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Full Length Article

Tail dependence between oil and stocks of major oil-exporting countries using the CoVaR approach

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Abstract

This paper investigates the negative tail risk dependence between oil shocks and stock indices (at aggregated and desegregated levels) for Saudi Arabia (KSA), United Arab Emirates (UAE) and Russia, over the period between 2007 and 2016. DCC-MGARCH approach and CoVaR measure are employed to assess the oil shock exposure. The results show that the tail dependence is significant and depends on the origin of the oil shocks, with intensity that varies across countries and sectors.

JEL Classification: C58; G11; Q4

Keywords: Oil price shocks; Oil-exporting countries; Conditional VaR

1. Introduction

Many analysts and energy professionals expect oil process to remain low for a long period, owing to the current oil demand-supply imbalance and the global economic turmoil. However, like all market shifts, falling oil prices will produce clear-cut winners and losers. While countries that rely on importing oil will be the biggest winners, the oil-exporting countries will be the ones to lose. To exemplify, when oil prices had plummeted in mid-2014, Gulf Cooperation Council (GCC) stock indices had all been declining.[1] It must be recalled that the last GCC financial market falls in this magnitude had occurred during the Global Financial Crisis (GFC) of 2008.[2] The GCC countries were not alone in bearing the ill effects of the falling oil prices. Several other countries, including Russia, Nigeria, and Venezuela, also faced similar economic pressures. The Russian stock market, in particular, had registered a large decline with a 30% drop in just the first half of December 2014.

This study aims at empirically investigating the temporal dependence between the declining oil market and the stock market collapse. This study will also help investors who attempt to avoid future losses in their portfolios that may result from the contagion effects of the oil market crisis. In modern portfolio theory, diversification strives to reduce unsystematic risk events in a portfolio. Nevertheless, the economic consequences and the possible risk spillovers arising from falling oil

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[1] In 2015, the Kuwait Stock Index and Saudi Arabia Index were the worst hit, registering negative returns of −11.9% and −10.7%, respectively. The return of Dubai and Abu Dhabi indices dropped by 5.08% and 0.28% while the Qatar Exchange General Index declined by 6.94%.

[2] According to some analysts, such a result is not surprising, although it is interest to note that a number of policies have been adopted by GCC economies to diversify their revenues and reduce their reliance to oil and Gas rents.

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prices could make sectoral diversification more difficult. Therefore, it is often said that risky assets tend to be strongly correlated during periods of stress, which can amplify the risk of collapse. Thus, to provide a clear image for investors and policy-makers, it is important to investigate the consequences of oil shock on the sectors that form the majority of the stock market in oil-exporting countries, and identify the sectors that are the most exposed to oil shock and the sectors that are least exposed to it.

In general, three questions motivated this research: (i) How does the oil market crisis negatively affect the aggregate financial market of major oil-exporting countries? (ii) Does oil market stress spread to non-oil sectors and reduce investment opportunities? (iii) What are the alternatives that could be considered to be safe by investors during the period of oil-price shock?

To put it briefly, this study concentrates on negative return tail dependence between the US Benchmark oil market (i.e., West Texas Intermediate (WTI) Crude Oil) and three major oil-exporting stock markets (KSA, UAE, and Russia) at both the aggregate and the sectoral levels. These markets are selected for three major reasons. First, while the available research has been conducted across various oil-importing countries which have faced previous episodes of oil price increases for almost 20 years, the recent GFC and the downward trend of oil prices in recent years have also highlighted attention to the effects of oil-exporting countries. Findings (see literature review below) revealed that although GCC countries and some other oil-exporting countries (such as Venezuela, Nigeria, and others.) share a number of specific structural economic features, they differ in their reliance on oil changes (Arouri & Fauquau, 2009). Second, Arouri and Rault (2010) assumed that unlike other major oil-exporters, GCC countries are largely segmented from the international markets and are overly sensitive to regional political events. Finally, as most previous studies had examined similar areas, this ensures the best comparison of our results to others.

The sample covers the weekly returns from February 2007 to July 2016 of Tadawul All Share Index (TASI), Dubai Financial Market (DFM) General Index, Russian Stock Index (RSI), and Weekly Futures Prices of WTI. During this period, the oil price had reached its historic peak in July 2008, and it had dropped sharply by the end of 2008; and again, from mid-2014 to early 2016.[3] According to Malik and Ewing (2009) as well as Arouri and Nguyen (2010), the weekly data may better capture the interaction between markets than the daily data. This is because the use of weekly data can significantly reduce the bias that is likely to occur from the bid-ask effect and the non-synchronous trading days.

Price shocks may, of course, be positive (a rise), or it may be negative (a fall). However, this paper is mainly concerned with the negative effects of price shocks. It is interesting to note that the few recent research works on the impacts of falling oil prices is mostly related to the GFC. Nonetheless, the events and factors that played a role in driving down the oil prices in 2008 and in mid-2014 are very different and appear to have different implications. For this very reason, this analysis will focus on two event windows, consistent with the two negative oil price shocks of the past decade. First, the oil price shock event window from December 19, 2008 to April 24, 2009, that has been caused by a fall in the aggregate demand. Second, the oil price shock event window from June 13, 2014 to May 27, 2016 in which it was the oversupply that was primarily responsible.[4]

This study is conducted by implementing a CoVaR approach. It represents the VaR of a stock index conditional on downturn in the international oil market. The study also focuses on delta CoVaR measure or "exposure CoVaR" that represents the change from its CoVaR under distress state and its CoVaR in its benchmark state. This measure permits to gauge the size of the potential tail spillover effects from oil market to each equity index.

The empirical results gathered from this study show that the responses of almost all stock indices to oil price downturn are significantly positive with a magnitude that may differ among countries and sectors that form each stock market. Furthermore, the responsive of stock markets depends on the origin of the oil shock event. These results have important implications for investors, portfolio managers, and policy-makers.

