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Volatility spillover and hedging effectiveness among crude oil and Islamic markets: evidence from the Gulf region

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Abstract

This paper studies the volatility spillover between oil price and conventional and Islamic stock markets. We use a sample of five standard MSCI indexes and their Islamic counterparts from five countries from the Gulf region (Jordan, Kuwait, Oman, Qatar, UAE) and Brent crude oil price index, obtained from MSCI and Energy Information Administration (EIA), to represent the world oil market. We analyze the spillover effects between crude oil and Islamic and conventional indexes using the bivariate VARMA-BEKK-GARCH model of Ling and McAleer (2013), which includes spillover effects in return and variance. Our findings show particular specificities of Islamic marketplaces in reducing the volatility transmission and lowering the volatility persistence, which gives the investors and market participants an opportunity in terms of international diversification and hedging effectiveness. Although our results are indicative of crude oil hedging strategies, they also testify the distinction of Islamic financial markets and raises the issue of strategic posture and competitiveness in the global financial system.

JEL classification: G11, G15, G32, E3

Keywords: Volatility spillover, Gulf region, Oil price, Islamic finance

1. Introduction

Oil has a great importance in modern global economy. Several studies have investigated the role played by oil price in financial markets. Understanding the return and volatility spillovers effects between the Gulf region and oil markets is of great importance because the countries in this region of the world are the major players in the global oil market. According to EIA (Energy Information Administration), the countries of the Gulf region possess the largest part of the world oil reserves. Exploring the characteristics of return and volatility spillovers across Gulf markets using conventional and Islamic indexes is helpful for institutional and individual investors to endorse and implement more effective risk management strategies and asset allocation. Various empirical studies explore the issue of volatility spillover between oil and conventional

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stock markets and show some difference in return structure and volatility spillover. (e.g., Narayan and Sharma, 2011; Arouri et al., 2012).

The objective of this article is to build on this empirical literature and study the volatility spillover difference between oil price and both conventional and Islamic stock markets.[1] Malik and Hammoudeh (2007) examine the volatility and shock transmission mechanism among US equity, global crude oil market, and equity markets of Saudi Arabia, Kuwait, and Bahrain. The results of the authors show that, in all cases, Gulf equity markets receive volatility from the oil market, with the exception of a significant volatility spillover from the Saudi market to the oil market. Arouri et al. (2012) study the transmission of volatility between the oil markets to the European stock markets using the VAR-GARCH model. The results show that the volatility spillover between oil prices and stock market returns is significant. In addition to this fact, Arouri et al. (2012) show that the link between oil prices and stock market is important for portfolio management and optimal hedging.

Zhang and Wang (2014) analyze the return and volatility spillovers between China and world oil markets and show that the return and volatility spillovers between them are bi-directional and asymmetric. Jouini and Harrathy (2014) explore the empirical evidence of the volatility structure among the GCC stock markets and oil price between 2005 and 2011 and show evidence of asymmetric shock and volatility spillover among GCC stock and oil markets. Recently, Narayan and Gupta (2015) investigate the integration structure between the oil and US stock markets over a century based on a predictive regression model. The findings show that the oil return predicts US stock returns and document asymmetric effects among series.

The dynamics of volatility structure and linkages between conventional and Islamic stock indexes was introduced by Majdoub and Mansour (2014) who investigate the conditional correlations between Turkey, Indonesia, Pakistan, Qatar, and Malaysia and US market. They find a low dynamic conditional correlation in the case of the Islamic MSCI index compared to conventional indexes. Several additional studies investigated recently the co-movement between standard and

[1] See Majdoub et al. (2018) for an empirical study of the impact of volatility of energy markets on Islamic equity markets. See Almarzoqi et al. (2018) for the conceptual foundation of Islamic stock markets.

Islamic index (e.g., Hammoudeh et al. 2014; Jawadi et al., 2014; El Aloui et al., 2015; and Majdoub et al., 2016)

The research question of this article aims at filling the gap in the empirical literature by exploring whether there is interplay between the volatility of Islamic equity market index and the volatility of the oil price. In other words, we will study the extent to which the volatility spillover of the Islamic equity index can be modified when compared to the volatility spillover of the conventional index. In order to reach this goal we use daily data about market index return and oil price spanning over February 21, 2011 to February 16, 2016. The remaining of the paper is organized as follows. Section 2 provides the econometric method. Section 3 describes the data and preliminary analysis. Section 4 presents the interpretation of results and policy implications. Section 5 concludes.

2. Econometric design

We use the VARMA(1,1)-BEKK-GARCH(1,1) model developed by Ling and McAleer (2003) and applied by Arouri et al. (2011) and Salisou and Oloko (2015) - in various economic settings - to investigate the volatility spillover between oil and conventional and Islamic stock markets in Gulf countries as well as to determine the optimal weights and hedge ratios for oil and conventional and Islamic stock portfolios. This section outlines this model and sheds some light on the features of portfolio management embedding oil-risk hedging strategies.

2.1. Bivariate VARMA(1,1)-BEKK-GARCH(1.1) model

We estimate the model in order to assess the dynamic difference between two pairs, namely oil/MSCI conventional index and oil/MSCI standard index for each country in the Gulf region. We specify the bivariate VARMA(1,1)–BEKK–GARCH(1,1) model under separate headings for the conditional mean equation and conditional variance equations as follows.

2.1.1. The conditional mean equation

The conditional return equation and its corresponding variables are given as follows:

$$\begin{cases} R_t = \mu + \Omega R_{t-1} + \varepsilon_t + \Phi \varepsilon_{t-1} \\ \varepsilon_t = D_t \eta_t \end{cases} \tag{1}$$

where

$R_t = (r_t^o, r^{s_{ij}})$, r_t^o and $r_t^{s_{ij}}$ are the returns pertaining to crude oil and each S_{ij} stock markets index, respectively.

$i = 1$, corresponds to the conventional market and $i = 2$ corresponds to the Islamic market.

$j = 1$ for Jordan ; $j = 2$ for Kuwait ; $j = 3$ for Oman ; $j = 4$ for Qatar ; $j = 5$ for UAE.

μ is a (2 × 1) vector of constant terms of the form $\left(\mu^o, \mu^{s_{ij}}\right)$.

Ω is a (2 × 2) matrix of coefficients of the form $\Omega = \begin{pmatrix} \omega_{11} & \omega_{12} \\ \omega_{21} & \omega_{22} \end{pmatrix}$.

$\varepsilon_t = (\varepsilon_t^o, \varepsilon_t^{s_{ij}})$, ε_t^o and $\varepsilon_t^{s_{ij}}$ are the residual terms of the mean equations for oil stock and each stock markets returns, respectively.

Φ is a (2 × 2) matrix of the coefficients of lagged terms of residuals of the form $\Phi = \begin{pmatrix} \varphi_{11} & \varphi_{12} \\ \varphi_{21} & \varphi_{22} \end{pmatrix}$, which explains shock spillovers between oil stock return and each stock markets returns, respectively.

$\eta_t = (\eta_t^o, \eta_t^{s_{ij}})$ refers to a sequence of independently and identically distributed random vectors.

