of individual or joint efficiency of the markets. They found that each market in GCC was not efficient, suggesting that past price cannot be used to predict current price. In the same vein, the market as a group cannot also be predicted, implying that the price movement of stock market in one country member cannot be used to suggest what the future price of another country member.

Jain, Vyas, and Roy (2013) considered daily closing prices of S&P CNX Nifty, BSE, CNX100, S&P CNX 500 in studying the weak form efficiency of Indian capital market during the period of global financial crisis. Both parametric and nonparametric tests (“ex-posts” in nature) are applied for the purpose of testing weak-form efficiency. The results suggested that the Indian stock market was efficient in its weak form during the period of recession. It means that investors should not be able to consistently earn abnormal gains by analyzing the historical prices. Nwidobie (2014) determine if there exists randomness in share price movements in the Nigerian capital market as has been determined in other capital markets the world over adopting augmented dickey-fuller (ADF) test. The author concluded that share price movements on the Nigerian Stock Exchange do not follow the random walk pattern described by Fama (1970), that is, not random.

Graham, Peltomaki, and Hildur (2015) show that fiancial liberalization is not a solution to market inefficiency. Supporting this argument, they obtained data for Icelandic stock, that is, OMX15 and 16 alongside Denmark, Finand, Norway and Sweden stock markets, from Jaunary 1993 to December 2013. Controlling for the period of financial liberalization, they found that countries with liberalized stock markets, that is, Iceland and Finland are not efficiently better



than others. They also discovered Icelandic stock market were more efficient in the period of financial regulation than the period of financial liberalization. Hence they conclude that financial liberalization tends not to drive efficiency of the stock market as the theory suggests. The weak-form efficiency was also tested in Nigeria by Obayagbona and Igbinosa (2015) and it was confirmed that the stock prices behaves non-randomly, which means Nigeria stock prices can be predicted using historical prices.

Shirvani and Delcours (2016) examine the presence of unit roots in the stock prices of 16 OECD countries using heterogeneous panel unit root tests developed by Im, Pesaran and Shin (2003) and Pesaran (2007). Under the assumption of cross-sectional independence across the panel, the study found no evidence of unit roots, and so, fails to reject mean reversion in the stock prices for all the countries in the sample. However, under the assumption of cross-sectional dependence, an assumption borne out by the diagnostic test results, the authors find support for the presence of unit roots in the stock prices. Andrianto and Mirza (2016) examine the movement of stock price of listed companies on the Jakarta Islamic Index (JII) LQ45, and Kompas 100 Index and determine the relationship among daily stock prices. The findings show that Indonesian stock market has been categorized as weak form efficiency. The statistical testing was done and the result indicates that the daily stocks price movement follows random walk

Given the various contributions of different scholars on the random walk literature, none has investigated the case of the OPEC countries despite the role they play in world oil market and the concomitant effect it could have on their stock markets. Besides, most studies did not show whether the current stock price of a country member could be predicted using the historical stock price of another country member. Providing information about the effect that a price movement of one oil-producing country could have on the other will allow investors to spot mispricing in order to make more profit with moderate risk. It is in this area that the present study is unique and different from previous works.

3. DATA AND METHODOLOGY

There are two approaches for computing stock returns, namely, simple and continuously compounded. The simple return is the percentage change of stock prices. The continuously compounded returns is the log of difference of stock prices. Standard financial literature prefer the latter to the former for at least two reasons.



First, returns computed using continuously compounding approach renders the frequency of compounding irrelevant, and so, allows for any comparison of stock returns across firms or countries to be made. Second, it is possible to work with time-additive without necessarily violating the properties of the log returns (BROOKS, 2014). Given these reasons and what is commonly used in standard finance academic literature, the continuously compounded approach is utilized for this study and the specification is provided in equation 1. The equation says that the continuously compounded stock returns series, p is the log of difference of stock price series P , that is,

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

The predictability or otherwise of stock returns is linked to the presence of autocorrelation in the returns series. This implies that stock price return follows autoregressive process of the form provided in equation 2

$$p_t = \theta p_{t-1} + x\delta' + \varepsilon_t \quad 2$$

Equation 2 says that stock price return at time t , p_t , depends on information from past stock price, an exogenous variable x , which is normally a constant or constant and trend, and the error term that is assume to be pure white noise. The presence of unit root in equation 2 will require that the value of θ should be greater than or equal to unity in absolute term. If θ is less than unity in absolute term, it means the stock return is (trend)-stationary.