2. Literature review

In one recent study that is related to our research, Mensi, Hammoudeh, Shahzadd, and Shahbaz (2017) looked at the tail dependence between oil price changes and stock market indices, but only for major regional developed stock markets (such as the US, Canada, and others.). Using the variational mode decomposition method along with static and time-varying symmetric and asymmetric copula functions, this study has shown that there is a tail dependence between oil markets and all stock markets. There is also an average dependence between the considered markets in the near and distant future, with the exception of the S&P 500 index that exhibits only average dependence with the oil market. This current study extends this analysis by examining the tail dependence between oil market and stock indices of major oil-exporting countries. For this reason, we will confine our review on the connection between oil price shocks and stock market specifically for oil-exporting countries. Zarour (2006) suggests that the response of these markets to shocks in oil prices have increased and have become faster during episodes of oil price increases. This evidence, however, was not confirmed by Hammoudeh and Choi (2006). In their findings,

[3] The WTI spot price fell close to 30$ a barrel in February 2016, losing nearly ¾ of its value since June 2014.

[4] Following Wakeford (2006), there are two important dimensions of a price shock: (i) the magnitude of the price decrease (increase) measured in percentage changes. (ii) The timing or the speed and durability, where three cases may be identified (1) a rapid (e.g., occurring within a few quarters) and sustained price decrease or increase (a break); (2) a rapid and temporary price decrease or hike (a "spike"), and (3) a slower but sustained fall (rise) (a trend).

there is no evidence of direct effect of oil movements on any GCC stock markets. Malik and Hammoudeh (2007) report that GCC equity markets receive volatility from the oil markets, but it is only in the case of Saudi Arabia that there is a significant bi-directional volatility spillover. This result for Saudi Arabia market is also shown by Arouri and Rault (2010). For other GCC countries, they found robust statistical evidence that oil price disturbances lead to changes in the stock price. Maghyereh and Al-Kandari (2007) support the hypothesis that oil prices have affected GCC stock markets in a non-linear manner for the period between 1996 and 2003. In a related study, Fayyad and Daly (2011) show that Qatar, UAE, and the United Kingdom (UK) are more responsive to oil shocks than the other markets in the study.

After the GFC, there is another trend of empirical researches that investigate time-varying framework. For instance, Filis, Degiannakis, and Floros (2011) show that oil prices have a negative effect on oil-importing and oil-exporting countries with only one exception during the GFC period. However, Arouri, Jouini, and Nguyen (2011) find that oil price shocks affect the stock returns in an asymmetric fashion in GCC countries. Similarly, Awartani and Maghyereh (2013) refer to an asymmetric bi-directional dynamic spillover of return and volatility between oil and equities in the GCC countries. Further, Bharn and Nikolovann (2010) have provided a new insight into the dynamic correlation between the Russian stock market and oil prices. Recently, Chang et al. (2013) documented very low conditional correlations for returns across markets, and some were not statistically significant.

Other authors have examined the dynamic relationship between oil prices and stock prices from a sector-by-sector perspective. One of the earlier existing studies had been conducted by Faff and Brailsford (1999), where they concluded that in Australia, oil prices have a positive effect on energy related industries and a negative effect on paper, packaging, and transportation industries. In a related study, El-Sharif, Brown, Burton, Nixon, and Russell (2005) found that rising oil prices significantly increase UK's oil and gas sector equity index. However, Arouri and Nguyen (2010) suggest that the response to oil price shock differs among industries in Europe and in USA. Malik and Ewing (2009) focus on the volatility relationships over time and between weekly returns in five sector indices (i.e., financial sector, industrial sector, consumer services, health care, and technology) that represent a large cross-section of firms and industries in the US economy. Their results support evidence of significant transmission of shocks and volatility between oil prices and some of the examined market sectors. For markets in Saudi Arabia, Jouini (2013) shows that there are strong unidirectional spillover effects from the oil market to some sectors for returns; and bi-directional volatility patterns with more apparent links from sectors to oil market. More recently, Hamma, Jarboui, and Ghorbel (2014) have found a unidirectional relationship between the oil market and the Tunisia stock market, and the conditional variance of a stock sector returns is affected not only by the volatility surprises of the stock market, but also by those of oil market. As for the aggregate and sectoral level in Europe and USA, Reboredo and Rivera-Castro (2014) have found no evidence of lead-lag effects in the pre-crisis period, and have therefore rejected the under-reaction hypothesis. Since the onset of the GFC, oil prices lead stock prices and vice versa for higher frequencies, whereas for lower frequencies oil and stock prices lead each other in a complex way.

To sum up, the above results indicate that the existing literature remains insignificant and inconclusive in parts. In addition, few empirical studies have considered time-varying and conditional tail dependence. On the other hand, the depth of the recent energy shock looks comparable with that of the late 2008. However, while the oil shock in late 2008 resulted from liquidity, the current oil shock, prevalent since mid-2014, seems to be underpinned by more fundamental demand and supply factors. Such a distinction between oil shocks can lead to deeper insights and pave the way for further studies in the field. Moreover, in recent years, it has witnessed that there is a heightened interest in portfolio management, especially by foreign and local oil exporter investors in face of the sensitivity of their asset portfolios to various risk factors related to the successive abrupt changes in oil prices. Hence, the topic is still open for debate. This paper adds to the recent trend of literature in this field. To the best of authors' knowledge, this might be the second paper that uses a CoVaR approach (after the recent publication of Mensi et al. (2017)) to examine the dependence structures between oil price changes and stock market indices. The model is implemented with a DCC-multivariate GARCH. According to Engle (2002), this model provides a very good approximation to a variety of time-varying correlation processes. Additionally, the comparison of DCC with simple multivariate GARCH and several other estimators shows that the DCC is often the most accurate.