$D_t = diag(\sqrt{h_t^o}, \sqrt{h_t^{s_{ij}}})$, h_t^o and $h_t^{s_{ij}}$ are respectively the conditional variances of r_t^o and $r_t^{s_{ij}}$.

2.1.2. The conditional variance equation

The conditional variance equation and its corresponding variables are given as follows:

$$H_t = \Theta'\Theta + A'\varepsilon_{t-1}\varepsilon_{t-1}'A + B'H_{t-1}B \qquad (2)$$

where A and B are square matrices and Θ is a lower triangular matrix defined as follows:

$$A = \begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{pmatrix} \qquad B = \begin{pmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{pmatrix} \quad and \quad \Theta = \begin{pmatrix} \theta_{11} & 0 \\ \theta_{21} & \theta_{22} \end{pmatrix}$$

As Eq. (2) shows, H_t is the conditional variance–covariance matrix that defines the market volatility. The elements of matrix A are the ARCH coefficients that reflect the shocks effect in the market and shocks spillover from other market on the conditional volatility of a given market. In addition, the elements of matrix B are the GARCH coefficients indicating the effect of past volatility in the own market and past volatility spillover from the other market on the conditional volatility of a given market.

It must, however, be noted that the ARCH terms represent the short-term persistence volatility since the effect of shocks on conditional volatility is not expected to last a long period. The GARCH terms represent the long-term persistence volatility given the autoregressive nature of conditional volatility. Furthermore, the summation of ARCH and GARCH terms for a particular market is expected to be positive and less than the unity to satisfy the mean reverting condition. In other words, the sum of these terms is expected to be positive and less than the unity for the establishment of the long-run equilibrium in conditional volatility. In addition, the magnitude of summation of these terms for a particular market determines the speed of convergence of the conditional volatility in the market to its long run equilibrium.[2]

[2] The structural and statistical properties of the model we use, including the necessary and sufficient conditions for stationarity and ergodicity of VARMA-BEKK-GARCH, are explained in detail in Ling and McAleer (2003).

The resulting variance and covariance equations for the estimation of bivariate VARMA–BEKK–GARCH can be expressed as follows:

$$h_{11,t} = \theta_{11}^2 + a_{11}^2\varepsilon_{1,t-1}^2 + a_{21}^2\varepsilon_{2,t-1}^2 + 2a_{11}a_{21}\varepsilon_{1,t-1}\varepsilon_{2,t-1} + b_{11}^2 h_{11,t-1} + b_{21}^2 h_{22,t-1} + 2b_{11}b_{21}h_{21,t-1} \tag{3}$$

$$h_{22,t} = \theta_{22}^2 + a_{12}^2\varepsilon_{1,t-1}^2 + a_{22}^2\varepsilon_{2,t-1}^2 + 2a_{12}a_{21}\varepsilon_{1,t-1}\varepsilon_{2,t-1} + b_{22}^2 h_{22,t-1} + b_{12}^2 h_{11,t-1} + 2b_{22}b_{21}h_{21,t-1} \tag{4}$$

$$h_{21,t} = \theta_{21}\theta_{22} + a_{11}a_{22}\varepsilon_{1,t-1}^2 + a_{21}a_{22}\varepsilon_{2,t-1}^2 + (a_{21}a_{12} + a_{11}a_{22})\varepsilon_{1,t-1}\varepsilon_{2,t-1} + b_{11}b_{22}h_{11,t-1}$$
$$+ b_{21}b_{22}h_{22,t-1} + (\mathrm{b}_{21}\, b_{12} + b_{11}b_{22})h_{21,t-1} \tag{5}$$

Eqs. (3) and (4) measure the own volatility for crude oil and each conventional/Islamic stock markets, respectively, for all countries. Eq. (5) measure the volatility spillover between crude oil return and each conventional/Islamic stock market in all countries.

2.2. Portfolio management with oil-risk hedging strategies

We compute the optimal weights of oil-conventional stock and oil-Islamic stock portfolios as well as the optimal hedge ratios for the purpose of analyzing the hedging effectiveness. Following Kroner and Ng (1998), the portfolio optimal weight of crude oil/ conventional stock and crude oil/ Islamic stock is given by:

$$w_t^{os_{ij}} = \frac{h_t^o - h_t^{os_{ij}}}{h_t^{s_{ij}} - 2h_t^{os_{ij}} + h_t^o}$$
$$and, \tag{6}$$
$$w_t^{os_{ij}} = \begin{cases} 0, & if \;\; w_t^{so} < 0 \\ w_t^{so}, & if \;\; 0 \le w_t^{so} \le 1 \\ 1, & if \;\; w_t^{so} > 1 \end{cases}$$

where $w_t^{os_{ij}}$ refers to the weight of oil in a one-dollar of the two assets defined at time t, $h_t^{s_{ij}}$ and h_t^{o} are the conditional variances of conventional/Islamic stock index and the oil market respectively. The term $h^{os_{ij}}$ corresponds to the conditional covariance between oil and each stock market at time *t*. The weights of the stock index in our considered portfolios are obtained by the amount $(1 - w_t^{os_{ij}})$.

The objective of the investor is to optimally hedge the risk related to her investment in oil stock. She should take an appropriate position on the stock market such that she minimizes the risk of the hedged portfolio. A long position (buying) of one dollar on the oil stock must be hedged by a short position (selling) of $\beta_t^{os_{ij}}$ dollars on the stock market *i,j*. Following Kroner and Sultan (1993) and Hammoudeh et al. (2009), the minimum-variance, optimal hedge ratio β_t^{so} can be expressed as:

