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# Oil-Stock Nexus: The Role of Oil Shocks for GCC Markets

**Abstract**
This study examines the links between oil price shocks and GCC stock markets from February 2004 to December 2019. Initial results show a positive oil price change increases stock returns, while greater volatility decreases returns. Shock decomposition results reveal a significant positive impact of supply-side shocks on stocks. This contrasts with the literature that argues demand-side shocks are more important. Our result reflects the unique economic structure of the GCC bloc, marked by its dependence on oil revenues. In analysing quantile-based results, oil supply shocks mainly exhibit lower-tail dependence, while we uncover some evidence of demand-side shocks affecting mid and upper-tail dependence. These results will be of interest to global investors and GCC policy-makers.

**1. Introduction.**

The energy finance literature highlights important links between oil prices and stock markets (see, for example, Sadorsky, 1999; Papapetrou, 2001; Bjornland, 2009; Park and Ratti, 2008; Le and Chang, 2015; Wang et al., 2013). To better understand these links, a notable advance is presented in work that decomposes the oil price into its respective shocks (Hamilton, 2009; Kilian, 2009). Given the high dependence of the Gulf Cooperation Council (GCC[1]) countries on oil production,[2] the analysis of oil price shocks on GCC stocks is important to investors and policy-makers, as well as academics interested in modelling financial market relations. Thus, this paper seeks to examine the impact of oil price shocks using the decomposition of Ready (2018) on GCC stock returns.

As relatively young stock markets, those of the GCC are understudied. Moreover, the markets, classed as either emerging or frontier (Balcilar et al., 2015), have witnessed considerable efforts to enhance efficiency (Benlagha, 2020) and have undergone economic and financial liberalisation (Bley and Chen, 2006; Al-Khazali et al, 2006; Akoum et al., 2012). This includes, for example, structural reforms to allow foreign investors to channel funds towards GCC financial markets, improving liquidity (Al Janabi et al., 2010; Arouri and Rault, 2012). Consequently, in 2014, the MSCI re-categorised the markets of the UAE and Qatar to emerging market status, while Saudi Arabia followed in 2019. The markets of Kuwait, Oman and Bahrain remain in the frontier category. Nonetheless, the GCC markets generally enjoy many macroeconomic fundamentals equivalent to developed nations (Awartani and Maghyereh, 2013).

Given these features, several studies consider the importance of GCC markets in the context of global portfolio diversification. For example, Hammoudeh and Choi (2007) argue that, in comparison to Mexico as another big oil producer, GCC markets are less connected with world markets. Arouri and Rault (2010) and Mimouni et al. (2016) conclude that the inclusion of GCC markets improves diversification in a cross-country portfolio. Therefore, establishing what may influence GCC stock market movements is of interest to global portfolio managers.

Recently, and in pursuit of diversification, investors began to regard the oil market as a suitable alternative destination leading to the so-called financialization of oil markets

[1] Established in 1981, The Cooperation Council for the Arab States of the Gulf is a regional organisation of six members: Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates.

[2] The GCC bloc holds 30.6% of proven oil reserves (BP Statistical Review of World Energy 2019). Moreover, Khalifa et al. (2014) note that the oil industry constitutes 35% of the GCC economies.

(Silvennoinen and Thorp, 2013). McMillan et al. (2021) argue that this financialisation of oil is linked with higher comovements of GCC stocks with their US counterparts. Moreover, together with the recent instability in oil prices, this motivates a new examination of the oil-stock nexus.

The literature on the links between oil prices and the economy can be traced back to the work of Hamilton (1983). Subsequently, a wave of research sought to establish a link between oil prices and financial markets using Vector Autoregressive (VAR) models. Examples include the work of Sadorsky (1999), Papapetrou (2001), Bjornland (2009), Park and Ratti (2008) and Le and Chang (2015). Hamilton (2009) argues that oil price shocks are not uniquely instigated by supply shortages, but also by innovations in the demand side. Moreover, Kilian and Park (2009) note, studies that do not recognise the causes of oil shocks, will be predisposed to uncover trivial links between oil prices and stocks.

In a notable development, Kilian[3] (2009) suggests that a rise in oil price should be attributed to its underlying cause and identifies three distinctive sources of oil price increases: supply-side shock caused by shortfalls in oil production, demand-side shock due to the expansion of the global economy, and precautionary demand shock triggered by expectations of future oil supply shortfalls. In a further significant study, Ready (2018) proposes a technique to disentangle oil price shocks based on the traded asset price data of oil-producing firms. Ready (2018) argues that while oil producers benefit from price increases due to oil demand, they remain numb to supply disruptions (for example, when extraction complications arise, oil producers will sell less but at higher prices). Empirically, Ready (2018) identifies demand shocks as returns to an index of oil-producing firms that are orthogonal to innovations in the VIX index, and supply shocks as oil price changes that are orthogonal to demand shocks and to changes in VIX.

Subsequently, a number of studies examine the impact of oil price shocks on stocks. Earlier work, such as Kilian and Park (2009) and Abhyankar et al. (2013) concentrate on the major developed markets of the US and Japan, while Kang and Ratti (2015) examine the impact of oil price shocks and economic policy uncertainty on Chinese stocks. Further studies include

[3] Within this framework, Kilian (2009) reports that supply and demand shocks account for 4% of the monthly variation in the oil price. Precautionary demand shocks, which are unspecified by this procedure account for 77% of the variation, which lead to some criticism. Kolodzej and Kaufmann (2014) argue that the Kilian (2009) index of global real economic activity captures little more than transportation costs such that the identified demand shock is not sufficient. Elaborating, Ready (2018) reveals that the measure will not capture anticipated variation in aggregate demand, leaving these to the precautionary demand. Likewise, Demirer et al. (2020) document the over emphasis of Kilian's (2009) decomposition on precautionary demand shocks.

the work of Wang et al. (2013), Kang and Ratti (2013) and Apergis and Miller (2009). However, despite the importance of oil to the GCC economies, as well as the strong role they play in the oil market, examining the link between oil price shocks and GCC markets remains largely neglected.

Focusing on oil exporters and using the approach of Kilian and Murphy (2014), Basher et al. (2018) study the influence of oil shocks on Canada, Mexico, Norway, Russia, the UK, Kuwait, Saudi Arabia, and the UAE. Using a two-state Markov-switching model, they show that both oil aggregate demand shocks and oil precautionary demand shocks have a significant impact on stock returns in Norway, Russia, Kuwait, Saudi Arabia, and the UAE. While oil supply shocks influence stocks in the UK, Kuwait, and the UAE. Therefore, to the best of our knowledge, this is the only study that incorporates (some) GCC markets in an empirical analysis that focuses on oil price decompositions.

Building on the work of Basher et al. (2018), this paper exploits the Ready (2018) decomposition of oil innovations on stock return. We also incorporate all GCC markets as we believe that heterogeneity exists in terms of their economic structure and oil dependence. For instance, while Kuwait has the highest level of dependence on oil, the UAE has a growing diversified economy based on tourism and services. In this regard, Fenech and Vosgha (2019) argue that the dependence structure between oil and GCC stock exchanges varies. Moreover, Alqahtani et al. (2019) maintain that the link between oil price uncertainty and GCC markets differs significantly with the smaller markets of Bahrain and Oman being less susceptible to oil shocks than their Saudi and Emirati counterparts. Furthermore, Mokni and Youssef (2019) show that the Saudi market displays the largest degree of persistence in the dependence with oil prices. Thus, examining the heterogeneity among GCC nations in their interactions with oil shocks can be an enhancement to the current literature.

Therefore, we examine the impact of oil price shocks on the GCC stocks markets using the method of Ready (2018). In extending this, we further examine the dependence structure between oil price shocks and GCC stocks using the quantile regression of Koenker and Bassett (1978). Specifically, we first consider the standard linear relation between oil return and volatility. Oil volatility is included in this initial analysis as it may capture risk in the oil market. Although that analysis is then subsumed in the next stage that considers oil price shocks. Second, we then decompose oil price changes according to their source as supply, demand and risk shocks. Third, we consider whether the relation varies across different quantiles of the returns process. In examining the impact of oil innovations on GCC stock returns, we control for global factors using the VIX index, Global Economic Policy Uncertainty (GEPU) and the MSCI world portfolio. Controlling for these variables is essential to ensure the accuracy of results. According to Dickinson (2000) and Rigobon and Sack (2003), asset prices are intertwined, therefore, analyzing a single market in segregation overlooks important information about its behaviour. The MSCI world portfolio is designed to capture common fundamentals that steer global equity returns. Oil price shocks are believed to be related with both VIX and GEPU as argued by Antonakakis et al. (2013) and Kang and Ratti (2013). These variables can influence stock prices by affecting expected cash flows and discount rates. Moreover, oil price increases caused by supply-side factors may be associated with higher GEPU with the opposite for demand-side factors (Kang and Ratti, 2013).

This study contributes to the literature from several angles. First, we apply the Ready (2018) methodology to the GCC markets while detailing the dependence structure of the oil-stock nexus. Second, we include all GCC countries, hence, we highlight the heterogeneities among them. This latter point could carry important information for portfolio managers interested in intra-regional diversification. Third, we also consider heterogeneity across the stock return distribution and thus, whether the relation with oil shocks depends on the state of the stock market and whether it is a bullish or bearish phase. Of note, our results point to the importance of oil supply shocks in explaining the changes in GCC equity returns, especially during bear market phases.