Many tests have been advanced to test the values of θ in equation 2. For the purpose of this work, three of such tests are utilized and these are the ADF, PP and KPSS. The augmented Dickey-Fuller 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 provide evidence for a random walk. Phillip Perron proposes long run variance using Newey-Wester estimation. The PP is difference 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 using the residual term in equation 8 and then use it to test the presence of stationarity (no random walk).

The acceptance or rejection of the presence of unit root in any of the equations provides necessary condition for random walk. According to Gilmore and MaManus (2003), the unit root tests did not account for the variance of the stock price returns which may correlate with the returns. There are many versions of variance ratio but this study considers three, that is, the individual variance ratio proposed by Lo and MacKinlay (1988), the multiple (or joint) variance ratio by Cho and Denning (1993), and the Wright (2000) tests.

The Lo and MacKinlay (1988) variance ratio is based on the assumption that the variance of the random walk increases linearly with time. The Lo and MacKinlay (1988) variance ratio has been the workhorse for testing the random walk hypothesis. There are two versions of the variance ratio tests, namely the homoscedasticity version, where it is assumed that the error terms are independently and identically distributed (*iid*) and no normality condition is considered necessary. This is called homoscedastic random walk hypothesis.

The second version is based on the assumption that the variance of random walk term is time-dependent. This assumption allows for more general forms of conditional heteroskedasticity and dependence. A random walk that follows heteroskedastic conditional variance is also called the martingale hypothesis. From these two versions, it is possible to investigate whether returns on stock price follow an *iid* (homoscedasticity) or martingale difference of sequence (heteroskedasticity).

The Multiple Variance-Ratio tests improved on the flaws of the Lo and MacKinlay variance ratio tests. The variance ratio test appears to overcome the problem of the predictability elements in the unit root approach but the condition for the presence of random walk is questionable. According to Chow and Denning (1993), the random walk test proposed by Lo and MacKinlay (1988) proposes that the variance ratio of lag q ($VR(q)$) must be 1 for all possible q . Since not only one q will be chosen, the result from this traditional VR test is only valid for individual q . Therefore, in a case of multiple q , the value of VR for all the available q should also be 1.

Thus, a joint test for $VR(q) = 1$ should be conducted for all q . The new $z(q)$ or $z^*(q)$, which is assumed to be standardized are then compared with standardized maximum modulus (smm) critical value. Upon the acceptance of the null hypothesis, it will be concluded that the



stock returns are either jointly homoscedastic random walk across q or Martingale random walk.

Meanwhile, the conventional variance ratio test was based on the fact that the series are normally distributed. The implication of this assumption is that when series of stock price is not normally distributed, in which case, it is right (or left) skewed, these variance ratios will be of little help for random walk analysis. Hence, caution should be exercised when interpreting the results of variance ratio tests when the series are non-normally distributed.

Hence, Wright (2000) proposed a statistical method to deal with this problem by developing a non-parametric variance ratio based on ranks and signs. These approaches appear to be more powerful and more appropriate than the previous tests. Further, the large sample condition for the conventional variance ratio test is relaxed. Therefore, under the condition of small sample size and or non-normal distribution, the Wright tests (ranks and sign) are capable for providing reliable decision on the nature of the stock returns.

As noted, there are two forms of the Wright test, that is, the ranks and signs. The ranks test are capable of dealing with problem of small sample distortion under heteroskedasticity while the sign is exact under conditional heteroskedasticity (UQUHART; MCGROHARTY, 2016). To develop the test, r_t is assumed to be the log of return $p(r)$ is the rank of $r(p)$ among (r_1, r_2, \dots, P_r) . Under the null hypothesis, r_t is *iid*, that is, a random permutation of numbers 1,2,3,..., T with equal probability for each t . Given this information, the rank-based variance ratio tests, that is, R_1 and R_2 is specified in equations 14 and 15

$$R_1(q) = \left(\frac{\frac{1}{T} \sum_{t=q}^T (r_{1t} + \dots + r_{1t-q+1})^2}{\frac{1}{T} \sum_{t=1}^T r_{1t}^2} - 1 \right) \Theta \sqrt{(q)} \quad 3$$

$$R_2(q) = \left(\frac{\frac{1}{T} \sum_{t=q}^T (r_{2t} + \dots + r_{2t-q+1})^2}{\frac{1}{T} \sum_{t=1}^T r_{2t}^2} - 1 \right) \Theta \sqrt{(q)} \quad 4$$