$$\beta_t^{os_{ij}} = \frac{h_t^{os_{ij}}}{h_t^{o}} \qquad (7)$$

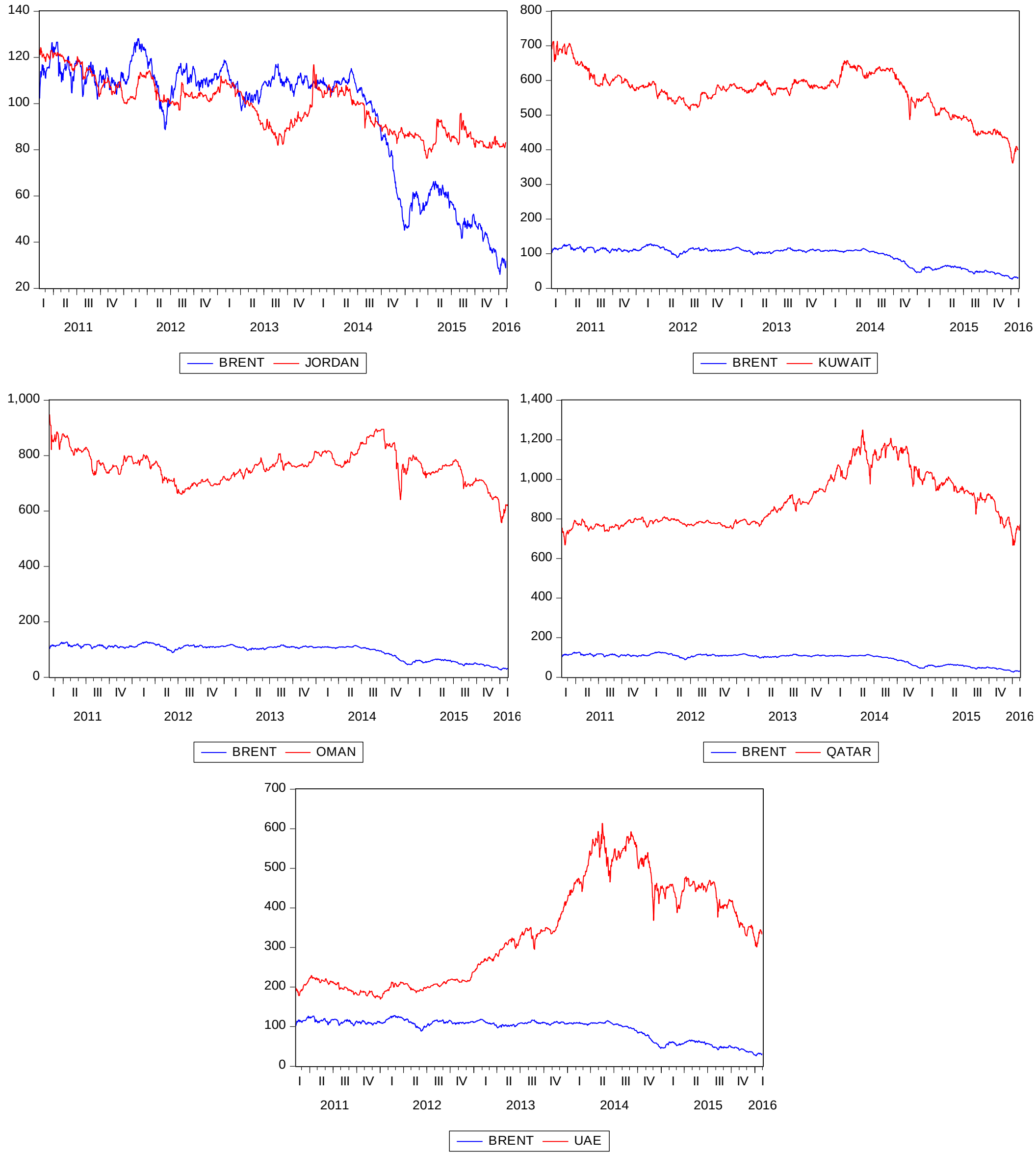
3. Data description and preliminary analysis

We consider daily data about conventional and Islamic MSCI[3] equity markets of five countries in Gulf region (Jordan, Kuwait, Oman, Qatar, UAE) and crude oil Brent Stock from February 21, 2011 to February 16, 2016, yielding 1302 observations. The Saudi market is excluded from our Gulf region sample because of the unavailability of historical data. We, however, do not use supplementary historical data for the other series to exclude the effect of the global financial crisis in our study. The data are collected from the Morgan Stanley Capital International (MSCI) database and Energy Information Administration (EIA). All items are denominated in US dollars to preserve the homogeneity across equity markets and avoid the effects of currency risk. In contrast to previous works on the comovement between oil and equity stock markets, the empirical contribution of this article is based on the conventional MSCI index and

[3] Majdoub and Mansour (2014) provide a detailed description of the difference between the conventional MSCI index and its Islamic counterpart and the corresponding conditions to include companies into this index. Mansour et al. (2015) explain the ethical and *shari'ah*-related maxims lying behind the design of Islamic indexes and the related conditions/filters.

its Islamic counterpart that stems from the *shari'ah* maxims. This allows us to further diversify the analysis of comovements across financial markets and the related international portfolio diversification in the light of different financial intermediation modes (i.e., conventional vs. Islamic).[4]

Figure 1a. Brent vs. daily conventional index



[4] Some empirical results are not reported in this article. They, however, are available upon request from the corresponding author.