## 2. Literature Review.

Oil prices and financial markets are linked through their effects on, and from, the wider economy. In considering the theoretical transmission mechanisms, Mohanty and Nandha (2011) argue that oil price changes impact a firm's future cash flows, positively or negatively, depending on whether it is an oil-consumer or oil-producer. As rising oil prices amplify production costs, Basher and Sadorsky, (2006) argue that as policy-makers increase short-term interest rates in response to higher inflationary pressures, this increases borrowing costs and reduces company cash flows. Brown and Yücel (2002) argue that rising oil prices cause greater uncertainty in the real economy, reducing investment and future expected cash flows. Bjornland

(2009) argues that, in oil-exporting nations, rising oil prices increase government and individual consumption and overall wealth.

In the GCC context, early research explores the long-term relations between oil and stock prices. Maghyereh and Al-Kandari (2007) use a non-linear cointegration approach with daily data from 1996 to 2003. They support the existence of non-linear linkages between the stock markets of Bahrain, Kuwait, Oman, and Saudi Arabia and an oil price index. Arouri and Rault (2012) use both panel cointegration and Seemingly Unrelated Regression (SUR) frameworks and provide evidence of long-run dependence across GCC and oil markets. The SUR results show that higher oil prices have a positive impact on GCC markets, except for Saudi Arabia. Using the NARDL method of Shin et al. (2014), which allows for short- and long-run asymmetric adjustment, Siddiqui et al. (2019) report that during the 2014 - 2016 oil price fall, negative oil price changes had a larger effect than positive changes. Akoum et al. (2012) use a wavelet approach for weekly data from 2002 to 2011 and show that GCC stock returns display comovement over the long term with oil returns.

A further direction for research considers volatility spillovers between oil and stock markets. Using daily data from September 30, 2005 through October 24, 2016, Al-Yahyaee et al. (2019) examine the volatility spillovers between commodity futures and the GCC stock markets. Relying on dynamic equicorrelation (DECO) models and the spillover index of Diebold and Yilmaz (2012), they report that oil is a considerable transmitter of volatility to the GCC markets. Arouri et al. (2011) use a VAR–GARCH model and reveal significant volatility spillovers from oil, particularly during market turbulence. Awartani and Maghyereh (2013) use the Diebold and Yilmaz (2009, 2012) spillover index for returns and volatility between oil and GCC stocks from 2004 to 2012. They report that return and volatility transmission is more pronounced after the financial crisis. The authors argue that despite evidence of bi-directional causality, oil constitutes the larger source of spillovers. Likewise, Bouri and Demirer (2016) report volatility transmissions from oil prices to Kuwait, Saudi Arabia and UAE. Khalifa et al. (2014) using weekly data from 2004 to 2011 to investigate the volatility transmission among oil, the MSCI-world portfolio and US and GCC markets. Using the Multi-Chain Markov Switching approach of Gallo and Otranto (2008), they find evidence of interdependence between oil and the stocks of Kuwait and Abu Dhabi. Additionally, spillovers from oil to Dubai are reported, with no linkages between oil and the Saudi, Qatari and Omani markets.

Ashfaq et al. (2019) use daily data from 2009 to 2018 for three oil-exporting countries (Saudi Arabia, United Arab Emirates, Iraq) and four oil-importing countries (China, Japan, India, South Korea). They measure correlations and spillovers between oil and stock prices using DCC and BEKK GARCH models. They conclude that the sensitivity of stock returns to oil shocks is higher in oil-exporting nations than oil-importing nations. Using the Kilian (2009) method, Ziadat et al. (2022) find that oil exporters display susceptibility to oil precautionary demand shocks. The effect is positive and important in all market conditions in the oil exporters of Canada, Norway and Russia. In the GCC market of Saudi Arabia, Abu Dhabi, Dubai, Bahrain, Oman and Qatar, the impact is positive and significant during bear market phases.

McMillan et al. (2021) use the Asymmetric DCC model and monthly data from 2003 to 2019 to investigate the impact of oil on the interdependence of the GCC and US stocks. They find that oil returns and volatility significantly explain changes in the US-GCC correlation.

Overall, despite the absence[4] of the application of oil price decompositions in examining the relation with GCC stock returns, the literature, using a variety of empirical designs, documents a significant impact of oil prices on the GCC markets. However, the heterogeneity of links between oil and individual GCC markets remains a matter of debate.

## 3. Methodology.

To examine the impact of oil shocks on GCC market returns, we use the following regression:

$$r_{i,t} = \alpha_0 + \Sigma_i \beta_i x_{i,t} + \varepsilon_t \quad (1)$$

Where $r_{i,t}$ refers to the stock return series at time period $t$, $x_{i,t}$ are the explanatory variables and $\varepsilon_t$ is the random error term. The explanatory variables include oil returns, oil volatility and oil shocks as well as the control variables, MSCI world index return, VIX and GEPU.

*Oil Price Decomposition*

Ready (2018) introduces a methodology to decompose oil price changes into supply, demand and risk shocks. Following Ready (2018), we use the World Integrated Oil and Gas Producer Index as a proxy of oil producing firms stock returns, one-month crude oil futures returns on the second nearest maturity contract on the New York Mercantile Exchange to reflect oil price changes and the VIX index.

[4] McMillan et al. (2021) apply the Kilian (2009) oil price decomposition to explain the US-GCC correlation.

Based on the view that the return to oil producers is affected by the level of demand and risk shocks, risk shocks are identified as the residuals from an ARMA(1,1) model on VIX.[5] Demand shocks are measured as the segment of current returns to oil producing firms that is orthogonal to risk shocks. Supply shocks are defined as that portion of the current oil return that is orthogonal to both demand and risk shocks. Oil supply, demand and risk shocks are normalised and constrained to sum to the total oil price change.

*Quantile regression*

The quantile regression, developed by Koenker and Bassett (1978), estimates the effect of the explanatory variables on the conditional quantile of the dependent variable. This presents information on average dependence as well as the upper and lower tail dependence and is robust to both outliers and non-normality.

The quantile regression therefore extends the linear model in equation (1) by allowing a different coefficient for each specified quantile:

$$r_{i,t} = \alpha^{(q)} + \Sigma_i \beta_i^{(q)} x_{i,t} + \varepsilon_t \quad (2)$$

where $\alpha^{(q)}$ represents the constant term for each estimated quantile *(q)*, $\beta^{(q)}$ is the slope coefficient that reveals the relation between the correlation and the explanatory variable at each quantile, and $\varepsilon_t$ is the error term.

**4. Data.**

Following Ready (2018), we use the WTI benchmark as a proxy of oil prices, which is obtained from the EIA website. For the volatility of oil, we apply the realised volatility approach of Schwert (1989) by summing the daily squared oil returns. We obtain the oil price shocks using the approach of Ready (2018). Thus, we obtain data on the world integrated oil and gas producer index to represents oil producers stock price, the second nearest maturity of the NYMEX WTI futures contract and the VIX index.

All share indexes are obtained for Dubai, Saudi Arabia, Abu Dhabi, Qatar, Oman, Bahrain, and Kuwait. Except where noted, the data is from DataStream and sampled monthly

[5] Bollerslev et al. (2009) note the risk premium captured by the VIX index correlates negatively with stock returns and has the ability to forecast them. Therefore, supporting the argument of Ready regarding the ability of VIX to capture changes in risk.

from February 2004 to December 2019. The stock return series are denominated in US dollars to be comparable across countries and to be regarded as more pertinent for global investors. Returns are generated by applying the natural logarithmic difference. This study incorporates a set of global factors including the MSCI world index (following Demirer et al., 2020), the VIX index (Whaley, 1993)

and Global Economic Policy Uncertainty index (GEPU). The GEPU Index (Davis, 2016), is a GDP-weighted average of national Economic Policy Uncertainty indices (EPU) for 16 countries that account for two-thirds of global output.

Table 1 presents summary statistics for our data. The GCC stock return series exhibit a positive mean for returns, exception for Kuwait, while Dubai has the highest standard deviation. With the exception of the oil demand shock, the Jarque-Bera test reveals that all series display non-normality. The Philip-Perron unit root test shows that stationarity holds for all sampled data.

## 5. Empirical Results.

*Oil Price changes and GCC markets*

As much of the literature on the oil-stock nexus focuses on the effect of the oil price return and volatility on stocks, we first examine these to provide comparability.

Table 2 presents the results of regressing GCC stock returns on oil price changes, oil volatility, VIX, GEPU and the World portfolio. The results indicate that oil, either the return or volatility, affects the stock markets of all GCC countries, except for Qatar, for which gas is the main export commodity. Across the seven GCC countries, there is a positive relation between stocks and oil returns and a negative relation between stock returns and oil volatility. The positive stock and oil return relation is statistically significant for Saudi Arabia, Dubai, Oman and Abu Dhabi, with the highest coefficient magnitude for Dubai and Saudi Arabia. The negative relation between stock returns and oil volatility is significant for Bahrain, Kuwait and Oman.