Where $\Theta \sqrt{(q)} = \sqrt{\frac{2(2q-1)(q-1)}{3qT}}$

$$r_{1t} = \frac{(r(p_t) - ((T+1)/2))}{\sqrt{[(T-1)(T+1)]/12}}$$



$$r_{2it} = \Phi^{-1}\left(\frac{r(p_t)}{T+1}\right)$$

Φ^{-1} is the inverse of the standard normal cumulative distribution function

T is the first difference of the variable p_t

Under the signs-based first difference is provided in equation 5:

$$S_j(q) = \left[\frac{(Tq)^{-1} \sum_{t=q}^T (s_{jt} + \dots + s_{it-q+1})^2}{T^{-1} \sum_{t=1}^T s_{jt}^2} - 1 \right] \sqrt{\left(\frac{2(2q-1)(q-1)}{3qT} \right)} \quad 5$$

Where $s_1 = 2u(p_t, 0)$ and $u(p_t, 0)$ is the $\frac{1}{2}$ if p_t is positive and if negative, the value will be $-\frac{1}{2}$

This study does not only investigate the predictive ability of stock returns in each country of interest but also investigate whether the current stock price of a particular oil producing country can be influenced by the previous price of any other oil producing country in the OPEC. The idea here is that if the stock returns behave randomly, they are likely to settle at a particular point in the long run. The implication of this is that if 2 countries' stock prices have long run relationship, then it is possible to use the current stock price of one country to guess the future stock prices of another country (GUIDI; GUPTA, 2013).

The outcome of this result will provide additional evidence to either accept or reject the random walk hypothesis. The traditional test statistic for cointegration is the use of trace and maximum Engle value. In the case of trace test, r cointegrating vector is computed with n cointegrating vector. The decision is that if $r = 0$, then there is no relationship among the nonstationary variables. For the maximum Engle value, r cointegration is related to $(r+1)$ cointegrating vector. Johansen cointegration begins with the specification of an autoregressive of order q of stock returns given in equation 6

$$p_t = \lambda + \phi_1 p_{t-1} + \phi_2 p_{t-2} + \dots + \phi_q p_{t-q} + \varepsilon_t \quad 6$$

Where p_t is a vector of cointegrated variable and ε_t is the $n \times 1$ innovation vector

The trace test likelihood and the maximum Engle values are provided as follow:

$$J_{trace} = -T \sum_{i=r+1}^n \ln(1 - \hat{\lambda}_i) \quad 7$$



$$J \max = -T \sum_{t=r+1}^n \ln(1 - \hat{\lambda}_{r+1}) \quad 8$$

Where T is the sample size and $\hat{\lambda}_i$ is the i^{th} biggest canonical correlation. The null hypothesis is that there is no cointegration among the variables. If this is rejected based on equations 7 and 8, then it will be suggested that current price of returns in one oil producing countries can be predicted by the previous price of another oil producing countries among the OPEC For the purpose of this study, all the tests explained above are carried out. Data for the stock prices were extracted for all the OPEC members from the International Monetary Fund's International Financial Statistics between January 2005 to April 2016.

4. RESULTS AND DISCUSSIONS

4.1. Properties of the series

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 4.2% in Venezuela. Hence, Venezuela had the highest expected stock returns among the OPEC countries under study. Nigeria's expected stock return was about 0.53% while that of UAE was 0.11%. Iran had the lowest expected stock returns, posting only 0.006% within the period of investigation. The lowest expected returns observed in Iran conforms with the work of Jamaani (2015). The maximum stock returns ranged between 0.01% in Iran and 11.5% in Venezuela. The maximum stock returns in Nigeria, Qatar and Kuwait were 0.8%, 0.08% and 0.04% respectively.