3. Methodology

Recall, that the unconditional VaR of an asset "i" at the percentile q is:

$$Pr\left(R^i \leq Var_q^i\right) = q \tag{1}$$

where R^i denotes the weekly return. VaR_q^i is typically a negative number.

According to Adrian and Brunnermeier (2016), we propose to estimate the most extremely negative return of aggregate or sectoral stock index "s" within q%-confidence interval via the conditional VaR (CoVaR), in respect to oil market, being in a state of distress. Mathematically:

$$\Pr\left(R_t^s \leq CoVaR_{q,t}^{s/oil} | R_t^{oil} = VaR_{q,t}^{oil}\right) = q \tag{2}$$

We use $\Delta CoVar_q^{s/oil}$ which we label "exposure CoVaR", to assess stock exposure to oil market turmoil. By definition, $\Delta CoVaR$ is the difference between its CoVaR when the oil market is, or is not, in distress (median state).

$$\Delta CoVar_q^{s/oil} = CoVar_q^{s/oil} - CoVar_{50\%}^{s/oil} \quad (3)$$

Compared with other models, this measure has advantage to assess the degree of exposure of each sector to oil price shocks. This seems interesting to portfolio managers and policy-makers.

We follow three steps procedure to estimate CoVaRs[5]:

Step 1. Univariate AR(1)-GARCH(1,1) model is fitted for each stock index in order to estimate isolated time series of VaRs. The Value-at-Risk of a stock index is given by:

$$VaR_{q,t}^s = \Phi^{-1}(q)\sigma_t^s \quad (4)$$

Step 2. In order to capture the dynamic of time-varying conditional correlation, we estimate a bivariate GARCH model with DCC specification (Engle, 2002).

Step 3. Once we estimate the bivariate density of each pair in step 2, in step 3 we proceed to obtain $CoVaR_{q,t}^{s/oil}$ measure for each stock index "s" and time period t.

Under the assumption of bivariate Gaussian distribution, CoVaR has a closed form solution defined by:

$$CoVaR_{q,t}^{s/oil} = \Phi^{-1}(q)\sigma_t^s\sqrt{1-\rho_{so,t}^2} + \Phi^{-1}(q)\rho_{so,t}\sigma_t^s \quad (5)$$

where $\rho_{so,t}$ is the correlation coefficient and "q" is the confidence level for the VaR of oil market.

Because $\Phi^{-1}(50\%) = 0$, we can deduce $\Delta CoVaR$ at each time as following:

$$\Delta CoVaR_{q,t}^{s/oil} = \Phi^{-1}(q)\rho_t\sigma_t^s \quad (6)$$

A weaker or positive $\Delta CoVaRs$ argued that equity index is less exposure to oil price collapse.

4. Data description and preliminary statistics

Some descriptive statistics of data are shown in Table 1.

It is observed that the average weekly return varies among the sectors within the same country, and within the same sector across the three selected countries. In Saudi Arabia, the tourism sector provides the greatest average return to the other sectors. This sector is now considered as one of the most promising economic areas in KSA, being the second highest contributor to the Gross Domestic Product (GDP) growth after the petrochemical sector.

In the Dubai financial market, both the telecommunication sector and the transport sector generate the highest returns, while the insurance and the services sectors yield the lowest returns. In the Russian stock market, the oil and the gas sector have the highest returns. In terms of historical (unconditional) risk, as defined by the standard deviation, most of the risk is in the media and the publicity sector for Saudi Arabia, and in real estate and finance sectors for the markets in the United Arab Emirates and in Russia respectively.

The skewness is mixed with some stock indices having a skewness that is positive, implying that there is a greater chance that the sectors to rise rather than fall in a given period of time. This is concerning with the financial and hydrocarbon sectors for KSA and Russia, respectively. Compared with the normal density, the kurtosis of all returns is higher, and this causes fat tails in the data series.

Fig. 1 plots the log weekly prices of each stock market during the last decade.

As can be seen from Fig. 1, a long period of relative high oil prices was interrupted by two distinct troughs in late 2008 and from mid-2014. Indeed, in 2008, the world crossed its most severe global financial shock that originated in the US banking sector before translating into shocks in other markets, especially the hydrocarbon market (Filis et al., 2011, among others). During the period that extended from December 2008 to April 2009 which was the first oil shock time window, oil prices were derived by a sharp downward trend from nearest 150$ per barrel to 33.87$ per barrel on December 19, 2008. After a long lower price trading period of over four months, WTI prices rose again to 51.55$ on April 24, 2009. In between the year 2013 and mid-2014, the oil price has been strongly influenced by a steep upward trend, reaching a level around 110$, which has led to increasing concern from emerging markets, combined with a capacity constraint on the supply side by the Organization of Petroleum Exporting Countries (OPEC).

However, since mid-2014, the oil prices have steadily fallen again and have continued to decrease to this day, even as this posting was prepared. The main causes of this oil shock are the excess in oil supply by OPEC members, as well as, a downturn of the global economy activity that has slowed the growth of world-wide oil demand. For instance, the price of US benchmark crude oil decreased to less than 35$ on June 8, 2014 and then to 29.42$ on January 15, 2016. On May 27, 2016, the price rose again to 49.33$. This decline period of over two consecutive years coincides in time with the second oil price shock window, as mentioned before in this paper. Another important observation that can be made from Fig. 1 is the fact that the selected stock markets have been moving in the same direction as long as the oil price shock and the GFC deepened. However, when the second oil crisis struck, a large drop was observed in the stock markets in Arabia rather than Russia stock market. Therefore, both foreign and domestic investors have the question whether the Gulf countries are mainly exposed to oil price stress than any others.

5. Results and interpretations

5.1. Aggregate stock indices

We would now propose to use the univariate GARCH family and unconditional VaR measures to explore tail events happening in the international oil market as well as selected stock indices during the period under consideration. Empirical results are presented in Table 2 and Fig. 2.

[5] See Girardi and Ergün (2013) for more details.