Given that higher oil prices are expected to boost wealth, economic activity and firm cash flows in oil-exporting nations (Bjørnland, 2009), the previous literature establishes a positive link between oil and stocks. For example, Park and Ratti (2008) and Ramos and Vega (2013) argue that oil price increases boost the stock market of oil-exporting countries, and harm those of oil-importing countries. In the GCC context, Mokni and Youssef (2019) show that the GCC markets have a positive relation with oil prices. Mokni and Youssef (2019) and Mohanty et al.

(2011) argue that, except for Kuwait, GCC stocks have positive exposures to oil price innovations. Thus, our results are broadly consistent with these findings, in that we note a positive relation as well as the Kuwaiti market isolation from oil shocks. As noted, the insignificant result for Qatar may arise as gas is its main export, while for Bahrain, the oil industry there is comparatively small. Nonetheless, our findings do contrast with those of Fayyad and Daly (2011) who argue that Qatar and the UAE exhibit the highest sensitivity to oil shocks in the GCC bloc. Equally, the results contrast with Al Janabi et al. (2010), who find that the relation between oil price and GCC stock markets are weak. Further, it is of interest to note that the large oil producers, Saudi Arabia and Abu Dhabi, are not affected by oil price volatility despite the positive oil return relation. For the UAE this may arise from its increased economic diversification with now established service and tourism industries (see Callen et al, 2014). Equally, the large nature of the Saudi Arabian market, with 50% of the total GCC market capitalisation, may provide some resilience to oil price swings. Conversely, the smaller GCC markets in Bahrain and Oman are more vulnerable to oil return volatility.

In regard of the other coefficients, the signs of VIX and GEPU are negative but not significant (except the VIX for Saudi Arabia). The world portfolio is strongly positive especially in the markets of Dubai and Qatar where the coefficient is twice as large as its Kuwaiti, Omani and Bahraini counterparts. Such results hint at higher levels of global integration in the markets of Dubai and Qatar (see Ziadat et al, 2020).

*Oil shocks and GCC markets*

Having conducted an initial examination of the effect of oil price changes on stock returns, we now consider the impact of different oil price shocks. The oil price shocks are intended to capture unexpected oil price innovations. For this, we use the decomposition of Ready (2018) and examine the effect of supply, demand, and risk shocks. We consider this first in the usual linear regression before turning to the quantile regression framework.

Table 3 illustrates the impact of the different oil price shocks on the GCC markets while controlling for the influence of GEPU and the MSCI world index.[6] The results presented here suggest an interesting pattern of influence emerges and one that appears to contradict the results of similar and recent analysis across global markets. Notably, where research finds the influence

[6] The effect of VIX is now captured within the oil price shocks.

of shocks is significant and negative (see Ready, 2018; Demirer et al., 2020), our results support a positive effect arising only from oil supply shocks.

Demirer et al. (2020), Wang et al. (2013), Guntner (2014) and Jung and Park (2011) show that oil price increases, triggered by stronger global demand for oil, are associated with higher stock market returns across all countries, regardless of the classification of the country as an exporter/importer of oil. However, our results do not share such a conclusion. Although the coefficient on demand shocks is positive throughout, it is only significant for Qatar (and marginally for Dubai). Given that oil demand shocks constitute good news for the global economy, the relative high integration of Qatar and Dubai (when compared with the rest of GCC markets) into the world economy, might explain this result. A further channel to this effect may arise through spillovers from global financial markets given the integration of Qatar and Dubai (see Ziadat et al., 2020).

The strongest factor influencing GCC stock returns is evidently oil supply shocks. The influence is positive and significant in all GCC markets, albeit only at the 10% significance level for the UAE markets of Dubai and Abu Dhabi. This result run counter to the literature that relies on the Kilian (2009) decomposition method (see, Kilian and Park, 2009; Abhyankar et al., 2013; Kim and Vera, 2019) where the findings point to only a trivial impact of oil supply shocks. Using the Ready (2018) decomposition, Demirer et al. (2020) find that supply shocks have a significant and negative effect on stock market returns for the majority of 21 countries examined. Interestingly, Demirer et al. (2020) incorporate the oil-exporters of Canada, Mexico and Norway in their analysis, however, they only find positive links between oil supply shocks and Canadian stocks whereas, similar to oil-importers, a negative effect is found for Mexico and Norway. Accordingly, the positive link between oil supply shocks and stocks appears to be a unique feature of the GCC region.

In the method of Ready (2018), the oil supply shock is obtained as the residual after incorporating both the demand and risk shocks. Ready reports that this shock is responsible for 80% of the change in oil prices. Hence, the results reported here may stem from a broad range of underlying variables. For instance, Malik and Umar (2019) argues that oil supply shocks could be triggered by issues linked to unexpected changes in proven reserves, technologies related to oil well completions and oil recovery. Clements et al. (2019) argue that the oil supply shocks, defined by Ready (2018), can be linked to an exogenous measure of precautionary demand, reflecting future oil supply uncertainty rather than contemporaneous supply changes. In seeking to understand the results for the GCC markets, while acknowledging the strong ties between the GCC economies as well as the impact of supply shocks on the price of oil, Filis and Chatziantoniou (2014) argue that the magnitude of the stock market reaction to oil price shocks is higher for new or less liquid stock markets, which will apply to several GCC markets. Further, the lack of hedging instruments in emerging markets can increase their sensitivity to oil shocks (Balcilar et al., 2019).

*Oil price shocks and the state of the market*

While the above results examine the links between oil price shocks and GCC stock markets in a linear model, here, we consider the impact of oil shocks across different market states. Developed by Koenker and Bassett (1978), the quantile regression estimates the effects of the explanatory variables on the conditional quantile of the dependent variable. Therefore, in addition to the average (median) dependence, the quantile regression offers information regarding the tail dependence. There are several advantages in using the quantile regression approach, for example, Baur (2013) notes the ability of the model to capture the changing nature of dependence across different market conditions, from bullish to bearish. Moreover, this allows examination of the whole return distribution rather than, for example, two or three market states in a regime switching model. Further, quantile regression estimators are robust to heteroskedasticity and skewness of the dependent variable (Koenker and Hallock, 2001).

Table 4 depicts the quantile coefficient estimates for oil supply, demand and risk shocks for each GCC market. The first two quantiles correspond to the bear market phase, the upper quantiles reflect bull market conditions, with the middle quantiles representing normal market states. As a general observation, the coefficients of oil demand shocks tend to increase with the quantiles, while those for oil supply shocks decrease and with no clear pattern for the risk shock. An interesting pattern also develops in the statistical significance of the demand and supply shocks over the quantiles, with the demand shocks typically significant at higher (bull market) quantiles and supply shocks significant at lower (bear market) quantiles.

Oil demand shocks exhibits mid and upper tail dependence with the stock returns conditional distribution in Saudi Arabia, Qatar, Kuwait and Dubai, while upper-tail[7] only

[7] The markets of Dubai and Kuwait also exhibit lower-tail dependence with oil demand shocks.

dependence is reported for Abu Dhabi. This leaves the markets of Oman and Bahrain for which oil demand shocks are wholly insignificant. An oil demand shock is associated with higher demand for oil due to expansion in the global economy and the findings here are consistent with those of Ready (2018) in supporting a positive link between stock markets and oil demand shocks.[8]

The quantile process estimates show a clear evidence of lower-tail dependence between oil supply shocks and GCC returns. For the first quantile (Q1), which represents a bear market phase, oil price shocks exert a significant positive impact on all GCC markets. When comparing our results with those of Ziadat et al. (2022), they report lower tail dependence between oil precautionary demand shocks and GCC markets. The discrepancy is a result of the different approach in constructing oil shocks. Nonetheless, our results appears consistent with the view of Balcilar et al. (2019) who state that financial markets responses to oil shocks are stronger during extreme market conditions. Moreover, given the general view in the literature, which points to a negative impact of oil supply shocks on stocks, among oil importers and some oil exporters, the results here convey important insights for the potential of cross-regional diversification.

You et al. (2017) and Le and Zheng (2011) report that the impact of oil price shocks on stocks mainly occurs when stock markets are in a bull or bear phase, indicating that the relation between stocks and oil shocks are governed by investor (optimistic or pessimistic) sentiments. Furthermore, citing factors related to less sophisticated investors in emerging markets, You et al. (2017) and Le and Zheng (2011) argue that investors might display irrational behaviour when facing instabilities in oil markets. This argument is therefore applicable to the GCC markets given GCC investor profiles and the importance of oil to GCC economies. Thus, the positive oil price supply shock may be an indicator of improving economic conditions in GCC economies, thus, boosting their confidence in future stock market behaviour.