Table 1: Descriptive Statistics of the series across countries

	KUWAIT	NIGRERIA	IRAN	QATAR	SAUDI ARABIA	UAE	VENEZUELA
Mean	0.024	0.527	0.006	0.042	0.049	0.108	4.176
Maximum	0.036	0.835	0.011	0.082	0.083	0.163	11.572
Minimum	0.013	0.180	0.003	0.027	0.019	0.059	0.038
Std. Dev.	0.007	0.170	0.001	0.010	0.013	0.029	3.230
Skewness	-0.119	-0.358	0.178	0.938	0.009	0.127	0.213
Kurtosis	1.754	2.239	5.327	4.526	2.940	1.540	2.164
Jarque-Bera	8.982	6.098	30.952	32.639	0.022	12.259	4.915
Probability	0.011	0.047	0.000	0.000	0.989	0.002	0.086
Observations	134	134	134	134	134	134	134

The standard deviation, which measures the extent of risk incurred in investing in any of the stocks, reveals that Venezuela's stock appears to be the riskiest with standard deviation of 3.2%, followed by the Nigeria's with 0.17% standard deviation. Iran's stock had the lowest risk with standard deviation of 0.001%. The Table therefore confirms the trade-off between returns and risk. The literature predicts that stocks that exhibit high expected returns will be associated with high risk, so that for investors that is willing to capture more return will also



be ready face more risk. Venezuela's returns was the highest but also posed the highest risk (standard deviation). Nigeria's stock was the second highest returns but this is also associated with second most risky. Conversely, Iran had the lowest return but this is also associated with lowest risk

The skewness of returns was positive for all the countries except Kuwait and Nigeria. What this implies is that all the countries for which positive skewness were observed indicate asymmetric tail extending further towards positive monthly returns than negative. This provide first-hand information about the possible normality of the monthly stock returns. In the countries with negative skeweness, the asymmetry tail extend further towards negative monthly return than positive, providing a first-hand information about possible non-normality of the stock returns. The monthly Kurtosis are higher than 3 in two countries (Nigeria and Qatar), indicating that in these countries, the monthly return distribution have fatter tails. Virtually all the series are not normally distributed except the monthly stock return of Saudi Arabia, given the values of the Jarque-Bera probabilities.

The relationship of stock returns between any country pair is provided in Table 2. This Table shows that not all monthly stock returns among some OPEC countries have strong relationship. Only the monthly stock returns of Kuwait and Nigeria; Kuwait and Venezuela, UEA and Qatar and UAE and Saudi Arabia have strong correlation. If the monthly stock returns in Qatar increases, that of Saudi Arabia should also increase. The same interpretation goes for UAE-Saudi Arabia and Kuwait-Nigeria. However, the relationship between the stock returns of Kuwait and Venezuela was negative, suggesting that if the monthly stock returns in Kuwait increases, that of Venezuela will necessarily fall. This information could be important for investors willing to purchase Venezuela's stocks and or Kuwait stocks.

Table 2: Pairwise Correlation Matrix

	KUWAIT	NIGRERIA	IRAN	QATAR	SAUDI ARABIA	UAE	VENEZUELA
KUWAIT	1						
NIGRERIA	0.640	1					
IRAN	0.134	0.545	1				
QATAR	-0.099	0.102	0.317	1			
SAUDI ARABIA	0.438	0.360	0.038	0.631	1		
UAE	0.392	0.400	0.230	0.735	0.764	1	
VENEZUELA	-0.688	-0.132	0.216	0.310	-0.208	0.051	1

4.2. Test for Unit root/stationarity

Test for random work or weak-form efficiency of stock returns series in the OPEC countries are investigated by employing the first test, that is, the ADF, PP and KPSS. 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, suggesting that the markets are not efficient. 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 OPEC countries.

The result of the monthly ADF and PP test show that all OPEC returns on stock, except Iran, validates the null hypothesis of the manifestation of a random walk, at 1% and 5% significant level both at constant and constant and trend. When KPSS was utilized, the result is slightly different. As can be observed, the monthly KPSS test rejects the incidence of a unit root test in Nigeria and Iran stock returns at 1% and 5% significant level both at constant and constant and trend.