Table 1
Descriptive Statistics

Sector	TASI index	Transport	Tel & Inf.	Retail	Real estates	Petrochemical	Media & Pub.	Multi Invest.	
Panel a. TASI									
Mean	0.001	0.189	−0.068	0.250	0.167	0.034	0.075	−0.070	
S.D	3.466	0.310	3.467	3.535	4.146	4.621	5.8976	4.591	
Skewness	−0.836	−0.947	−0.811	−0.390	−0.352	−0.781	0.7470	−0.821	
Kurtosis	8.073	7.358	6.606	7.890	9.205	7.581	11.6958	7.811	
Jarque-Bera	562.453	4.45	308.697	483.401	768.734	461.809	1534.304	509.453	
Correlation	0.05	0.08	0.03	0.01	0.03	0.06	−0.02	−0.01	
	Insurance	Industrial	Hot. & Tour.	Energy & Util	Cement	Financial Ser.	Buil. & Const.	Agri. & Food	
Mean	0.059	0.144	0.301	0.135	−0.021	−0.037	−0.096	0.171	
S.D	4.959	4.166	5.333	3.202	3.149	3.697	4.504	3.945	
Skewness	−0.440	−1.238	0.497	0.650	−0.357	0.236	−0.410	−0.456	
Kurtosis	5.142	8.789	7.393	9.334	6.306	8.797	11.405	9.828	
Jarque-Bera	105.747	781.453	399.880	824.053	225.483	666.80	1405.669	935.461	
Correlation	0.06	0.04	0.03	0.08	0.02	0.04	0.06	−0.03	
Sector	DFM index	Transport	Telecom.	Banks	Services	Real estates	Investment	Insurance	
Panel b. DFM									
Mean	0.014	0.099	0.102	0.009	−0.183	0.067	0.054	−0.209	
S.D	4.060	3.697	4.665	3.437	7.450	5.884	5.668	2.660	
Skewness	−0.971	−0.727	−0.483	−0.634	2.074	−0.553	−0.171	0.068	
Kurtosis	8.533	7.040	14.559	7.598	20.051	7.997	6.889	6.179	
Jarque-Bera	676.354	362.764	2646.311	447.567	6056.994	515.251	299.798	199.203	
Correlation	0.13	0.04	−0.01	0.15	0.05	0.12	0.13	0.05	
Sector	RSI index	Industry	Met. & Min.	Finance	Oil & Gas	Cons. & Goods	Electric util.	Transport	Telecom.
Panel c. RSI									
Mean	0.105	−0.210	−0.018	−0.018	0.032	0.011	−0.277	−0.125	−0.392
S.D	4.5322	5.140	5.255	5.255	5.616	4.435	5.505	5.642	8.153
Skewness	0.785	0.3383	−0.4650	−0.4650	0.8767	−0.3453	−0.0694	−0.1040	−1.076
Kurtosis	15.663	9.114	8.310	8.310	13.940	6.264	5.142	4.556	9.760
Jarque-Bera	3202.00	744.201	571.542	571.54	2414.614	218.909	6.431	44.088	971.144
Correlation	0.36	0.33	0.42	0.41	0.46	0.35	0.36	0.28	0.24

Note: Weekly data for the period of 23/02/2007 to 15/07/2016. J-B denotes the Jarque-Bera statistic for normality. S.D denotes standard deviation. Telecommunication & Information (Tel. & Inf.), Media & Publicity (Media & Pub.), Multi investment (Multi Invest), Hotel & Tourism (Hot. & Tour.), Energy and Utilities (Energy & Util.), Financial services (Financial Ser.), Building & Construction (Buil. & Const.), Agriculture and Food (Agri. & Food), Telecommunication (Telecom.), Metals & mining (Met. & Min.) and Consummation & Goods (Cons. & Goods) and Electric utilities (Electric util.). Correlation is between weekly oil returns and each sector index.

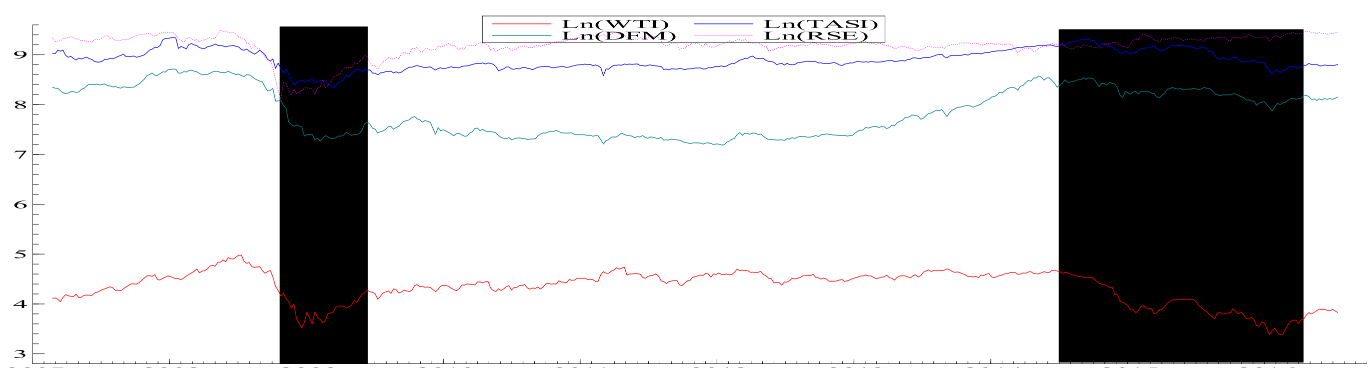

Fig. 1. Graphs plot logarithm of weekly prices related to WTI and three major oil-exporting stock indices. TASI (Tadawul All Share Index), DFM (Dubai Financial Market General Index) and RSI (Russian Stock Index). Time-series are weekly for the period of 23/02/2007 to 15/07/2016.