To further elaborate on the lower-tailed dependence between oil supply shocks and GCC markets, we consider the role of geopolitical factors. This is motivated by the fact that a considerable share of the global oil supply is produced in the region, which has experienced a history of conflict and wars. Hammoudeh and Li (2008) report substantial sensitivity of GCC

[8] The lack of significance for Bahrain and Oman may arise from their relatively small market capitalisation (Oman and Bahrain combined constitute only 4% of total GCC market capitalisation as of 2016). While smaller firms are likely to be less globally connected, the low capitalisation is also associated with poor liquidity, which will be less attractive to global investors. Indeed, we can see only a small response to changes in the world portfolio (see Table 3) when compared with other GCC markets.

markets to geopolitical stress. Antonakakis et al. (2017) maintain that aggregate demand shocks transmit most of the information to stock markets during periods characterised by economic–driven events, while supply and oil precautionary demand shocks prevail during periods of geopolitical unrest. Such events can trigger change in both financial markets and portfolio allocations (Kollias et al., 2013). This supports the view that when oil supply shocks concur with geopolitical tensions, the changing risk appetite of investors can lead to such results.

## 6. Summary and Conclusion.

Motivated by the importance of oil as a commodity to the world economy and especially the GCC bloc, this study characterises the links between oil price shocks and the GCC stock markets. The analysis utilises the oil price decomposition of Ready (2018) and monthly data from February 2004 to December 2019. The results reveal that the type of shock is important for GCC markets. While the previous literature argues that supply-side shocks have a negative or negligible impact on global markets, our results support a significant positive effect on GCC stocks. Such a result reflects the heavy dependence on oil revenue and the structure of the GCC economies. That said, when examining the relation across the stock return distribution, we also find the oil demand shocks exhibit a positive relation with stock returns during a bull market, while the effect of the supply shock is more evidence in bear market conditions.

From an academic standpoint, this study provides a comprehensive and up-to-date examination of the oil-stock nexus for the GCC markets using decomposed measures of oil price innovations. The results convey important information to global investors, as the characterisation of the links between individual GCC markets and oil shocks enhance our understanding of inter-market relations and the effects on portfolio compositions in an inter and intra-regional perspective. Moreover, given that portfolio diversification is achieved by investing in different classes of assets or investing in similar classes of assets in multiple markets through international diversification, the results here can improve decision making for asset allocation.

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Table.1 Summary Statistics

| | Abu Dhabi | Bahrain | Dubai | Kuwait | Oman | Qatar | Saudi Arabia | World | GEPU |
|---|---|---|---|---|---|---|---|---|---|
| Mean | 0.005 | 0.001 | 0.005 | 0.000 | 0.002 | 0.005 | 0.003 | 0.005 | 0.000 |
| Median | 0.004 | 0.001 | -0.001 | 0.000 | 0.002 | 0.004 | 0.009 | 0.011 | -0.012 |
| Maximum | 0.359 | 0.092 | 0.382 | 0.139 | 0.162 | 0.260 | 0.187 | 0.096 | 0.769 |
| Minimum | -0.196 | -0.135 | -0.408 | -0.224 | -0.250 | -0.272 | -0.278 | -0.173 | -0.496 |
| Std. Dev. | 0.065 | 0.033 | 0.096 | 0.047 | 0.049 | 0.078 | 0.076 | 0.037 | 0.176 |
| Skewness | 0.586 | -0.404 | 0.052 | -0.912 | -0.575 | -0.304 | -0.694 | -1.112 | 0.730 |
| Kurtosis | 8.235 | 4.942 | 6.128 | 7.960 | 6.936 | 4.759 | 4.486 | 5.743 | 5.022 |
| Jarque-Bera | 229.013 | 35.225 | 77.940 | 222.227 | 133.837 | 27.569 | 32.897 | 99.253 | 49.487 |
| Probability | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| PP test | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

| | Oil demand shock | Oil supply shock | Oil risk shock | VIX | Oil | Oil volatility | GEPU |
|---|---|---|---|---|---|---|---|
| Mean | -0.103 | -0.467 | -0.027 | 0.001 | 0.003 | 0.011 | 0.000 |
| Median | -0.002 | -4.096 | 0.304 | -0.017 | 0.017 | 0.007 | -0.012 |
| Maximum | 11.317 | 73.905 | 19.859 | 0.853 | 0.297 | 0.110 | 0.769 |
| Minimum | -12.246 | -43.897 | -26.878 | -0.486 | -0.533 | 0.001 | -0.496 |
| Std. Dev. | 4.615 | 19.257 | 7.197 | 0.205 | 0.105 | 0.014 | 0.176 |
| Skewness | -0.045 | 1.000 | -0.653 | 0.619 | -1.234 | 3.755 | 0.730 |
| Kurtosis | 2.873 | 4.581 | 4.499 | 4.353 | 8.007 | 20.510 | 5.022 |
| Jarque-Bera | 0.193 | 51.731 | 31.444 | 26.773 | 247.968 | 2888.971 | 49.487 |
| Probability | 0.908 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| PP test | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

Notes. The sample period runs from February 2004 to December 2019 including 191[9] monthly observations. Std. Dev. and PP test stand for Standard deviation and Phillip-Perron test. GEPU is the Global Economic Policy Uncertainty. GCC national return series, MCSI world index, oil, VIX, and GEPU are calculated using the first logarithmic difference.

[9] An exception to this is the GCC spillover index where the sample runs from December 2009 to December 2019 generating 137 observations.

Table.2 GCC returns response to oil price change and volatility

| Country | | C | Oil | Oil Vol | VIX | GEPU | World | Adj. R2 |
|---|---|---|---|---|---|---|---|---|
| Abu Dhabi | Coeff | 0.010 | 0.090 | -0.534 | -0.015 | -0.001 | 0.285 | 0.076 |
| | P Value | 0.082 | 0.022 | 0.248 | 0.502 | 0.967 | 0.029 | |
| | | | | | | | | |
| Bahrain | Coeff | 0.010 | 0.026 | -0.939 | 0.000 | 0.000 | 0.170 | 0.264 |
| | P Value | 0.000 | 0.138 | 0.000 | 1.000 | 0.958 | 0.006 | |
| | | | | | | | | |
| Dubai | Coeff | 0.012 | 0.178 | -0.912 | -0.024 | -0.013 | 0.682 | 0.177 |
| | P Value | 0.163 | 0.005 | 0.087 | 0.444 | 0.644 | 0.000 | |
| | | | | | | | | |
| Kuwait | Coeff | 0.009 | 0.038 | -0.981 | -0.022 | 0.014 | 0.390 | 0.271 |
| | P Value | 0.050 | 0.303 | 0.021 | 0.100 | 0.257 | 0.006 | |
| | | | | | | | | |
| Oman | Coeff | 0.008 | 0.094 | -0.753 | -0.023 | 0.004 | 0.340 | 0.237 |
| | P Value | 0.050 | 0.029 | 0.002 | 0.197 | 0.779 | 0.003 | |
| | | | | | | | | |
| Qatar | Coeff | 0.004 | 0.116 | -0.227 | -0.039 | 0.043 | 0.749 | 0.195 |
| | P Value | 0.602 | 0.224 | 0.528 | 0.128 | 0.236 | 0.005 | |
| | | | | | | | | |
| Saudi Arabia | Coeff | 0.002 | 0.141 | -0.243 | -0.055 | 0.022 | 0.690 | 0.205 |
| | P Value | 0.708 | 0.003 | 0.428 | 0.021 | 0.395 | 0.000 | |

Notes. The regressions above are generated by regressing oil returns, oil realised volatility, the VIX index, and Global Policy Uncertainty (GEPU) and the MSCI world portfolio on GCC equity returns. C, Coeff and Oil Vol stand for constant, coefficient and oil volatility, respectively. The equations runs as follows: GCC market return$_{i,t}$ = $C_{0,i} + \beta_1 Oil_{,t} + \beta_2 Oil\ Vol_{,t} + \beta_3 VIX_{,t} + \beta_4 GEPU_{,t} + \beta_5 World_{,t} + \varepsilon_{i,t}$. The P Value is based on the robust standard errors of Newey-West (1987). The sample ranges from February 2004 to December 2019 yielding a total of 191 observations.

Table.3 GCC returns response to oil price shocks

| Country | | C | Supply | Demand | Risk | GEPU | World | Adj. R2 |
|---|---|---|---|---|---|---|---|---|
| Abu Dhabi | Coeff | 0.003 | 0.002 | 0.000 | 0.000 | 0.004 | 0.486 | 0.071 |
| | P Value | 0.568 | 0.093 | 0.785 | 0.581 | 0.841 | 0.054 | |
| | | | | | | | | |
| Bahrain | Coeff | -0.001 | 0.001 | 0.001 | 0.000 | 0.003 | 0.370 | 0.171 |
| | P Value | 0.760 | 0.021 | 0.374 | 0.454 | 0.782 | 0.027 | |
| | | | | | | | | |
| Dubai | Coeff | 0.002 | 0.003 | 0.003 | 0.000 | -0.013 | 0.812 | 0.168 |
| | P Value | 0.859 | 0.083 | 0.070 | 0.985 | 0.658 | 0.066 | |
| | | | | | | | | |
| Kuwait | Coeff | -0.003 | 0.001 | 0.000 | 0.000 | 0.017 | 0.665 | 0.216 |
| | P Value | 0.513 | 0.042 | 0.516 | 0.325 | 0.213 | 0.023 | |
| | | | | | | | | |
| Oman | Coeff | 0.000 | 0.002 | 0.002 | 0.000 | 0.005 | 0.401 | 0.196 |
| | P Value | 0.994 | 0.011 | 0.124 | 0.783 | 0.729 | 0.036 | |
| | | | | | | | | |
| Qatar | Coeff | 0.002 | 0.002 | 0.004 | 0.000 | 0.034 | 0.849 | 0.240 |
| | P Value | 0.771 | 0.014 | 0.013 | 0.346 | 0.356 | 0.013 | |
| | | | | | | | | |
| Saudi Arabia | Coeff | 0.000 | 0.002 | 0.003 | 0.000 | 0.020 | 0.734 | 0.192 |
| | P Value | 0.978 | 0.013 | 0.129 | 0.746 | 0.440 | 0.001 | |