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

Countries	KUWAIT			NIGERIA			IRAN			QATAR			SAUDI-ARABIA			UAE			VENEZUELA		
	Model	Critical values		Critical values		Critical values		Critical values		Critical values		Critical values		Critical values		Critical values		Critical values			
		ADF test	1%	5%	ADF test	1%	5%	ADF test	1%	5%	ADF test	1%	5%	ADF test	1%	5%	ADF test	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

Table 4: Result of Phillips-Perron (PP) test for Random Walk

Countries	KUWAIT			NIGERIA			IRAN			QATAR			SAUDI-ARABIA			UAE			VENEZUELA		
	Model	Critical values		Critical values		Critical values		Critical values		Critical values		Critical values		Critical values		Critical values		Critical values			
		PP test	1%	5%	PP test	1%	5%	PP test	1%	5%	PP test	1%	5%	PP test	1%	5%	PP test	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	1.88	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

Table 5: Result of Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test for Random Walk

countries	KUWAIT			NIGERIA			IRAN			QATAR			SAUDI-ARABIA			UAE			VENEZUELA		
	Model	Critical values		Critical values		Critical values		Critical values		Critical values		Critical values		Critical values		Critical values		Critical values			
		KPSS test	1%	5%	KPSS test	1%	5%	KPSS test	1%	5%	KPSS test	1%	5%	KPSS test	1%	5%	KPSS test	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

To further investigate the independence of successive price changes of the selected OPEC stock returns, variance ratio tests are utilized. It must be recalled that the null hypothesis for random walk suggests the sum of the variance ratio should sum to unity. Consequently, it will be assumed that there is no autocorrelation (dependence) between the lags of the stock price returns. In the event that the value exceeds or not up to one, it will mean that the stock prices are actually predictable. The result of the variance ratio tests for monthly stock price returns of selected OPEC countries is presented in Table 6. In order to be consistent with the Wright lag selection, this study chose the 2,5,10 and 30 lags, with the consideration of homoscedastic and heteroskedastic growth of each country's stock returns' residuals. The result indicate that stock returns of Kuwait, Nigeria, Iran, UAE and Venezuela for lags 2, 5 and 10 are above the critical value at 5%.



Table 6: Variance Ratio test result based on

Number of months q, in holding period	2	5	10	30
KUWAIT				
VR(q)	1.38	2.07	2.58	2
z(q)	4.46***	5.7***	5.43***	1.89
z*(q)	1.81***	2.47***	2.53	0.74
NIGERIA				
VR(q)	1.23	1.73	2.14	1.5
z(q)	2.67**	3.81***	3.87***	0.93
z*(q)	1.81*	2.47**	2.53**	0.74
IRAN				
VR(q)	1.28	1.7	1.56	0.63
z(q)	3.27***	3.71***	1.94*	-0.7
z*(q)	2.61**	3.44***	2.42**	-0.4
QATAR				
VR(q)	1.03	1.03	0.9	0.21
z(q)	0.36	0.9	-0.3	-1.5
z*(q)	-0.1	0.14	-0.1	-1.2
SAUDI-ARABIA				
VR(q)	1.21	1.35	1.31	0.55
z(q)	2.45**	1.86*	1.05	-0.8
z*(q)	1.42*	1.4*	1.14	-0.8
UAE				
VR(q)	1.29	1.44	1.52	0.79
z(q)	3.36***	2.31**	1.78*	-0.4
z*(q)	1.71*	1.08	1.11	-0.6
VENEZUELA				
VR(q)	1.26	1.21	0.57	0.38
z(q)	2.94**	0.71	-0.8	-0.9
z*(q)	2.68**	3.2***	3.83***	4.42***

Note: **,*** implies significant at 5% and 1% respectively

This indicates that the random walk hypothesis is rejected at 5% level of significant. The homoscedastic random walk hypothesis in these countries show significantly positive serial correlations in lags 2, 5 and 10 and 5% level of significance. When investigating the Matingale hypothesis, in which case, the variances are heteroskedastic, the positive correlations for all these countries differ. For instance, it is only in the 2nd and 5th lags that the series follow Matingale difference in Kuwait, and Saudi Arabia. In Venezueala, the homoskedatic hypothesis can only be established at the 2nd lag while the Matingale difference is established in lags 2, 5 and 10. In UAE, the monthly series is more of homoscedastic than heteroskedastic. The null hypothesis for the presence of random walk of monthly Qatar stock returns cannot be rejected at 5% level of significance even after controlling for the presence of time-dependent variance.

The findings therefore indicate that the null hypothesis of independent dynamics of stock prices of all monthly OPEC stock returns, except Qatar, is significantly rejected. Put in another form, the stock price returns of Kuwait, Nigeria, Iran, Saudi Arabia, UAE and

Venezuela are not weak-form efficient. It must also be noted that the stock price of UAE and Saudi Arabia are more of homoscedastic than Matingale while the converse is the case in Venezuela.