Figure 1b. Brent vs. daily Islamic index

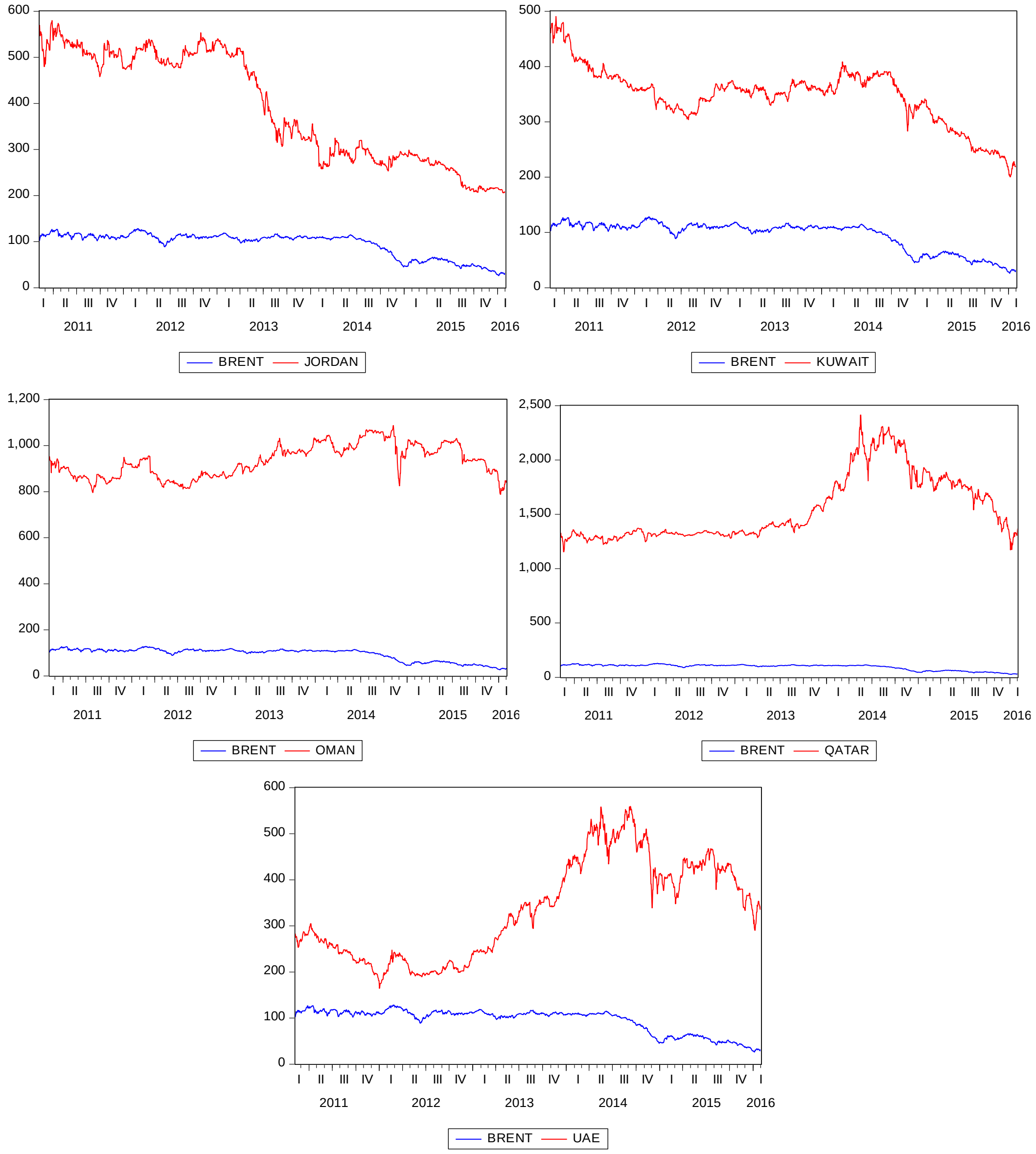


Figure 2a. Daily returns of Brent and conventional indexes

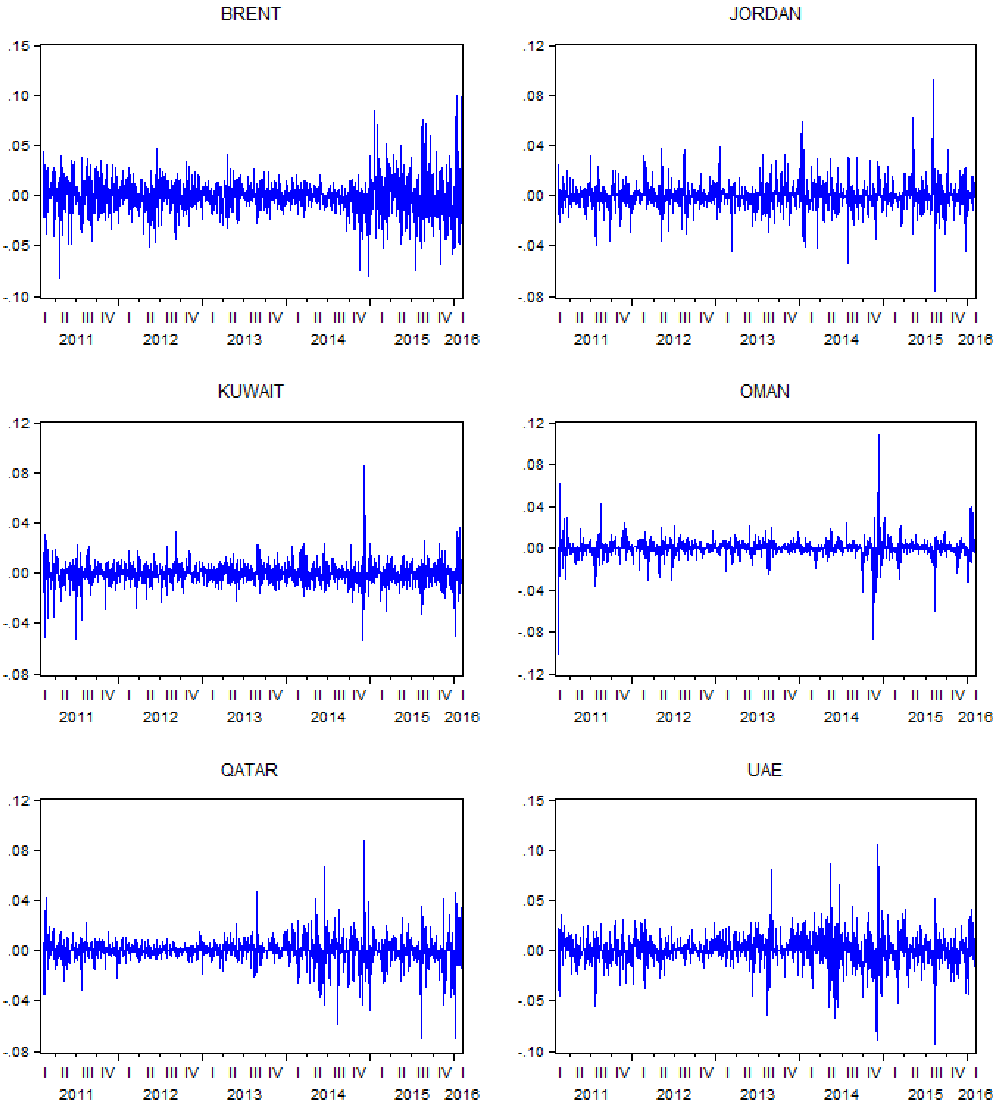


Figure 2b. Daily returns of Brent and Islamic indexes

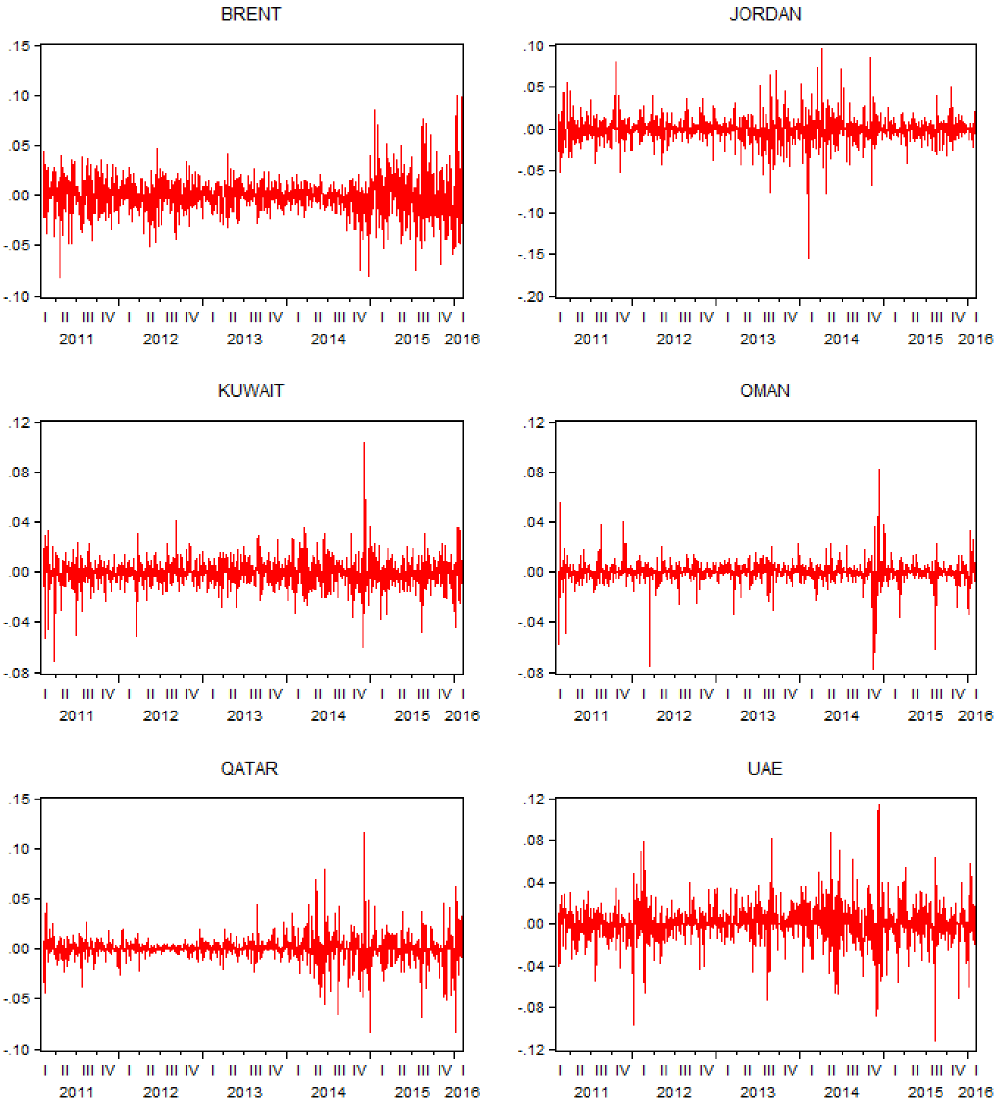


Table 1a. Descriptive statistics and statistical properties of conventional indexes.