Notes. C, Coeff , Supply, Demand and Risk stand for constant, coefficient, oil supply shocks, oil demand shocks and oil risk shocks, respectively. Oil price shocks are measured using the method of Ready (2018). The rest of the variables are the VIX index, and Global Policy Uncertainty (GEPU) and the MSCI world portfolio and the dependent variable is the stock market return of each GCC nation. The equations runs as follows: GCC market $\text{return}_{i,t} = C_{0,i} + \beta_1 \text{Supply}_{,t} + \beta_2 \text{Demand}_{,t} + \beta_3 \text{Risk}_{,t} + \beta_4 \text{GEPU}_{,t} + \beta_5 \text{World}_{,t} + \varepsilon_{i,t}$. The P Value is based on the robust standard errors of Newey-West. The sample ranges from February 2004 to December 2019 yielding a total of 191 observations.

Table. 4 GCC returns dependence structure with oil price shocks

| | | Abu Dhabi | | Bahrain | | Dubai | | Kuwait | |
|---|---|---|---|---|---|---|---|---|---|
| | Q | Coeff | Prob. | Coeff | Prob. | Coeff | Prob. | Coeff | Prob. |
| | | | | | | | | | |
| Oil supply shock | 0.100 | 0.003 | 0.000 | 0.001 | 0.023 | 0.003 | 0.000 | 0.002 | 0.007 |
| | 0.200 | 0.001 | 0.098 | 0.001 | 0.120 | 0.002 | 0.065 | 0.001 | 0.007 |
| | 0.400 | 0.001 | 0.129 | 0.001 | 0.088 | 0.001 | 0.488 | 0.000 | 0.950 |
| | 0.600 | 0.001 | 0.139 | 0.000 | 0.239 | 0.001 | 0.213 | 0.000 | 0.393 |
| | 0.800 | 0.000 | 0.958 | 0.001 | 0.050 | 0.001 | 0.412 | 0.001 | 0.058 |
| | 0.900 | 0.001 | 0.426 | 0.001 | 0.048 | 0.001 | 0.832 | 0.002 | 0.077 |
| | | | | | | | | | |
| Oil Demand shock | 0.100 | -0.001 | 0.599 | 0.000 | 0.907 | 0.000 | 0.938 | -0.002 | 0.049 |
| | 0.200 | 0.001 | 0.679 | 0.000 | 0.817 | 0.003 | 0.031 | -0.001 | 0.488 |
| | 0.400 | 0.001 | 0.244 | 0.001 | 0.351 | 0.003 | 0.038 | 0.001 | 0.254 |
| | 0.600 | 0.002 | 0.120 | 0.001 | 0.446 | 0.002 | 0.216 | 0.001 | 0.020 |
| | 0.800 | 0.003 | 0.006 | 0.000 | 0.842 | 0.006 | 0.001 | 0.003 | 0.001 |
| | 0.900 | 0.003 | 0.014 | 0.002 | 0.127 | 0.009 | 0.001 | 0.002 | 0.380 |
| | | | | | | | | | |
| Oil Risk shock | 0.100 | 0.001 | 0.114 | 0.000 | 0.801 | 0.001 | 0.331 | 0.001 | 0.078 |
| | 0.200 | 0.000 | 0.764 | 0.000 | 0.688 | 0.000 | 0.514 | 0.000 | 0.294 |
| | 0.400 | 0.000 | 0.664 | 0.000 | 0.603 | -0.001 | 0.171 | 0.000 | 0.543 |
| | 0.600 | 0.000 | 0.921 | 0.000 | 0.492 | 0.000 | 0.817 | 0.000 | 0.644 |
| | 0.800 | 0.000 | 0.760 | 0.000 | 0.561 | 0.000 | 0.687 | 0.000 | 0.417 |
| | 0.900 | 0.000 | 0.748 | 0.000 | 0.935 | 0.000 | 0.828 | 0.000 | 0.846 |
| | | | | | | | | | |
| | | Oman | | Qatar | | Saudi Arabia | | | |
| | Q | Coeff | Prob. | Coeff | Prob. | Coeff | Prob. | | |
| | | | | | | | | | |
| Oil supply shock | 0.100 | 0.002 | 0.017 | 0.001 | 0.043 | 0.003 | 0.015 | | |
| | 0.200 | 0.001 | 0.062 | 0.001 | 0.052 | 0.002 | 0.076 | | |
| | 0.400 | 0.001 | 0.059 | 0.002 | 0.030 | 0.001 | 0.186 | | |
| | 0.600 | 0.001 | 0.281 | 0.001 | 0.076 | 0.001 | 0.220 | | |
| | 0.800 | 0.001 | 0.233 | 0.001 | 0.282 | 0.001 | 0.659 | | |
| | 0.900 | 0.001 | 0.396 | 0.001 | 0.339 | 0.002 | 0.121 | | |
| | | | | | | | | | |
| Oil Demand shock | 0.100 | 0.001 | 0.303 | 0.001 | 0.710 | 0.001 | 0.581 | | |
| | 0.200 | 0.002 | 0.281 | 0.003 | 0.090 | 0.002 | 0.262 | | |
| | 0.400 | 0.001 | 0.226 | 0.003 | 0.036 | 0.003 | 0.044 | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 0.600 | 0.001 | 0.359 | 0.004 | 0.020 | 0.005 | 0.002 | | |
| | 0.800 | 0.001 | 0.252 | 0.006 | 0.008 | 0.004 | 0.009 | | |
| | 0.900 | 0.003 | 0.075 | 0.007 | 0.001 | 0.004 | 0.026 | | |
| | | | | | | | | | |
| Oil Risk shock | 0.100 | 0.000 | 0.584 | 0.002 | 0.019 | 0.001 | 0.393 | | |
| | 0.200 | -0.001 | 0.265 | 0.001 | 0.025 | 0.001 | 0.413 | | |
| | 0.400 | 0.000 | 0.607 | 0.000 | 0.365 | 0.000 | 0.895 | | |
| | 0.600 | 0.000 | 0.373 | 0.000 | 0.594 | -0.001 | 0.248 | | |
| | 0.800 | 0.000 | 0.874 | 0.000 | 0.415 | 0.001 | 0.238 | | |
| | 0.900 | 0.000 | 0.891 | 0.000 | 0.643 | 0.000 | 0.852 | | |

Notes. The table depicts the quantile process coefficients estimated from quantile regression framework wherein stock returns are regressed on oil supply shocks, oil demand shocks, oil risk shocks, GEPU and world index. The latter two variables are controlled for but their results are not reported to conserve space. Q stands for quantile.

# Oil-Stock Nexus: The Role of Oil Shocks for GCC Markets


**Abstract**

Purpose: This study examines the links between oil price shocks and GCC stock markets from February 2004 to December 2019. Knowledge of such links is important to both investors and policymakers in understanding the transmission of shocks across markets.

Methodology: We employ the Ready (2018) oil price decomposition method and the quantile regression to conduct our analysis.

Findings: Initial results show a positive oil price change increases stock returns, while greater volatility decreases returns. The oil shock decomposition results reveal a significant positive impact of supply-side shocks on stocks. This contrasts with the literature that argues demand-side shocks are more important. While factors such as the liquidity and the lack of hedging instruments can increase the vulnerability of GCC equities to oil price shocks, our result reflects the unique economic structure of the GCC bloc, marked by its dependence on oil revenues. In analysing quantile-based results, oil supply shocks mainly exhibit lower-tail dependence, while we do uncover some evidence of demand-side shocks affecting mid and upper-tail dependence.

Originality: Acknowledging the presence of endogeneity in the relation between oil and economic activity, the study is the first to combine the oil price decompositions of Ready (2018) with the quantile regression frameworks in the GCC context. Our results reveal notable difference to those previously reported in the literature.

**1. Introduction.**

The energy finance literature highlights important links between oil prices and stock markets (see, for example, Sadorsky, 1999; Papapetrou, 2001; Bjornland, 2009; Park and Ratti, 2008; Le and Chang, 2015; Wang *et al*., 2013; Batten *et al*., 2019; Batten *et al*., 2021). To better understand these links, a notable advance is presented in work that decomposes the oil price into its respective shocks (Hamilton, 2009; Kilian, 2009). Given the high dependence of the Gulf Cooperation Council (GCC[1]) countries on oil production,[2] the analysis of oil price shocks on GCC stocks is important to investors and policymakers, as well as academics interested in modelling financial market relations. Thus, this paper seeks to examine the impact of oil price shocks using the decomposition of Ready (2018) on GCC stock returns.