Table 2 reports the parameter estimates of the univariate GARCH(1,1) model for the weekly returns of WTI and the three selected stock indices (i.e., TASI, DFM and RSI).

It can be observed that the parameters relating to ARCH and GARCH are highly significant, though parameters of mean equation are quite significant. The sum of coefficient estimates on the ARCH and GARCH are very close to unity in each case, indicating significant persistence in volatility. These results are used to estimate in-sample dataset of 5%-VaR stock indices and 5%-VaR oil market.

Table 2
Univariate GARCH estimations (global market indices).

	WTI	TASI	DFM	RSI
Mean equation				
Intercept	−9.885*	0.166**	0.167	0.224***
AR(1)	0.948*	0.040	0.105**	−0.014
Variance equation				
constant	0.071***	0.465***	1.039**	0.485**
Arch	0.077**	0.310*	0.196*	0.140*
Garch	0.837*	0.652*	0.751*	0.830*
Volatility persistence	0.914	0.962	0.947	0.970

Note: We propose to estimate univariate VaRs (5%-quantile) a GARCH model with intercept and an AR(1) term in the mean equation. In the variance equation, we include an intercept, ARCH term and GARCH effect. Weekly data for the period of 23/02/2007 to 15/07/2016. An asterisk (*) indicates rejection of the null hypothesis at 1%, (**) at 5% and (***) at 10%. West Intermediate Texas crude oil (WTI), Tadawul All Share Index (TASI), Dubai Financial Market General Index (DFM), Russian Stock Index (RSI). Volatility persistence is the sum of Arch and Garch parameters.

Following the top panel of Fig. 2, it can be observed that 5%-VaR stock indices and 5%-VaR oil market display a similar tendency for most of the period, with a deep loss at the end of 2008. A final trough is also observed in the oil market in between mid-2014 and the beginning of 2016, followed by a significant trough for TASI VaR's returns. Note that these results are unable to confirm whether these stock market collapses have led to the oil price turmoil. There have been several other events that can cause stock market declines and which have occurred in the previous years. In short, the VaR measure is inadequate to detect the effects of oil crashes. However, the DCC and the CoVaR measures can make it possible.

The middle panel of Fig. 2 compares the conditional variances of each market under study. It is clear that Arabia stock indices have, in particular, encountered several periods of turbulence. More precisely, one can identify numerous periods of volatility in Saudi Arabia stock market during the last decade. The main adverse shock coincides for all markets with the event of GFC. During this period, a significant high volatility of TASI as well as RSI and DFM returns is observed. Although the energy market has showed another significant period in the second half of 2016 and earlier, the returns of RSI exhibit a very low volatility than Arabia stock ones.

The conditional correlation is estimated following Engle (2002). Contrary to what is expected, the bottom panel of Fig. 2 shows that the DCC between extreme negative returns of oil market and selected stock markets are not constant. A high positive correlation is observed not only during the turbulence of energy market but also at the time of its stability. This positive correlation between oil and stock market returns may support that oil market stress can spread to stock market and lead to the formation of bearish territories. This finding is in line with Bharn and Nikolovann (2010), Filis et al. (2011), Awartani and Maghyereh (2013) among others, with a new insight here on the contemporaneous correlation between extreme returns.

Table 3 summarizes, in terms of averages, the results of DCC, VaR, CoVaR, and ΔCoVaR measures relative to global and sectoral levels.

In view of the results produced in Table 3, there exists, on average, a positive dynamic correlation between oil and global stock indices tail returns with a higher level, related to RSI (0.49). The findings also suggest a high average level of RSI-VaR, compared to the markets in Saudi Arabia, which can be linked with the effects of the GFC. In the first oil shock window, the average of VaR is about (−21.95%), which represents (267%) of the average estimate VaR value for the overall period. More precisely, we provide a significant effect of oil price change on stock returns for the three selected countries (e.g., KSA, UAE and Russia). Nonetheless, the magnitude of this effect varies slightly from country to country.

The contribution of oil price decline in the global stock market collapses appears more clearly in KSA, followed by RSI, and DFM. During the first oil shock window, the average conditional extreme losses of TASI measured by CoVaR is about (−7%), which represents 94% of the overall extreme losses estimated, registered by the index during the same period (VaR = −7.45%). In addition, the contributions of oil shocks to RSI and DFM collapses are about 68% and 48%, respectively. On the other hand, CoVaR and ΔCoVaR seem, on average, to have higher values, compared to the entire period. In this period, RSI appeared more exposed to oil price crash with an average of CoVaR, close to (−19.63%), which represents 144% of the estimate univariate VaR of the same period. For the markets in Arabia, the averages of extreme losses, conditional on the first oil market distress, are about 115% for DFM and 140% for KSA.

In the second oil crash time window, we observe the same reaction of these stock markets, but with different intensities. More precisely, TASI remains more exposed to lower oil prices than others. The high level of CoVaR was registered in KSA which represents 92% of its univariate VaR. In addition, the RSI appears, however, to be more resistant to the recent oil crash with a lower CoVaR and ΔCoVaR values.

These results proved that the major oil-exporting stock markets differ in their reactions toward oil price drops. In particular, RSI is less dependent on oil price drops than the selected GCC countries since the second period where the prices of oil fell.

5.2. Disaggregate stock indices

To understand the aggregate reaction of the selected stock markets, it is important to investigate the reaction in the sectors that form each one. The sectoral analysis would be informative on sector return shifts to oil price drops as well as their counterweight to total stock market reaction. In this paper, we use DCC and ΔCoVaR to investigate the presence of spillover effects and identify the level of resistance of each sector to oil price shocks.