The result of the multiple (joint) variance ratio tests of monthly OPEC stock market return under homoskedasticity and heteroskedasticity assumptions are presented in Table 7. As can be observed, there is evidence of significant autocorrelation in these markets except in Qatar. Under the homoskedasticity and heteroskedasticity growth assumptions for the monthly OPEC stock returns, the null hypothesis is rejected at 5% level of significance for all the markets except Qatar.

Table 7: Multiple Variance Ratio Test result based on

COUNTRIES	MV (Homo)	MV (Hetero)
KUWAIT	5.697***	4.429***
NIGERIA	3.869***	2.526**
IRAN	3.714***	3.444***
QATAR	1.500	1.200
SAUDI ARABIA	2.448*	1.424
UAE	3.355***	1.700
VENEZUELA	2.938*	4.420***

Note: *, **, *** implies significant at 10%, 5% and 1% respectively

Although the multiple variance ratio test solves the problem of possible period-dependence, both variance ratio (VR) and multiple variance ratio (MVR) computed on the basis that the stock returns are normally distributed. It must be noted that the result of VR and MVR could be statistically biased for stock returns that are not normally distributed. The statistical properties of the series provided in Table 1 actually indicates that except that of Saudi Arabia, the stock price returns of all other OPEC are not normally distributed, indicating that care must be exercised in interpreting these results. In order to circumvent this problem, the Wright's non-parametric tests are computed using equations 14 (R_1), 15 (R_2) and 16 (S) which is shown in Table 8 as Ranks, Ranks score and Signs of data respectively. For variance ratio test computed using ranks, rank scores and signs of the data, the probabilities are computed by permutation boot-strapping.

Table 8: Variance Ratio test result based on

q	2	5	10	30
KUWAIT				
Ranks	3.586***	4.032***	3.850***	0.3
Ranks Score	3.873***	4.6467***	4.517***	1
Signs of data	3.012***	2.766***	2.258*	-0
NIGERIA				
Ranks	3.172***	3.737***	3.788***	0.7
Ranks Score	3.053***	3.892***	3.979***	0.7



Signs of data	2.959***	3.369***	3.629***	0.633***
IRAN				
Ranks	2.587***	3.068***	2.129*	-1
Ranks Score	3.185***	3.929***	2.638***	-1
Signs of data	2.496*	2.766*	2.513*	1.3
QATAR				
Ranks	-0.4	-0.3	-0.16	-1
Ranks Score	-0.2	-0.14	-0.2	-1.553***
Signs of data	-0.9	-1.02	-0.94	-1
SAUDI ARABIA				
Ranks	1.33	1.25	0.972	-1
Ranks Score	1.47	1.29	0.821	-1
Signs of data	0.87	0.44	0.804	-0
UAE				
Ranks	1.1	1.43	1.513	-0
Ranks Score	1.65	1.64	1.697	-0
Signs of data	0.52	0.76	0.691	-0
VENEZUELA				
Ranks	3.111**	2.869**	1.959*	1.3
Ranks Score	3.115***	3.014***	1.853*	1.4
Signs of data	2.785***	2.988*	2.629*	1.4

Note: *, **, *** implies significant at 5% and 1% respectively

The results from the Wright tests are different from the earlier ones, owing to the correction of the non-normality condition. In the present result, Kuwait, Nigeria and Venezuela's stock market prices exhibit significant serial correlation, indicating that there is a strong relationship between past and current stock movement. Unlike the case of VR and MVR, stock price returns in Saudi Arabia and UAE exhibit random walk.

Hence it is clear that normality condition can actually provide wrong result for stock returns that exhibit non-normality. Meanwhile, the stock price returns in Qatar still maintains the non-predictability situation. Hence, whether normality or non-normality holds, Qatar's stock price movement is weak-efficient. In the case of Saudi Arabia and UAE, the stock price exhibits non-normality distribution and it is so strong that only when it is taken into consideration that a reliable non-predictability can hold.

The results obtained so far investigated the weak-form efficiency at the country-specific level. The major objective of this work is to examine the possible long run convergence of these stock prices, that is, to show whether the movement in the previous sock returns in one country can influence the current stock return of another. The Johansen cointegration test requires stock price returns to be integrated at the same order². To perform Johansen

² The result of the unit root test at levels and 1st difference for the ADF, PP and KPSS (not shown here) indicates that the series are integrated of order one (I(1)) when constant and trend are applied.

cointegration test, there is need to choose the lag length. For the purpose of this study, 4 lags were chosen so as to allow for longer testing windows. Johansen cointegration can be tested based on 5 assumptions.