As relatively young stock markets, those of the GCC are understudied. Moreover, the markets, classed as either emerging or frontier (Balcilar *et al*., 2015), have witnessed considerable efforts to enhance efficiency (Benlagha, 2020) and have undergone economic and financial liberalisation (Bley and Chen, 2006; Al-Khazali *et al*, 2006; Akoum *et al*., 2012). This includes, for example, structural reforms to allow foreign investors to channel funds towards GCC financial markets and so improving liquidity (Al Janabi *et al*., 2010; Arouri and Rault, 2012). Consequently, in 2014, the MSCI re-categorised the markets of the UAE and Qatar to emerging market status, while Saudi Arabia followed in 2019. The markets of Kuwait, Oman and Bahrain remain categorised as frontier. Nonetheless, the GCC markets generally enjoy many macroeconomic fundamentals equivalent to developed nations (Awartani and Maghyereh, 2013), and the inclusion of GCC markets improves diversification in a cross-country portfolio (Arouri and Rault, 2010; Mimouni *et al*., 2016). Acknowledging these features, we contribute to the existing literature by detailing the dependence structure between oil and GCC stocks using the Ready (2018) decomposition and quantile regression frameworks.

Recently, and in pursuit of diversification, investors began to regard the oil market as a suitable alternative destination leading to the so-called financialization of oil markets (Silvennoinen and Thorp, 2013). McMillan *et al*. (2021) argue that this financialisation of oil is

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[1] Established in 1981, The Cooperation Council for the Arab States of the Gulf is a regional organisation of six members: Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates.

[2] The GCC bloc holds 30.6% of proven oil reserves (BP Statistical Review of World Energy 2019). Moreover, Khalifa et al. (2014) note that the oil industry constitutes 35% of the GCC economies.

linked with higher comovements of GCC stocks with their US counterparts. Moreover, together with the recent instability in oil prices, this motivates a new examination of the oil-stock nexus.

The literature on the links between oil prices and the economy can be traced back to the work of Hamilton (1983). Subsequently, a wave of research sought to establish a link between oil prices and financial markets using Vector Autoregressive (VAR) models. Examples include the work of Sadorsky (1999), Papapetrou (2001), Bjornland (2009), Park and Ratti (2008) and Le and Chang (2015). Hamilton (2009) argues that oil price shocks are not uniquely instigated by supply shortages, but also by innovations on the demand side. Moreover, Kilian and Park (2009) note, studies that do not recognise the causes of oil shocks will be predisposed to uncover trivial links between oil prices and stocks.

In a notable development, Kilian[3] (2009) suggests that a rise in oil price should be attributed to its underlying cause and identifies three distinctive sources of oil price increases: supply-side shocks caused by shortfalls in oil production, demand-side shocks due to global economic expansion, and precautionary demand shocks triggered by expectations of future oil supply shortfalls. In a further significant study, Ready (2018) proposes a technique to disentangle oil price shocks based on the traded asset price data of oil-producing firms. Ready (2018) argues that while oil producers benefit from price increases due to oil demand, they remain numb to supply disruptions (for example, when extraction complications arise, oil producers will sell less but at higher prices). Empirically, Ready (2018) identifies demand shocks as returns to an index of oil-producing firms that are orthogonal to innovations in the VIX index, and supply shocks as oil price changes that are orthogonal to demand shocks and to changes in VIX.

Subsequently, a number of studies examine the impact of oil price shocks on stocks. Earlier work, such as Kilian and Park (2009) and Abhyankar *et al*. (2013) concentrate on the major developed markets of the US and Japan, while Kang and Ratti (2015) examine the impact of oil price shocks and economic policy uncertainty on Chinese stocks. Further studies include the work of Wang *et al*. (2013), Kang and Ratti (2013) and Apergis and Miller (2009). However, despite

[3] Within this framework, Kilian (2009) reports that supply and demand shocks account for 4% of the monthly variation in the oil price. Precautionary demand shocks, which are unspecified by this procedure account for 77% of the variation, which lead to some criticism. Kolodzej and Kaufmann (2014) argue that the Kilian (2009) index of global real economic activity captures little more than transportation costs such that the identified demand shock is not sufficient. Elaborating, Ready (2018) reveals that the measure will not capture anticipated variation in aggregate demand, leaving these to the precautionary demand. Likewise, Demirer et al. (2020) document the over emphasis of Kilian's (2009) decomposition on precautionary demand shocks.

the importance of oil to the GCC economies, as well as the strong role they play in the oil market, examining the link between oil price shocks and GCC markets remains largely neglected.

Focusing on oil exporters and using the approach of Kilian and Murphy (2014), Basher *et al*. (2018) study the influence of oil shocks on Canada, Mexico, Norway, Russia, the UK, Kuwait, Saudi Arabia, and the UAE. Using a two-state Markov-switching model, they show that both oil aggregate demand shocks and oil precautionary demand shocks have a significant impact on stock returns in Norway, Russia, Kuwait, Saudi Arabia, and the UAE. While oil supply shocks influence stocks in the UK, Kuwait, and the UAE. Using a sample that incorporates the GCC markets and the Kilian (2009) methodology, Ziadat *et al*. (2022) examine the impact of oil shocks on equities in both oil-importing and exporting nations. They distinguish the market feedback to oil shocks during bull, normal and bear phases. Their results show that oil-exporters are stimulated by precautionary demand shocks. Also, among oil-exporters, the GCC markets are predominantly impacted during bear market conditions.

Building on the work of Basher *et al*. (2018) and Ziadat *et al*. (2022), this paper exploits the Ready (2018) decomposition of oil innovations on stock return. We also incorporate all GCC markets as we believe that heterogeneity exists in terms of their economic structure and oil dependence. For instance, while Kuwait has the highest level of dependence on oil, the UAE has an increasingly diversified economy based on tourism and services. In this regard, Fenech and Vosgha (2019) argue that the dependence structure between oil and GCC stock exchanges varies. Moreover, Alqahtani *et al*. (2019) maintain that the link between oil price uncertainty and GCC markets differs significantly with the smaller markets of Bahrain and Oman being less susceptible to oil shocks than their Saudi and Emirati counterparts. Furthermore, Mokni and Youssef (2019) show that the Saudi market displays the largest degree of persistence in the dependence with oil prices. Thus, examining the heterogeneity among GCC nations in their interactions with oil shocks is an enhancement to the current literature.

Therefore, we examine the impact of oil price shocks on the GCC stocks markets using the method of Ready (2018). In extending this, we further examine the dependence structure between oil price shocks and GCC stocks using the quantile regression of Koenker and Bassett (1978). Specifically, we first consider the standard linear relation between oil return and volatility. Oil volatility is included in this initial analysis as it may capture risk in the oil market. Although that analysis is then subsumed in the next stage that considers oil price shocks. Second, we then decompose oil price changes according to their source as supply, demand and risk shocks. Third, we consider whether the relation varies across different quantiles of the returns process. In examining the impact of oil innovations on GCC stock returns, we control for global factors using the VIX index, Global Economic Policy Uncertainty (GEPU) and the MSCI world portfolio. Controlling for these variables is essential to ensure the accuracy of results. According to Dickinson (2000) and Rigobon and Sack (2003), asset prices are intertwined, therefore, analysing a single market in segregation overlooks important information about its behaviour. The MSCI world portfolio is designed to capture common fundamentals that steer global equity returns. Oil price shocks are believed to be related with both VIX and GEPU as argued by Antonakakis *et al*. (2013) and Kang and Ratti (2013). These variables can influence stock prices by affecting expected cash flows and discount rates. Moreover, oil price increases caused by supply-side factors may be associated with higher GEPU with the opposite for demand-side factors (Kang and Ratti, 2013).

This study contributes to the literature from several angles. First, we apply the Ready (2018) oil price decomposition methodology to the GCC markets, detailing the dependence structure of the oil-stock nexus. Second, we include all GCC countries, hence, we highlight the heterogeneities among them. This latter point could carry important information for portfolio managers interested in intra-regional diversification. Third, we consider heterogeneity across the stock return distribution and whether the relation with oil shocks depends on the state of the stock market, notably whether it is in a bullish or bearish phase. Our results point to the importance of oil supply shocks in explaining the changes in GCC equity returns, especially during bear market phases.

The remainder of this paper is organised as follows. Section 2 presents a brief review of literature. Section 3 introduces the methodology. Section 4 presents the data and Section 5 discusses the results. Section 6 concludes the paper.

## 2. Literature Review.

Oil prices and financial markets are linked through their effects on, and from, the wider economy. In considering the theoretical transmission mechanisms, Mohanty and Nandha (2011) argue that oil price changes impact a firm's future cash flows, positively or negatively, depending on whether it is an oil-consumer or oil-producer. As rising oil prices amplify production costs, Basher and Sadorsky, (2006) argue that as policymakers increase short-term interest rates in response to higher inflationary pressures, this increases borrowing costs and reduces company cash flows. Brown and Yücel (2002) argue that rising oil prices cause greater uncertainty in the real economy, reducing investment and future expected cash flows. While economic theory proposes that the current stock price reflects its discounted future cash flow (Huang *et al.*, 1996), uniquely, in the context of oil exporting nations, we can explain the links between oil and the macroeconomy via the fiscal channel. Within this, Degiannakis *et al*. (2018) and Bjornland (2009) argue that, in oil-exporting nations, rising oil prices increase government and individual consumption. In this environment, higher cash flows are expected in enhance firm profitability. The latter, in turn, is anticipated to stimulate the stock market of oil exporting nations.