5.2.1. KSA sectoral stock indices

The Saudi Arabia stock market consists of 14 sectors. It is the biggest stock exchange among the GCC countries in terms of market capitalization. The top panel of Table 3 shows the

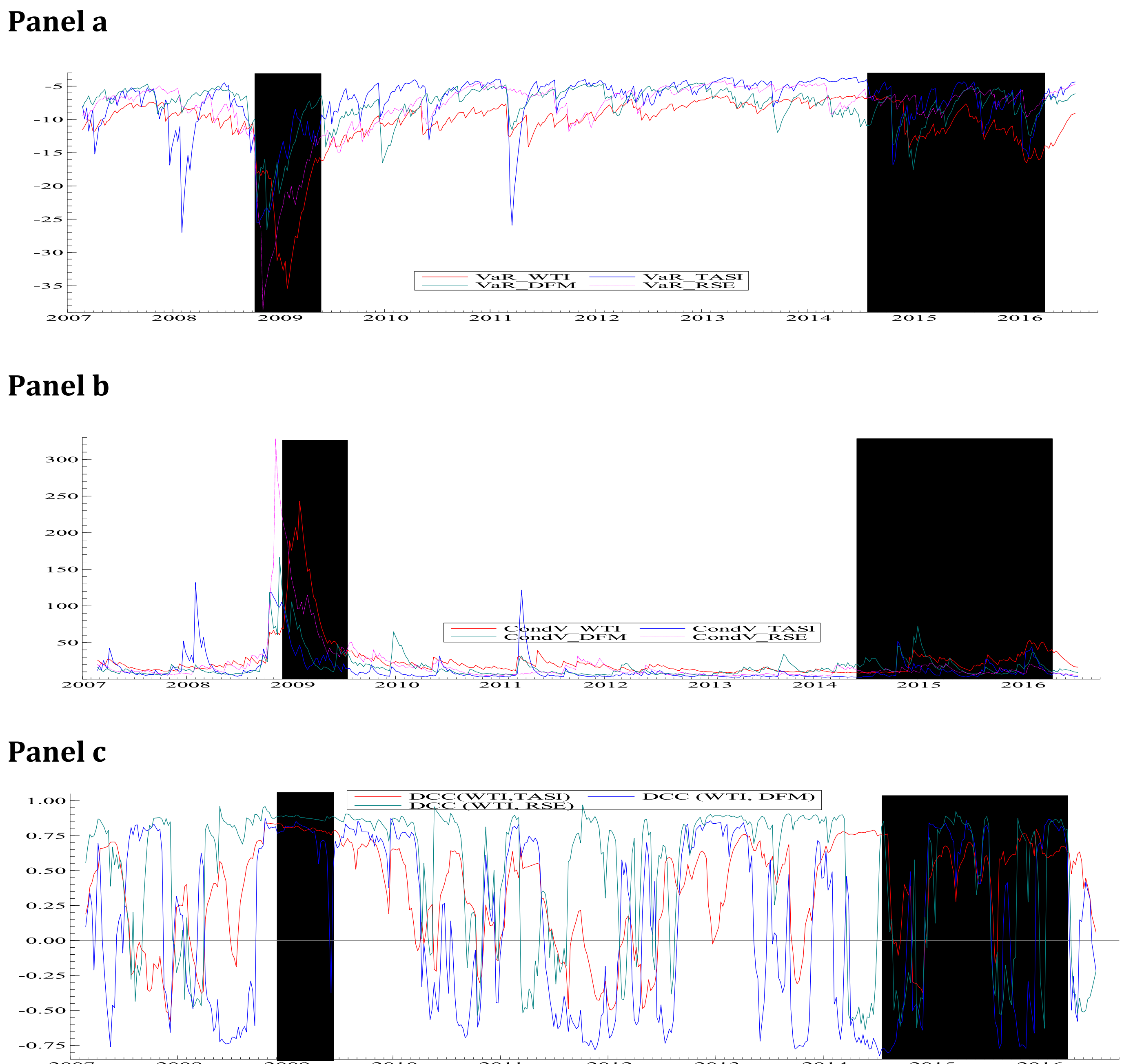

Fig. 2. Graphs plot VaR of WTI against VaRs of selected major-exporting oil countries (Panel a), Conditional variance of WTI and the indices of three major oil-exporting countries (Panel b) and DCC between WTI and Indices of selected major oil-exporting countries' indices (Panel c). TASI (Tadawul All Share Index), DFM (Dubai Financial Market General Index) and RSI (Russian Stock Index). Time-series are weekly for the period of 23/02/2007 to 15/07/2016.

averages values of DCC and ΔCoVaR evolution of each sector in KSA. Like in the whole Saudi Arabia stock market, there is a variable relationship between extreme losses of each sector and the international oil market. It appears that only the media and the publicity sector was negatively correlated with oil price drops for the entire period (−0.06). However, the link remains positive but lower for the real estate sector (0.10) and the investment sector (0.11). During the two oil shock periods, the extreme returns of almost all sectors are positively correlated with extreme oil returns. This helps to explain why there is a high reaction of the KSA economy on oil price shocks.

Following ΔCoVaR, there is strongest sensitivity of the building and construction sector to oil price shocks (−4.49) followed by the industry and petrochemical sectors. This should not be surprising as the Saudi Arabia construction projects are flooded with petrodollars and flushed with liquidity. The weaker overreaction on average of Saudi sectors to oil shocks was supported by the real estate sector during the first crash and the insurance sector and the energy sector during the second crash. For Saudi Arabia, the insurance sector is still one of the largest and fastest growing sectors in the region. The statistics reported that the Saudi Arabia insurance market grew 10.4% in the first quarter of 2016. The

Table 3
DCC, VaR, CoVaR and ΔCoVaR averages: Aggregate and sectoral levels.