Out of these five, this study based its assumption on the presence of a linear deterministic trend in the stock returns of the countries under investigation. The basis for this assumption is that linear growth of stock market price is expected as the countries experience economic and stock market boom. In the linear deterministic trend, we employed both deterministic trend with intercept and then with intercept and trend.

Table 9: Johansen cointegration test for the monthly stock price returns of selected OPEC

Number of cointegrating vector	Intercept without trend				Intercept with trend			
	Trace Statistic	5% critical values	Max-Eigen statistic	5% critical value	Trace Statistic	5% critical values	Max-Eigen statistic	5% critical value
None *	200.41	150.56***	47.45	46.23**	168.41	125.62***	51.73	50.60**
At most 1 *	148.68	117.71***	38.27	40.08	120.96	95.75***	46.21	44.50**
At most 2 *	102.47	88.80**	35.86	33.88**	82.69	69.82***	36.30	38.33
At most 3 *	66.17	63.88	23.95	27.58	46.83	47.86	24.18	32.12
At most 4	41.98	42.92	15.98	21.13	22.88	29.80	22.41	25.82
At most 5	19.57	25.87	6.85	14.26	6.90	15.49	13.55	19.39
At most 6	6.02	12.52	0.05	3.84	0.05	3.84	6.02	12.52

The result reveals that there is long run relationship among the monthly stock price returns of the OPEC under review (Table 9). The test result is shown with the two possible assumptions. In both cases, the Trace and Max-Eigen test statistics rejected the null hypothesis of the presence of no long run relationship between OPEC stock price returns. Three cointegrating vectors are present for monthly OPEC stock price returns at 5% level of significance in the case of trace statistics while one cointegrating vector is present when Max-Eigen value was computed. In which case, the implication of this is that the OPEC stock price returns are actually not weak-form efficient as a whole. This result implies that investors should be able to predict the future movement of one of the OPEC countries in our sample, from the previous movement patterns of another country's stock market price in the same Organization.

To further explore into the joint efficiency nature of monthly stock market price, this study also examines the test that jointly consider all seven monthly stock price returns in a panel setting. The result from the exercise will show whether the monthly stock prices of OPEC members as a group are predictable or not. The panel result provided in Table 10 comprises the VR homoskedastic random walk hypothesis, VR martingale-based, and Wright's non-parametric ranks; ranks scores and signs of data.

The Fisher combine bootstrap probabilities is significant at 1% level virtually all the test types. This implies that the monthly stock market returns of the OPEC as a group is not weak-efficient, indicating that the OPEC monthly price return as a whole is predictable. But which country actually drive this predictability ability? In the homoscedastic random walk assumption, the monthly stock price return of Kuwait, Nigeria, Iran and UAE are the driving force. When we corrected for heteroskedasticity, Kuwait, Nigeria, Iran and Venezuela are the driving force. The monthly stock prices of these same countries accounted for the strong predictability of the movement in the OPEC stock prices for all other test types except the Wright signs test where Nigeria, Kuwait and Iran are the driving force.