Series	Obs	Mean	Median	Max	Min	Std.dev	Skew	Kurto	JB	LB-Q (1)	LB-Q (5)	LB-Q (10)	ARCH LM test(1)	ARCH LM test(5)	ARCH LM test(10)
BRENT	1302	94,847	108,02	128,1	26,01	26,521	-1,097	-0,297	266,02***	1295,36***	6385,9***	12542,2***	1293,1***	1289,3***	1284,4***
JORDAN	1302	99,032	100,71	124,2	76,32	11,478	0,104	-0,954	51,77***	1287,64***	6260,0***	12152,1***	1262,8***	1260,2***	1255,5***
KUWAIT	1302	568,510	578,73	713,1	361,64	63,193	-0,624	0,571	102,32***	1286,51***	6246,7***	12068,0***	1281,8***	1278,2***	1275,9***
OMAN	1302	761,097	763,29	948,5	558,24	59,494	-0,096	0,435	12,32***	1271,62***	6041,1***	11318,6***	1252,7***	1252,1***	1261,9***
QATAR	1302	885,135	824,49	1249,1	666,68	133,193	0,790	-0,566	152,97***	1296,30***	6392,1***	12548,3***	1266,4***	1262,9***	1258,8***
UAE	1302	333,718	327,25	613,1	169,38	126,127	0,361	-1,217	108,76***	1300,74***	6467,4***	12841,3***	1277,1***	1273,6***	1269,93***
RETURN															
BRENT	1301	-9,147E-4	0	0,098	-0,082	0,017	0,166	4,101	917,3***	7,53***	12,76	17,816	36,1***	79,39***	133,57***
JORDAN	1301	- 3,02 E-4	0	0,092	-0,075	0,010	0,473	10,439	5956,8***	15,49***	45,27	48,885	54,0***	159,46***	183,36***
KUWAIT	1301	-4,09E-04	0	0,085	-0,054	0,008	7,1E-03	11,766	7505,4***	0,378	5,22	12,127	10,6***	130,27***	141,94***
OMAN	1301	-3,20E-04	0	0,108	-0,101	0,009	-0,646	36,181	71053,3***	0,242	39,37	52,310	20,8***	66,53***	81,35***
QATAR	1301	1,63E-05	0	0,088	-0,069	0,010	-0,069	11,781	7524,9***	0,014	8,78	11,018	30,2***	58,92***	81,96***
UAE	1301	4,23E-04	0	0,105	-0,093	0,015	-0,220	7,908	3401,0***	1,769	6,08	14,242	19,0***	227,04***	247,29***

Table 1b. Descriptive statistics and statistical properties of Islamic indexes.

Series	Obs	Mean	Median	Max	Min	Std.dev	Skew	Kurto	JB	LB-Q (1)	LB-Q (5)	LB-Q (10)	ARCH LM test(1)	ARCH LM test(5)	ARCH LM test(10)
BRENT	1302	94,847	108,025	128,1	26,01	26,521	-1,097	-0,297	266,0***	1295,3***	6385,9***	12542,2***	1293,1***	1289,3***	1284,4***
JORDAN	1302	390,728	365,463	579,7	205,8	119,15	-0,057	-1,669	151,9***	1297,2***	6422,8***	12706,1***	1266,7***	1263,2***	1259,8***
KUWAIT	1302	346,668	357,0545	490,5	200,5	52,079	-0,411	0,576	54,79***	1287,3***	6267,0***	12140,8***	1283,4***	1279,8***	1277,4***
OMAN	1302	931,971	932,3655	1086,8	788,6	69,731	0,127	-1,058	64,33***	1286,4***	6232,7***	11911,4***	1248,1***	1244,6***	1241,0***
QATAR	1302	1546,742	1391,085	2413,4	1155	297,81	0,970	-0,280	208,7***	1297,1***	6409,0***	12626,5***	1267,6***	1264,6***	1260,4***
UAE	1302	333,444	329,772	559,3	164,4	105,68	0,275	-1,205	95,28***	1299,6***	6450,2***	12772,4***	1269,0***	1265,4***	1262,2***
RETURN															
BRENT	1301	-9,1E-04	0	0,098	-0,082	0,0176	0,166	4,101	917,9***	7,531***	12,767**	17,816**	36,126***	79,396***	133,57***
JORDAN	1301	-7,6E-03	0	0,0959	-0,154	0,0155	-0,259	13,00	9179,9***	0,165	7,753	21,328**	9,286***	16,210***	23,015***
KUWAIT	1301	-5,6 E-03	0	0,1026	-0,070	0,0109	0,042	9,997	5418,8***	3,563	6,922	15,077	2,785	101,75***	109,56***
OMAN	1301	-9,0E-05	0	0,0817	-0,076	0,0085	-1,098	25,69	36045,5***	0,017	26,584	39,863	14,533***	99,413***	123,24***
QATAR	1301	2,4E-05	0	0,1160	-0,083	0,0125	0,164	14,29	11087,3***	1,9E-05	5,660	10,414	18,425***	51,551***	68,99***
UAE	1301	1,5E-05	0	0,1131	-0,111	0,0177	-0,128	7,292	2886,0***	0,349	6,054	16,454	8,321***	165,29***	186,30***

Table 2a. Empirical unconditional correlations between Brent and conventional equities

Level series	BRENT	JORDAN	KUWAIT	OMAN	QATAR	UAE
BRENT	1	0,76901082	0,79335083	0,4124316	-0,2094328	-0,4384358
JORDAN		1	0,69688551	0,34792664	-0,3939116	-0,5473315
KUWAIT			1	0,7639879	0,1339816	-0,0868132
OMAN				1	0,450658	0,28876907
QATAR					1	0,93600567
UAE						1
Returns	**BRENT**	**JORDAN**	**KUWAIT**	**OMAN**	**QATAR**	**UAE**
BRENT	1	0,00186598	0,07552036	0,03957317	0,10006183	0,11901244
JORDAN		1	0,11361817	0,16723951	0,15887031	0,14733313
KUWAIT			1	0,31132789	0,32752033	0,35999896
OMAN				1	0,41817755	0,43340308
QATAR					1	0,60780436
UAE						1

Table 2b. Empirical unconditional correlations between Brent and Islamic equities