	Overall period				Oil shock1 (19/12/2008-24/04/2009)				Oil shock 2 (13/06/2014-27/05/2016)			
	DCC	VaR	CoVaR	ΔCoVaR	DCC	VaR	CoVaR	ΔCoVaR	DCC	VaR	CoVaR	ΔCoVaR
Panel a. TASI												
TASI	0.37	−7.45	−7.00	−2.51	0.81	−14.01	−19.63	−12.82	0.49	−7.62	−6.71	−2.34
transport	0.16	−10.12	−5.08	−1.24	0.52	−11.66	−12.15	−5.11	0.46	−9.86	−6.30	−1.99
Tel. & Inf.	0.31	−8.49	−5.39	−2.03	0.73	−12.19	−17.80	−11.04	0.46	−8.30	−6.91	−2.62
Retail	0.31	−6.96	−5.52	−1.41	0.77	−11.76	−20.04	−10.29	0.46	−7.35	−6.64	−2.40
Real Estates	0.10	−8.37	−4.30	−0.83	0.53	−10.18	−9.35	−4.21	0.35	−8.37	−1.29	−4.26
Petrochemical	0.43	−8.77	−8.15	−3.29	0.84	−18.07	−32.30	−19.67	0.52	−8.98	−7.77	−2.88
Multi Inv.	0.11	−10.49	−8.15	−1.63	0.46	−14.58	−8.61	−23.24	0.20	−9.93	−6.82	−1.67
Media & Pub	−0.06	−12.28	−6.96	−0.93	0.74	−17.28	−19.51	−10.39	−0.01	−18.60	−16.13	−4.89
insurance	0.53	−11.42	−3.50	−2.03	0.93	−15.98	−11.91	−8.42	0.29	−9.93	−1.73	−0.91
Industry	0.48	−10.95	−6.30	−4.16	0.92	−21.77	−30.23	−20.77	0.71	−11.72	−9.26	−5.29
Hot. & Tour.	0.18	−10.22	−6.62	−2.06	0.88	−15.70	−18.77	−12.25	0.49	−10.98	−7.73	−4.19
Energy & Util	0.36	−6.38	−4.10	−1.15	0.84	−7.89	−3.10	−1.71	0.38	−6.43	−1.98	−0.63
Buil. & Const	0.39	−10.55	−9.76	−4.49	0.91	−26.56	−43.13	−29.17	0.64	−10.67	−9.97	−4.90
Financial Ser.	0.46	−7.44	−7.17	−3.14	0.91	−14.77	−18.43	−12.56	0.48	−7.25	−5.67	−2.25
Agr. & Foods	0.26	−8.68	−7.83	−2.79	0.90	−17.32	−19.44	−13.04	0.58	−9.81	−9.03	−4.37
Cement	0.32	−6.58	−4.38	−1.62	0.73	−11.74	−15.34	−8.57	0.40	−6.55	−4.35	−1.82
Panel b. DFM												
DFM	0.12	−7.95	−3.82	−1.77	0.79	−14.24	−18.51	−22.91	0.11	−8.61	−3.66	−1.35
Banks	0.14	−6.51	−6.18	−0.83	0.22	−10.34	−10.40	−2.06	0.14	−6.91	−6.50	−0.81
Investment	0.05	−11.11	−4.89	−0.85	0.78	−18.27	−18.77	−11.02	0.20	−12.41	−6.04	−1.80
Telecom.	0.17	−7.00	−4.99	−1.35	0.70	−15.45	−28.07	−14.14	0.09	−5.70	−3.01	−0.67
Services	−0.04	−15.56	−7.92	−0.14	0.49	−22.35	−26.37	−10.31	−0.29	−13.32	−4.10	1.29
Real Estates	0.32	−12.19	−8.85	−3.52	0.79	−23.62	−40.71	−22.91	0.27	−12.49	−7.97	−2.31
Transport	0.10	−7.99	−2.60	−0.62	0.85	−13.63	−13.13	−8.33	−0.03	−7.53	−1.65	0.03
Insurance	−0.04	−5.46	−2.95	0.16	0.11	−5.19	−4.05	−1.09	0.23	−6.40	−4.44	−0.83
Panel c. RSI												
RSI	0.49	−8.20	−5.64	−3.14	0.88	−21.95	−31.69	−22.84	0.27	−7.06	−2.30	−0.85
Transport	0.11	−12.36	−5.06	−1.31	0.91	−23.49	−20.99	−14.63	0.22	−12.48	−5.46	−1.64
Telecom.	0.30	−9.40	−5.11	−1.79	0.80	−11.61	−28.56	−5.34	0.34	−10.80	−5.80	−2.57
Industry	0.27	−10.07	−4.91	−1.81	0.82	−15.98	−18.13	−10.72	0.25	−10.87	−4.97	−1.77
Met. & Min.	0.32	−10.08	−5.87	−2.50	0.79	−20.82	−35.62	−20.50	0.34	−8.44	−2.63	−0.87
Finance	0.42	−10.09	−5.86	−2.95	0.86	−21.62	−35.42	−22.74	0.44	−8.45	−2.68	−1.12
Oil & Gas	0.52	−10.84	−7.98	−4.41	0.86	−24.55	−44.72	−28.32	0.40	−11.36	−7.03	−3.66
Cons. & Goods	0.31	−9.21	−7.63	−2.93	0.80	−17.92	−28.81	−16.88	0.34	−10.21	−8.25	1.12
Electric Util.	0.27	−12.22	−7.38	−2.72	0.85	−21.21	−21.51	−13.60	0.36	−12.68	−6.93	−2.94

Note: Weekly data for the period of 23/02/2007 to 15/07/2016. DCC denotes Dynamic Conditional Correlation. VaR denotes Value-at-Risk. CoVaR denotes Conditional Value-at-Risk. Telecommunication & Information (Tel. & Inf.), Media & Publicity (Media & Pub.), Multi investment (Multi Invest), Hotel & Tourism (Hot. & Tour.), Energy and Utilities (Energy & Util.), Financial services (Financial Ser.), Building & Construction (Buil. & Const.), Agriculture and Food (Agri. & Food), Telecommunication (Telecom.), Metals & mining (Met. & Min.) and Consummation & Goods (Cons. & Goods) and Electric utilities (Electric util.). TASI (Tadawul All Share Index), DFM (Dubai Financial Market General Index) and RSI (Russian Stock Index).

revenues of this sector remain partly independent of oil price decline. However, the challenging macroeconomic environment, including low oil prices and the strength of the dollar, would continue to impact the Saudi Arabia real estate sector negatively in 2016, along with a slowdown in the GDP and a reduction in government spending. Such an environment did not occur in 2008, where, despite the crisis, the real estate market has demonstrated resistance.