In the GCC context, early research explores the long-term relations between oil and stock prices. Maghyereh and Al-Kandari (2007) use a non-linear cointegration approach with daily data from 1996 to 2003. They support the existence of non-linear linkages between the stock markets of Bahrain, Kuwait, Oman, and Saudi Arabia and an oil price index. Arouri and Rault (2012) use both panel cointegration and Seemingly Unrelated Regression (SUR) frameworks and provide evidence of long-run dependence across GCC and oil markets. The SUR results show that higher oil prices have a positive impact on GCC markets, except for Saudi Arabia. Using the NARDL method of Shin *et al*. (2014), which allows for short- and long-run asymmetric adjustment, Siddiqui *et al*. (2019) report that during the 2014 - 2016 oil price fall, negative oil price changes had a larger effect than positive changes. Akoum *et al*. (2012) use a wavelet approach for weekly data from 2002 to 2011 and show that GCC stock returns display comovement over the long term with oil returns.

A further direction for research considers volatility spillovers between oil and stock markets. Using daily data from September 30, 2005, to October 24, 2016, Al-Yahyaee *et al*. (2019) examine volatility spillovers between commodity futures and GCC stock markets. Relying on dynamic equicorrelation (DECO) models and the spillover index of Diebold and Yilmaz (2012), they report that oil is a considerable transmitter of volatility to the GCC markets. Arouri *et al*. (2011) use a VAR–GARCH model and reveal significant volatility spillovers from oil, particularly during market turbulence. Awartani and Maghyereh (2013) use the Diebold and Yilmaz (2009, 2012) spillover index for returns and volatility between oil and GCC stocks from 2004 to 2012. They report that return and volatility transmission is more pronounced after the financial crisis. The authors argue that despite evidence of bi-directional causality, oil constitutes the larger source of spillovers. Likewise, Bouri and Demirer (2016) report volatility transmissions from oil prices to Kuwait, Saudi Arabia and UAE. Khalifa *et al*. (2014) use weekly data from 2004 to 2011 to investigate the volatility transmission among oil, the MSCI-world portfolio and US and GCC markets. Using the Multi-Chain Markov Switching approach of Gallo and Otranto (2008), they find evidence of interdependence between oil and the stocks of Kuwait and Abu Dhabi. Additionally, spillovers from oil to Dubai are reported, with no linkages between oil and the Saudi, Qatari and Omani markets.

Ashfaq *et al*. (2019) use daily data from 2009 to 2018 for three oil-exporting countries (Saudi Arabia, United Arab Emirates, Iraq) and four oil-importing countries (China, Japan, India, South Korea). They measure correlations and spillovers between oil and stock prices using DCC and BEKK GARCH models. They conclude that the sensitivity of stock returns to oil shocks is higher in oil-exporting nations than oil-importing nations. Using the Kilian (2009) method, Ziadat *et al*. (2022) find that oil exporters display susceptibility to oil precautionary demand shocks. The effect is positive and important in all market conditions in the oil exporters of Canada, Norway and Russia. In the GCC market of Saudi Arabia, Abu Dhabi, Dubai, Bahrain, Oman and Qatar, the impact is positive and significant during bear market phases.

McMillan *et al*. (2021) use the Asymmetric DCC GARCH model and monthly data from 2003 to 2019 to investigate the impact of oil on the interdependence of the GCC and US stocks. They find that oil returns and volatility significantly explain changes in the US-GCC correlation. Parallel to that, Ziadat and McMillan (2021) establish a link between oil price shocks on the connectedness among GCC markets.

Overall, despite the limited application of oil price decompositions in examining the relation with GCC stock returns, the literature, using a variety of empirical designs, documents a significant impact of oil prices on the GCC markets. However, the heterogeneity of links between oil and individual GCC markets remains a matter of debate.

**3. Methodology.**

To examine the impact of oil shocks on GCC market returns, we use the following regression:

$$r_t = \alpha_0 + \Sigma_i \beta_i x_{i,t} + \varepsilon_t \qquad (1)$$

Where $r_t$ refers to the stock return series at time period $t$, $x_{i,t}$ are the $i$ explanatory variables and $\varepsilon_t$ is a random error term. The explanatory variables include oil returns, oil volatility and oil shocks as well as the control variables, MSCI world index return, VIX and GEPU.

*Oil Price Decomposition*

Ready (2018) introduces a methodology to decompose oil price changes into supply, demand and risk shocks. Following Ready (2018), we use the World Integrated Oil and Gas Producer Index as a proxy of oil producing firms stock returns, one-month crude oil futures returns on the second nearest maturity contract on the New York Mercantile Exchange to reflect oil price changes, and the VIX index.

Based on the view that the return to oil producers is affected by the level of demand and risk shocks, risk shocks are identified as the residuals from an ARMA(1,1) model on VIX.[4] Demand shocks are measured as the segment of current returns to oil producing firms that is orthogonal to risk shocks. Supply shocks are defined as that portion of the current oil return that is orthogonal to both demand and risk shocks. Oil supply, demand and risk shocks are normalised and constrained to sum to the total oil price change.

*Quantile regression*

The quantile regression, developed by Koenker and Bassett (1978), estimates the effect of the explanatory variables on the conditional quantile of the dependent variable. This presents information on average dependence as well as the upper and lower tail dependence and is robust to both outliers and non-normality.

The quantile regression therefore extends the linear model in equation (1) by allowing a different coefficient for each specified quantile:

$$r_t = \alpha^{(q)} + \Sigma_i \beta_i^{(q)} x_{i,t} + \varepsilon_t \quad (2)$$

where $\alpha^{(q)}$ represents the constant term for each estimated quantile $(q)$, $\beta^{(q)}$ is the slope coefficient that reveals the relation between the correlation and the explanatory variable at each quantile, and $\varepsilon_t$ is the error term.

[4] Bollerslev et al. (2009) note the risk premium captured by the VIX index correlates negatively with stock returns and has the ability to forecast them. Therefore, supporting the argument of Ready regarding the ability of VIX to capture changes in risk.

## 4. Data.

Following Ready (2018), we use the WTI benchmark as a measure of oil prices, which is obtained from the EIA website. For the volatility of oil, we apply the realised volatility approach of Schwert (1989) by summing the daily squared oil returns. To construct the oil price shocks using the approach of Ready (2018). Thus, we obtain data on the world integrated oil and gas producer index to represent oil producers stock price, the second nearest maturity of the NYMEX WTI futures contract and the VIX index.

All-share indexes are obtained for Dubai, Saudi Arabia, Abu Dhabi, Qatar, Oman, Bahrain, and Kuwait. Except where noted, the data is from DataStream and sampled monthly from February 2004 to December 2019. The stock return series are denominated in US dollars to be comparable across countries and to be regarded as more pertinent for global investors. Returns are generated by applying the natural logarithmic difference. This study incorporates a set of global factors including the MSCI world index (following Demirer *et al*., 2020), the VIX index (Whaley, 1993) and Global Economic Policy Uncertainty index (GEPU). The GEPU Index (Davis, 2016), is a GDP-weighted average of national Economic Policy Uncertainty indices (EPU) for 16 countries that account for two-thirds of global output.

Table 1 presents summary statistics for our data. The GCC stock return series exhibit a positive mean for returns, except for Kuwait, while Dubai has the highest standard deviation. With the exception of the oil demand shock, the Jarque-Bera test reveals that all series display non-normality. The Philip-Perron unit root test shows that stationarity holds for all sampled data.

## 5. Empirical Results.[5]

*Oil Price changes and GCC markets*

As much of the literature on the oil-stock nexus focuses on the effect of the oil price return and volatility on stocks, we first examine these to provide comparability.

Table 2 presents the results of regressing GCC stock returns on oil price changes, oil volatility, VIX, GEPU and the World portfolio. The results indicate that oil, either the return or volatility, affects the stock markets of all GCC countries, except for Qatar, for which gas is the

[5] As robustness checks against the results presented in this section, including any potential issues arising from endogeneity, we re-estimate the models presented in Section 3 using lagged values of the explanatory variables. These results are qualitatively similar to those reported below and are available upon request.

main export commodity. Across the seven GCC countries, there is a positive relation between stocks and oil returns and a negative relation between stock returns and oil volatility. The positive stock and oil return relation is statistically significant for Saudi Arabia, Dubai, Oman and Abu Dhabi, with the highest coefficient magnitude for Dubai and Saudi Arabia. The negative relation between stock returns and oil volatility is significant for Bahrain, Kuwait and Oman.