Level series	BRENT	JORDAN	KUWAIT	OMAN	QATAR	UAE
BRENT	1	0,74666593	0,79983272	-0,2007021	-0,3280969	-0,4406397
JORDAN		1	0,57370241	-0,6480608	-0,7124377	-0,8452662
KUWAIT			1	0,03853269	-0,065251	-0,1515064
OMAN				1	0,81012753	0,83543302
QATAR					1	0,9103012
UAE						1
Returns	**BRENT**	**JORDAN**	**KUWAIT**	**OMAN**	**QATAR**	**UAE**
BRENT	1	0,01844146	0,0598233	0,02876445	0,11227137	0,11573406
JORDAN		1	0,0137863	0,06193278	0,1036111	0,10744713
KUWAIT			1	0,21915466	0,29600889	0,3291428
OMAN				1	0,31488813	0,33500351
QATAR					1	0,53415857
UAE						1

Tables 1a and 1b report the summary statistics for returns. Figures 1a and 1b show the dynamics of stock indexes. Figures 2a and 2b show the dynamics of return. The return series of the sample means and medians are close to zero. All series are leptokurtic, which is evidenced by the fact that the excess kurtosis coefficient exceeds 2. The JB test shows that the series are not normally distributed. The ARCH LM tests are indicative of a strong evidence of ARCH effects for 1, 5 and 10 lags. The unit root tests (not reported) indicate that all series of daily returns are stationary. All return series reject the null hypothesis of no ARCH effects at 1% level of statistical significance until 10 lags, while the Jung-Box Q-statistic test implies that there is a statistically significant autocorrelation in return series up to 10 lags for all series. Tables 2a and 2b show the matrices corresponding to the empirical unconditional correlations between oil price and conventional and Islamic indexes, respectively.

4. Results and policy implications

Table 3 shows the results of the estimated model. Using the model selection criteria, we find that the VARMA-BEKK-GARCH outperforms CCC and DCC models.[5] The results in Table 3 are divided into two panels. Whilst the first panel presents the results corresponding to the crude oil and conventional index, the second panel presents the results corresponding to crude oil and Islamic index. The mean equation analyzes the return and shock spillovers of returns and the variance equation analyzes the volatility and shock transmission for all markets.

4.1. Spillover returns effect between crude oil and both conventional and Islamic stock market

The mean equation results indicate that the returns of crude oil spillover exhibit a negative relationship for all countries in the case of conventional index and a positive relationship in the case of Islamic index for almost all countries. This fact suggests some evidence of short-term predictability between crude oil and the sample of Gulf region countries under consideration. This indicates that an increase in crude oil returns affects positively and negatively the Islamic stock markets and the conventional stock markets, respectively. This fact can be explained in terms of a real linkage between the two series, which is consistent with recent empirical findings (e.g., Hong et al. 2007; Narayan and Narayan 2010; Arouri et al., 2012).

The results corresponding to the other direction (i.e., equity market to oil price) indicate a positive response from each conventional index to crude oil, showing a bidirectional return spillover for all cases. Qatar and Jordan markets show the highest transmission to crude oil and UAE market shows the lowest value. This means that

[5] The CCC and DCC variants, including the BEKK, are not reported here to preserve space, but are available upon request from the corresponding author.

positive returns in conventional indexes increase the returns of crude oil. For the case of Islamic version of the index, the results show mixed, alternating (i.e., positive and negative) spillover effects between Islamic stock market and crude oil return, suggesting that crude oil responds differently to Islamic market in terms of return shocks. This implies that unanticipated occurrence in Qatar Islamic market affects positively crude oil return. Alternatively, it affects negatively the oil price for Kuwait, Jordan, Oman and UAE. This result is partly supported by Abdullah et al. (2016) who find evidence of return and volatility spillovers among crude oil and Islamic stock markets.

4.2. Shock and volatility spillovers between crude oil and both conventional and Islamic stock market

The examination of shock and volatility spillover effects between crude oil and the sample of Gulf countries stock markets shows empirical results reported in Table 3 and Figures 3a and 3b, as exhibited through ARCH effect shock and volatility transmissions between crude oil and conventional and Islamic stock markets. The results of ARCH effects for Jordan, Qatar and UAE are not significant since the corresponding a_{12} estimates are not statistically significant. There is no shock spillover between conditional volatility of crude oil return and the volatility of conventional index for these markets. The use of the Islamic version of the index reveals that all ARCH effects are not statistically significant at 5 %, which can indicate that the conditional volatility of crude oil return does not spillover to any Islamic markets of the Gulf region countries under consideration. Our findings show that Islamic markets are disconnected from crude oil effects relatively to the conventional markets.

The spillovers detected in conventional markets are negative from crude oil to both Kuwait and Oman conventional stock markets and positive from the Oman conventional stock market to crude oil return and negative from Qatar conventional stock markets to crude oil return. Others countries show no shock transmissions between all pairs since the corresponding a_{21} estimates are not statistically significant. The coefficient a_{11} is significant of all countries indicating short-term volatility persistence in both conventional and Islamic markets. However, the coefficient a_{22} is significant for the majority of markets except for Jordan Islamic stock market. The latter shows that there is no short-term volatility persistence (i.e., ARCH effect). The causal links between crude oil and Gulf region markets have important implications for financial policy and international portfolio diversification. Our results of volatility spillovers structure between crude oil and two selected benchmarks of conventional and Islamic equities can help finance practitioners to build an accurate asset pricing process and predict better volatility stocks.

The GARCH coefficients b_{11} and b_{22} are high, positive and statistically significant at 1% between crude oil and conventional markets, which suggests that the conditional volatility of all returns is highly sensitive to its own past conditional volatility. The fact that the GARCH coefficients are positive is indicative of volatility clustering and persistence in stock positive changes. However, the GARCH coefficient b_{11} between crude oil and Islamic stock markets returns are not significant – except for Jordan – at 5% suggesting that the conditional volatility of crude oil in Islamic markets is not sensitive to its own past conditional volatility. In contrast, the GARCH coefficient b_{22} is almost significant at 1% similarly to the conventional index. Our findings show a puzzling result of GARCH effects between crude oil and Islamic stock markets.

The GARCH spillover coefficient b_{12} shows evidence supporting the existence of long-term spillover volatility persistence from crude oil to Kuwait and Oman conventional stock markets and from Jordan, Oman and Qatar to crude oil return since the parameters are statistically significant at the 1% and 5 % statistical levels. For the remaining cross-markets, the results do not confirm a persistence in volatility spillover effect over the long term from crude oil to all Gulf region Islamic stock markets. Our findings have interesting implications for international diversification and hedging strategies. In addition, there is evidence of low persistence in the conditional volatility and reveals a weak mean reversion for long run equilibria for all Islamic markets since the sums of ARCH and GARCH coefficients are lower than the unity. The next sub-section will discuss the issue of international diversification and hedging strategies that investors can implement.