5.2.2. *Dubai sectoral stock indices*

The DFM General Index consists of 7 sectors and it is the second biggest stock exchange market in UAE in terms of market capitalization. The middle panel of Table 3 shows the averages of DCC and ΔCoVaR of each sector that formed the DFM General Index over the three considered sub-periods. Over the entire period, the sector that achieved the highest average of DCC was the real estate sector (0.32), followed by the telecommunication sector (0.30). The lowest average correlation was achieved by services and insurance sectors with negative values around −0.04. The investment and transport sectors exhibit a lower positive average DCC, but with a lower level (i.e., 0.05 and 0.10, respectively). Following ΔCoVaR results, there is a significant overreaction of the real estate sector towards oil price shocks. The services sector, followed by the transport sector, has proved to be the least exposed sector during the previous oil shocks. However, the insurance sector and the banks sector appeared as the least exposed sectors in the first oil crash period.

In summary, although GCC countries have many similarities in their economies, they differ in their reliance on oil changes on a sectoral level. Specifically, we observe that there are strong oil shock spillovers in between the different sectors of the KSA system, which can increase its exposure to a systemic risk. UAE demonstrates a moderate oil shock spillover effect between their sectors and the international oil market turmoil, with the exception of the real estate sector which is more sensitive to oil extreme returns changes.

5.2.3. Russian sectoral stock indices

The Russian stock index consists of 8 sectors. The bottom panel of Table 3 shows DCC and ΔCoVaR evolution of these sectors. In terms of DCC average setting, all stock sectors in Russia are positively correlated. The sector that achieved the highest DCC in the entire study period was the oil and gas sector (0.52), followed by the financial sector (0.42). The lowest DCC was reached by the transport sector index (0.11). During the period of the first oil shock, we observed that all the DCC average values are close to 1. Nevertheless, the industrial and the electric utilities sectors became negatively correlated with the oil price drops during the period of the second oil shock. In this period, the highest average of DCC has been experienced by the finance sector, followed by the oil and gas sector. The other sectors exhibit a positive link, but with lower intensities than in the first shock and in the overall period. In terms of ΔCoVaR average setting, there is a moderate exposition of different sectors in the oil price decline, except for the results shown in the first oil crash period which are highly positive. According to Hamilton (2009, pp. 215–283), Kilian (2008), Kilian and Park (2009), the response of the stock market to oil shocks depends on the cause or the origin of the oil price shock. For example, Kilian and Park (2009) say that the supply-side oil price shocks and the oil specific demand shocks (or precautionary demand oil price shocks) trigger a negative response from the stock markets, whereas the reverse is true for the aggregate demand oil price shocks. In accordance with the same line of reasoning, Lippi and Nobili (2009) show that supply-side oil price shocks exercise a negative effect in the economy, whereas a positive effect is observed from demand-side oil price shocks.[6] However, the aforementioned studies are mainly concerned with oil importing countries. In this study, we show that the response of stock markets in oil-exporting countries also depends on the origin of the oil price shock. More specifically, we point out that the demand-side oil shock that arose in 2008 and the supply-side oil price shock that took place from mid-2014, have different effects on the same sector. These results are also shared by Sadorsky (2001), Hammoudeh and Li (2005), Boyer and Filion (2007), Nandha and Faff (2008), Narayan and Sharma (2011), among others.

To sum up, our analysis shows that the markets in Russia and UAE relatively succeeded in reducing their high reliance on oil, except KSA which needs further efforts and brave legislations to strengthen themselves in order to face the current situation or any future disturbances in the oil market.

6. Conclusion

This study uses a DCC-GARCH approach and Delta CoVaR measure to assess oil price shock spillover among aggregate and sectoral stock indices of KSA, UAE, and Russia over the period between 2007 and 2016. The results show that the responses of the stock indices to oil price shocks are significantly positive, with an intensity that varies among considered countries and across different sectors. There is also evidence that the tail spillovers effects depend on the origin of the oil price shocks. More precisely, Russian stocks appear to be more exposed to the aggregate demand side oil shock such as the one that occurred during the GFC period. KSA stock indices followed by DFM indices are more exposed to the recent supply strands such as the oil shock that had occurred since mid-2014. These results have important implications for investors, portfolio managers, and policy-makers by taking into account the joint tail risk between oil and stock returns. Ignoring this joint relationship can lead to mispricing risk and therefore require frequent portfolio rebalancing involving significant costs.

The results partly agree with previous studies, such as those conducted by Bharn and Nikolovann (2010), Filis et al. (2011), Arouri et al. (2011), Awartani and Maghyereh (2013) among others, who also report a time-varying relationship between oil price changes or oil price shocks and stock returns. Nevertheless, the findings contrast with the past studies which suggest that there is no relationship between oil shocks and sectoral stock returns (Reboredo & Rivera-Castro, 2014, among others).

As a natural extension of our analysis, it is possible to examine the relationship between oil price shocks and stocks, especially during the bullish and bearish periods. It is also possible to use the copula theory to improve the modeling of tail dependence between markets (See Trabelsi, 2017).

[6] Other authors who have considered the origin of the oil price shocks in their studies include Kilian and Lewis (2011), Filis et al. (2011), Apergis and Miller (2009), Lescaroux and Mignon (2009), Kilian (2008) and Barsky and Kilian (2004), among others.

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