Table 10: Panel Result of Batteries of tests for Random Walk

Model	Homoskedasticity				Heteroskedasticity				Wright Rank test (1)					Wright Rank Test (2)					Wright sign test								
	Max(z)	prob	Wald	Prob	Max(z)	prob	Wald	Prob	Max(z)	prob	Wald	Prob		Max z	Prob.	Wald	Prob.		Max z	Prob.	Wald	Prob.					
Fisher combine	50.8***	0	50.126	0	45.89***	0			60.9***	0	40.16	0		49.1***	0	41.0	0		38.3***	0.00	38	5E-04					
Cross-section	Max z	Prob.	Wald	Prob.	Obs.	Cross-section	Max z	Prob.	Obs.	Cross-section	Max z	Prob.	Wald	Prob.	Obs.	Cross-section	Max z	Prob.	Wald	Prob.	Obs.	Cross-section	Max z	Prob.	Wald	Prob.	Obs.
1	6.74***	0.00	48.50	0.00	135	1	4.29	0.00***	135	1	4.03***	0.00	33.06	0.00	135	1	4.65***	0.00	35.93	0.00	135	1	3.01***	0.00	19.04	0.00	135
2	5.05**	0.02	28.31	0.03	132	2	2.54	0.02**	132	2	3.79***	0.00	26.47	0.00	132	2	3.98***	0.00	29.28	0.00	132	2	3.63***	0.00	26.01	0.00	132
3	5.68***	0.00	46.50	0.00	135	3	3.38	0.00***	135	3	3.07***	0.01	18.89	0.00	135	3	3.93***	0.00	26.74	0.00	135	3	2.77	0.06	8.84	0.13	135
4	1.16	0.72	5.79	0.49	132	4	1.25	0.58	132	4	1.45	0.42	5.33	0.30	132	4	1.55	0.32	5.14	0.32	132	4	1.02	0.72	1.32	0.91	132
5	2.33	0.18	13.71	0.12	132	5	1.43	0.36	132	5	1.33	0.55	9.93	0.06	132	5	1.47	0.41	10.08	0.05	132	5	0.87	0.71	4.92	0.25	132
6	3.13	0.06	18.98	0.06	132	6	1.71	0.22	132	6	1.51	0.35	8.18	0.10	132	6	1.70	0.21	11.27	0.03	132	6	0.76	0.92	2.16	0.84	132
7	3.67	0.12	19.48	0.03	132	7	2.49	0.05	132	7	3.11	0.00	11.09	0.03	132	7	3.12***	0.00	11.18	0.03	132	7	2.99	0.07	10.19	0.13	132

Note: 1= Kuwait; 2= Nigeria; 3= Iran; 4 = Qatar; 5 = Saudi Arabia; 6 = UAE; 7 = Venezuela

5. Conclusion and Policy implications

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 having up-to-date information about the working mechanism of the markets while the policy makers are interested in the alternative policy that will enhance the growth of the market as a tool for macroeconomic stability.

Each of these economic agents will like to understand the type of behavior of the stock returns. The specific question answered by this paper is whether the stock returns of the OPEC



country members are jointly efficient or otherwise. The result will be useful for the investors willing to buy any of the OPEC country member's stocks. Additional objectives include investigating the presence of risk-return trade-off of the stock. Monthly stock price index of each OPEC countries were obtained from January 2005 to April, 2016 for seven OPEC countries, that is, Kuwait, Nigeria, Iran, Qatar, Saudi Arabia, UAE and Venezuela.

The risk-return tradeoff was established in the countries under review. Venezuela stock provided the maximum expected return but also had the highest risk. Conversely, Iran had the lowest monthly expected returns among the OPEC members and this is also associated with the lowest risk. Further, strong relationship among the oil-rich Asian countries that are OPEC members were observed. 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.

The results of various variance ratio tests suggest that stock markets of the OPEC members are actually not weak-efficient. Indicating that present stock price movement can be used to predict future price movement. The result does not only hold for country-specific (single) market but also for all the markets as a whole. Meanwhile, the driving force of this predictability are the stock price movement of Kuwait, Nigeria and Iran. Venezuela contributed to it at some period later.

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 that stock price returns of the oil-rich OPEC are not weak-form either individually (except Qatar) or as a group. Also, we conclude 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).

Some implications can be drawn from these results. First, according to Jamaani (2015), efficiency of the equity market affords a theoretical and predictive model useful for the operation in the equity market that will help investors, particularly in the economies that share



the same characteristic such as the oil producing countries. This information will enable them identify possible mispriced assets, which in turn enable them to adjust their risk-return trade-off. The regulator will also benefit from efficiency equity market because it will act as a safeguard mechanism that will shield the market from possible asymmetry information emanating from the participants and by implication dwarfing regional and global investment capital flow. The result from this study will goes a long way to provide useful information for the participants in the equity markets of the oil-rich developing countries that are members of OPEC.

Second is on the relationship observed among the stock returns. As long as the relationship is not so strong that the correlation is 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 but will high return and that it negatively related with Kuwaiti stock return, more of Kuwait could be purchased while less of Venezuela should be purchased.

However, there are opportunities for further research. The result shows that the stock prices of the OPEC are jointly inefficient. It is important to investigate which of the factors significantly responsible for this. A relatively high frequency data such as weekly or daily could also be employed to test the robustness of our work. This is important if the market can quickly adjust to news in the market. Daily and or weekly data will track the news more than monthly data and so, it is important to test whether the monthly data actually fail to track the news.

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