Table 3. Estimates of bivariate VARMA(1,1)–BEKK-GARCH(1.1) model

	Panel 1: Brent vs. Conventional Index						**Panel 2: Brent vs. Islamic Index**				
	Brent Jordan	**Brent Kuwait**	**Brent Oman**	**Brent Qatar**	**Brent UAE**		**Brent Jordan**	**Brent Kuwait**	**Brent Oman**	**Brent Qatar**	**Brent UAE**
Mean equation											
ω_{12}	0,0539	0,0381	0,0548	0,0338	0,0037		0,0290	-0,0233	-0,0500	-0,0297	-0,1470***
ω_{12}	-0,0065	-0,0025	0,0111	-0,0237	-0,0294		-0,0397	-0,0168	0,0290	-0,0406	-0,9291***
μ_{10}	-0,0005	-0,0004	-0,0001	-0,0004	-0,0002		-0,0036	-0,0035	-0,0034**	-0,0036	-0,0024***
φ_{11}	-0,0144***	-0,0319***	-0,0698***	-0,0074***	0,0435***		0,0015***	-0,0278***	-0,0068***	-0,0081***	0,0002***
φ_{12}	-0,0384***	-0,0072***	-0,0269***	-0,0101***	-0,1077***		0,0054***	-0,0142***	0,0010***	0,0007***	0,0032***
ω_{21}	0,0428	0,0361***	0,0771***	0,0737***	0,1166***		0,0021	0,0006***	-0,0016	0,0026	0,0038
ω_{22}	0,0724	-0,0803**	0,0091	0,0208	0,0194		-0,0281	-0,0997***	0,0130	0,0466	-0,2097***
μ_{20}	-0,0004	-0,0003	0,0002	0,0002	0,0101***		-0,0005	-0,0007***	1,8E-4	0,0001	0,0003
φ_{21}	0,0542***	0,0237***	0,0299***	0,0522***	0,0165***		0,0171***	-0,0117***	-0,0253***	0,0044***	-0,0150***
φ_{22}	0,0188***	-0,0824***	0,0225***	0,0287***	0,0078***		-0,0030***	1,1060***	0,0083***	1,3713***	-0,1577***
Variance equation											
θ_{11}	-0,0002	0,0014***	-0,0003	-0,0004	0,0006**		0,0650***	0,0650***	-0,0650***	0,0650***	0,0122***
θ_{21}	-0,0046***	-0,0027***	0,0014***	0,0007***	-0,0036		0,0002	-2,5E-4	0,0002	0,0003	-0,0052***
θ_{22}	0,0000	0,0011	1,14E-6	8,8E-8	0,0006***		0,0022***	0,0024***	0,0023***	0,0003**	6,9E-8
a_{11}	0,2011***	0,2173***	0,0753***	0,1670***	0,1826***		0,3383***	0,3459***	0,3335***	0,3409***	2,0876***
a_{12}	-0,0235	-0,0565**	-0,1667***	-0,0133	0,0242		-0,0003	0,0012	-0,0020	0,0001	-0,1876
a_{21}	0,0094	-0,0111	0,4880***	-0,0482**	-0,0183		0,0094	0,0026	0,0641	-0,0663	0,2494***
a_{22}	0,3169***	0,3501***	0,0699**	0,3394***	0,3221***		0,0111	0,2963***	0,3935***	0,3089***	0,2947***
b_{11}	0,9804***	0,9721***	0,9174***	0,9857***	0,9826***		0,2715***	-0,0018	0,0098	0,0023	0,0647
b_{12}	0,0020	0,0176***	0,1753*	0,0028	0,0030		-0,0014	0,0051	0,0051	-0,0042	0,0075
b_{21}	-0,0280**	0,0549	-0,7450***	0,0180***	0,0153		-0,0041	0,1378	-0,0242	0,1225	0,3548***
b_{22}	0,8361***	0,8623***	0,8339***	0,9465***	0,9087***		0,9537***	0,9293***	0,8839***	0,9597***	0,9068***
Model diagnostics											
AIC	-11.831	-12.318	-12.378	-12.244	-11.314		-8.263	-8.920	-9.528	-9.063	-9.066
SBC	-11.747	-12.234	-12.995	-12.161	-11.231		-8.179	-8.836	-9.444	-8.980	-8.982
LOG-L	-11.831	-12.318	-12.378	-12.244	-11.314		-8.263	-8.920	-9.528	-9.063	-9.066
Obs.	1300	1300	1300	1300	1300		1300	1300	1300	1300	1300

****and*** *indicate the rejection of the null hypothesis of the student tests at the 1%, 5% , respectively.*

Figure 3a. Time-varying conditional correlations: Brent vs. conventional index

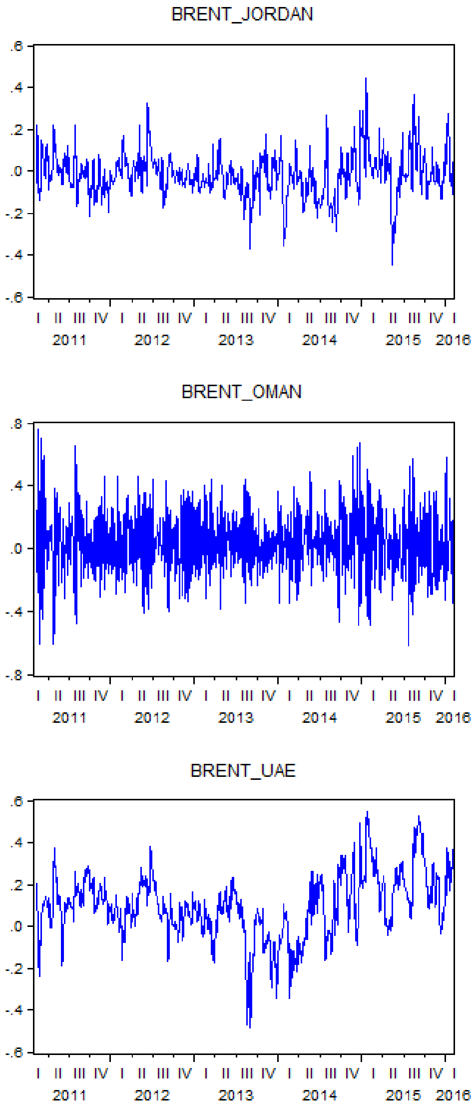
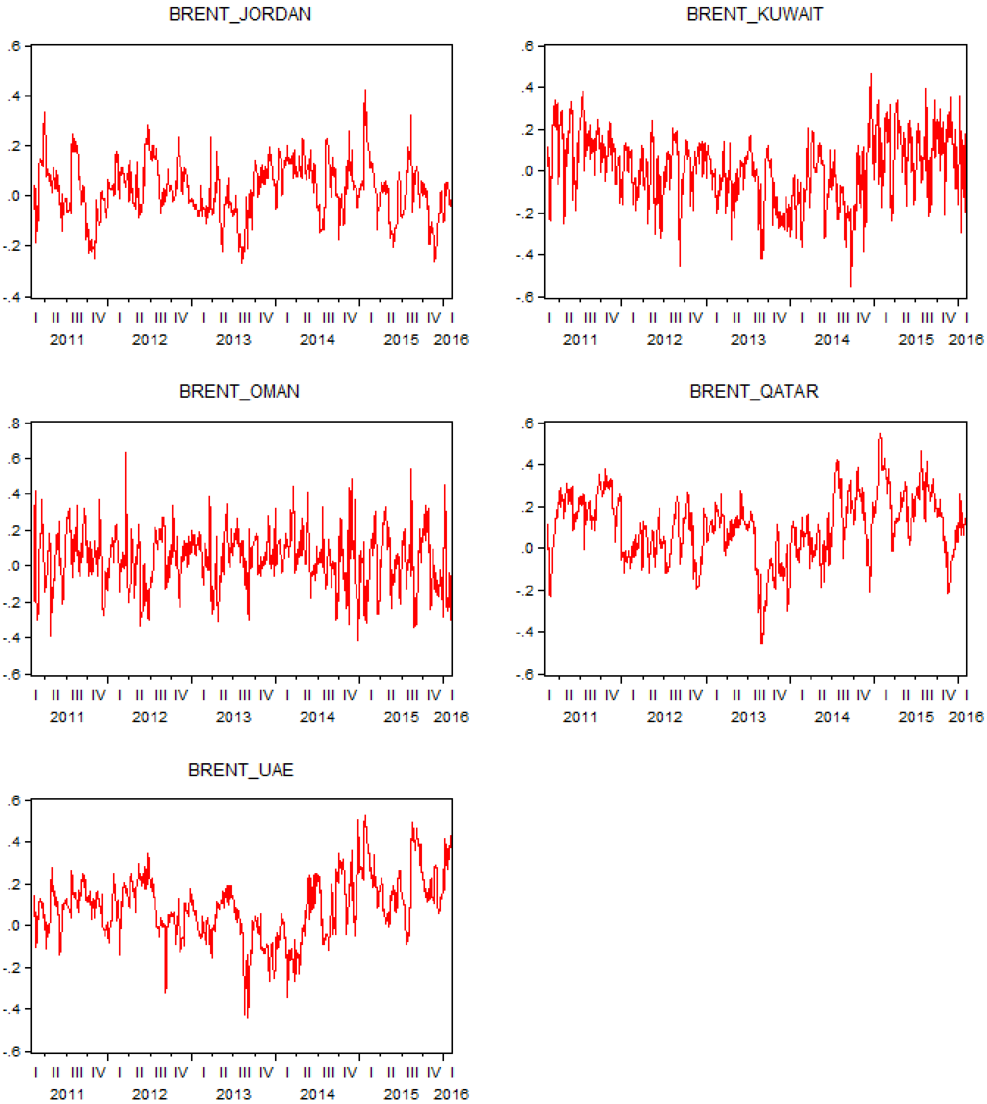


Figure 3b. Time-varying conditional correlations: Brent vs. Islamic index



4.4. Portfolio holding

The empirical regularity documented in the above discussion has revealed the existence of volatility transmissions among crude oil and each of the Gulf region markets for both Islamic and conventional indexes. Optimal weights and hedge ratios of crude oil/others stock holdings are used to examine the impact of these results on portfolio designs and hedging effectiveness. The average values (Table 4) show that the optimal weights of crude oil and conventional index/Islamic index are different. The results vary from 0.720 (0.977) for the Oman stock market to 0.996 (0.983) for the UAE stock market. As an illustration, this means that the optimal weight of crude oil holding in a one-dollar crude oil for the Omani market should be 72% (97.7%), with 28% (3,3%) invested in the Oman stock market, respectively for the conventional and Islamic indexes. These optimal weights minimize the portfolio risks without reducing the expected returns. The results further indicate that - for some markets - the optimal weights according to the conventional and Islamic indexes are different and the weight in conventional portfolio composition is higher than its Islamic counterpart for all countries except for UAE which shows approximately the same weight. This result can be interpreted by the fact that investors in the UAE marketplace are indifferent between investing less than 2% of one USD in *shari'ah*-based or conventional assets similarly.

Table 4. Portfolio optimal weights oil and hedge ratios

Optimal ratio		**Weight**	**Hedge**
Conventional index	JORDAN	0.94449	0.00717
	KUWAIT	0.94199	0.01438
	OMAN	0.72012	-0.18627
	QATAR	0.81232	0.08027
	UAE	0.99660	0.13284
Islamic index	JORDAN	0.98111	0.00225
	KUWAIT	0.96017	0.00710
	OMAN	0.97791	0.00191
	QATAR	0.87874	0.02293
	UAE	0.98322	0.08628

The findings indicate that the investors holding assets in the Gulf region's countries must have a higher proportion invested in crude oil than in stock market for both conventional and Islamic portfolios for all countries. As for the optimal weights, the average hedge ratios for conventional indexes range from 0.007 for Jordan to -0.186 for Oman. As an illustration, this means that the best hedging strategy for Oman is to short (sell) a fraction of conventional index of the Oman stock market. For the crude oil/Oman conventional stock market portfolio, a hedge ratio of -0.186 means that a one-dollar long position in crude oil should be shorted by 18 cents of the Oman conventional stock market. For the same country, the hedge ratio in Islamic portfolio is 0.001 implies that a one-dollar long position in crude oil asset should be shorted by 1 cent in the Oman Islamic stock market. The results are identical for Kuwait, Qatar and

Jordan. They indicate that crude oil/Islamic index portfolios are less risky than their conventional counterparts.

The results documented in this section constitute an addition to the empirical literature using volatility models to investigate the conditional volatility among stock markets and the resulting implications for international portfolio builders. The Islamic marketplaces provide to investors the opportunity to diversify their portfolios seeing the particular specificities of the financial mode they proclaim, the set of practices/tools they endorse, and the set of instruments/techniques they restrict. Using the estimated conditional covariance matrices for the calculation of optimal weights and optimal hedge ratios, an interesting result stems to indicate the benefit that investors can have in terms of portfolio variance reduction when investing in the Islamic MSCI index. Although this result can be used as an indication of crude oil hedging strategies, it also testifies the distinction of Islamic financial markets and raises the issue of strategic posture and competitiveness in the global financial system.

5. Conclusion

The purpose of this paper consists in the investigation of the causal relationship that might exist between the oil price and equity market indexes. Although this relationship has been thoroughly studies over the recent past, very few articles have pointed the interplay between oil price and faith-based market indexes. This paper suggested a comparative study of volatility spillover with conventional/Islamic stock markets. In addition, it extended this study to include the policy implications in terms of international portfolio diversification and hedging strategies.

Islamic stock markets have the specificity to endorse the Islamic financial intermediation mode that encourages a set of practices (e.g., use of return-bearing instruments, alleviation of complexity in financial contracts, and ethical investments) and limits a set of practices (e.g., gambling, use of interest-bearing instruments, and unethical investments). Such a mode can have a peculiar distinction if the connection of its volatility and return with the oil price is compared with the conventional markets.

In order to study this issue, a sample of five countries from the Gulf region is selected and the bivariate VARMA-BEKK-GARCH is used. This model has the benefit to consider that positive and negative shocks have equal impacts on conditional variance. The main result corroborates the fact that the volatility transmission is reduced and the volatility persistence is lowered in the case of Islamic MSCI index. This result means that there is no evidence of persistence in volatility spillover over the long term from crude oil to Islamic markets. The paper further investigated the optimal hedging weights and showed that, for both Islamic and conventional portfolios, the highest proportion must be invested in crude oil. In addition, the optimal hedge ratios indicate that Islamic index portfolios are less risky than the conventional index portfolios.

This paper can be extended in various ways. First, McAleer et al.'s (2009) contribution can be used to use to accommodate the asymmetric impacts of unconditional positive and negative shocks on conditional variance. Second, the hedging effectiveness of crude oil/Islamic index can be compared to the combination of crude oil and other faith-based indexes, such as Christian indexes.

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