Given that higher oil prices are expected to boost wealth, economic activity and firm cash flows in oil-exporting nations (Bjørnland, 2009), the previous literature establishes a positive link between oil and stocks. For example, Park and Ratti (2008) and Ramos and Vega (2013) argue that oil price increases boost the stock market of oil-exporting countries, and harm those of oil-importing countries. In the GCC context, Mokni and Youssef (2019) show that the GCC markets have a positive relation with oil prices. Mokni and Youssef (2019) and Mohanty *et al*. (2011) argue that, except for Kuwait, GCC stocks have positive exposures to oil price innovations. Thus, our results are broadly consistent with these findings, in that we note a positive relation as well as the Kuwaiti market isolation from oil shocks. As noted, the insignificant result for Qatar may arise as gas is its main export, while for Bahrain, the oil industry is comparatively small. Nonetheless, our findings do contrast with those of Fayyad and Daly (2011) who argue that Qatar and the UAE exhibit the highest sensitivity to oil shocks in the GCC bloc. Equally, the results contrast with Al Janabi *et al*. (2010), who find that the relation between oil prices and GCC stock markets is weak. Further, it is of interest to note that the large oil producers, Saudi Arabia and Abu Dhabi, are not affected by oil price volatility despite the positive oil return relation. For the UAE this may arise from its increased economic diversification with recently established service and tourism industries (see Callen *et al*, 2014). Equally, the large nature of the Saudi Arabian market, with 50% of total GCC market capitalisation, may provide some resilience to oil price swings. Conversely, the smaller GCC markets in Bahrain and Oman are more vulnerable to oil return volatility.

In regard of the other coefficients, the signs of VIX and GEPU are negative but not significant (except the VIX for Saudi Arabia). The world portfolio is strongly positive especially in the markets of Dubai and Qatar where the coefficient is twice as large as its Kuwaiti, Omani and Bahraini counterparts. Such results hint at higher levels of global integration in the markets of Dubai and Qatar (see Ziadat *et al*, 2020).

*Oil shocks and GCC markets*

Having conducted an initial examination of the effect of oil price changes on stock returns, we now consider the impact of different oil price shocks. The oil price shocks are intended to capture unexpected oil price innovations. For this, we use the decomposition of Ready (2018) and examine the effect of supply, demand, and risk shocks. We consider this first in the usual linear regression before turning to the quantile regression framework.

Table 3 illustrates the impact of the different oil price shocks on the GCC markets while controlling for the influence of GEPU and the MSCI world index.[6] The results presented here suggest an interesting pattern of influence emerges and one that appears to contradict the results of similar and recent analysis across global markets. Notably, where research finds the influence of shocks is significant and negative (see Ready, 2018; Demirer *et al*., 2020), our results support a positive effect arising only from oil supply shocks.

Demirer *et al*. (2020), Wang *et al*. (2013), Guntner (2014) and Jung and Park (2011) show that oil price increases, triggered by stronger global demand for oil, are associated with higher stock market returns across all countries, regardless of the classification of the country as an exporter/importer of oil. However, our results do not share such a conclusion. Although the coefficient on demand shocks is positive throughout, it is only significant for Qatar (and marginally for Dubai). Given that oil demand shocks constitute good news for the global economy, the relative high integration of Qatar and Dubai (when compared with the rest of GCC markets) into the world economy, might explain this result. A further channel to this effect may arise through spillovers from global financial markets given the integration of Qatar and Dubai (see Ziadat *et al*., 2020).

The strongest factor influencing GCC stock returns is evidently oil supply shocks. The influence is positive and significant in all GCC markets, albeit only at the 10% significance level for the UAE markets of Dubai and Abu Dhabi. This result run counter to the literature that relies on the Kilian (2009) decomposition method (see, Kilian and Park, 2009; Abhyankar *et al*., 2013; Kim and Vera, 2019) where the findings point to only a trivial impact of oil supply shocks. Using the Ready (2018) decomposition, Demirer *et al*. (2020) find that supply shocks have a significant and negative effect on stock market returns for the majority of 21 countries examined. Interestingly, Demirer *et al*. (2020) incorporate the oil-exporters of Canada, Mexico and Norway in their analysis. However, they only find positive links between oil supply shocks and Canadian stocks whereas, similar to oil-importers, a negative effect is found for Mexico and Norway.

[6] The effect of VIX is now captured within the oil price shocks.

Accordingly, the positive link between oil supply shocks and stocks appears to be a unique feature of the GCC region.

In the method of Ready (2018), the oil supply shock is obtained as the residual after incorporating both the demand and risk shocks. Ready reports that this shock is responsible for 80% of the change in oil prices. Hence, the results reported here may stem from a broad range of underlying variables. For instance, Malik and Umar (2019) argues that oil supply shocks could be triggered by issues linked to unexpected changes in proven reserves, technologies related to oil well completions and oil recovery. Clements *et al*. (2019) argue that the oil supply shocks, defined by Ready (2018), can be linked to an exogenous measure of precautionary demand, reflecting future oil supply uncertainty rather than contemporaneous supply changes. In seeking to understand the results for the GCC markets, while acknowledging the strong ties between the GCC economies as well as the impact of supply shocks on the price of oil, Filis and Chatziantoniou (2014) argue that the magnitude of the stock market reaction to oil price shocks is higher for new or less liquid stock markets, which will apply to several GCC markets. Further, the lack of hedging instruments in emerging markets can increase their sensitivity to oil shocks (Balcilar *et al*., 2019).

*Oil price shocks and the state of the market*

While the above results examine the links between oil price shocks and GCC stock markets in a linear model, here, we consider the impact of oil shocks across different market states. Developed by Koenker and Bassett (1978), the quantile regression estimates the effects of explanatory variables on the conditional quantile of the dependent variable. Therefore, in addition to the average (median) dependence, the quantile regression offers information regarding tail dependence. There are several advantages in using the quantile regression approach, for example, Baur (2013) notes the ability of the model to capture the changing nature of dependence across different market conditions, from bullish to bearish. Moreover, this allows examination of the whole return distribution rather than, for example, two or three market states in a regime switching model. Further, quantile regression estimators are robust to heteroskedasticity and skewness of the dependent variable (Koenker and Hallock, 2001).

Table 4 depicts the quantile coefficient estimates for oil supply, demand and risk shocks for each GCC market. The first two quantiles correspond to a bear market phase, the upper quantiles reflect bull market conditions, with the middle quantiles representing normal market states. As a general observation, the coefficients of oil demand shocks tend to increase with the quantiles, while those for oil supply shocks decrease and with no clear pattern for the risk shock. An interesting pattern also develops in the statistical significance of the demand and supply shocks over the quantiles, with the demand shocks typically significant at higher (bull market) quantiles and supply shocks significant at lower (bear market) quantiles.

Oil demand shocks exhibits mid and upper tail dependence with the stock returns conditional distribution in Saudi Arabia, Qatar, Kuwait and Dubai, while upper-tail[7] only dependence is reported for Abu Dhabi. This leaves the markets of Oman and Bahrain for which oil demand shocks are wholly insignificant. An oil demand shock is associated with higher demand for oil due to expansion in the global economy and the findings here are consistent with those of Ready (2018) in supporting a positive link between stock markets and oil demand shocks.[8]

The quantile process estimates show clear evidence of lower-tail dependence between oil supply shocks and GCC returns. For the first quantile (Q1), which represents a bear market phase, oil price shocks exert a significant positive impact on all GCC markets. When comparing our results with those of Ziadat *et al*. (2022), they report lower tail dependence between oil precautionary demand shocks and GCC markets. The discrepancy is a result of the different approach in constructing oil shocks. Nonetheless, our results appear consistent with the view of Balcilar *et al*. (2019) who state that financial market responses to oil shocks are stronger during extreme market conditions. Moreover, given the general view in the literature, which points to a negative impact of oil supply shocks on stocks, among oil importers and some oil exporters, the results here convey important insights for the potential of cross-regional diversification.

You *et al*. (2017) and Le and Zheng (2011) report that the impact of oil price shocks on stocks mainly occurs when stock markets are in a bull or bear phase, indicating that the relation between stocks and oil shocks are governed by investor (optimistic or pessimistic) sentiment. Furthermore, citing factors related to less sophisticated investors in emerging markets, You *et al*. (2017) and Lee and Zeng (2011) argue that investors might display irrational behaviour when facing instabilities in oil markets. This argument is therefore applicable to the GCC markets given

[7] The markets of Dubai and Kuwait also exhibit lower-tail dependence with oil demand shocks.

[8] The lack of significance for Bahrain and Oman may arise from their relatively small market capitalisation (Oman and Bahrain combined constitute only 4% of total GCC market capitalisation as of 2016). While smaller firms are likely to be less globally connected, the low capitalisation is also associated with poor liquidity, which will be less attractive to global investors. Indeed, we can see only a small response to changes in the world portfolio (see Table 3) when compared with other GCC markets.

GCC investor profiles and the importance of oil to GCC economies. Thus, the positive oil price supply shock may be an indicator of improving economic conditions (possibly via the aforementioned fiscal channel) in GCC economies, thus, boosting their confidence in future stock market behaviour.

To further elaborate on the lower-tailed dependence between oil supply shocks and GCC markets, we consider the role of geopolitical factors. This is motivated by the fact that a considerable share of the global oil supply is produced in the region, which has experienced a history of conflict and wars. Cheikh *et al*. (2021) report substantial sensitivity of GCC markets to geopolitical stress. Antonakakis *et al*. (2017) maintain that aggregate demand shocks transmit most of the information to stock markets during periods characterised by economic–driven events, while supply and oil precautionary demand shocks prevail during periods of geopolitical unrest. Such events can trigger change in both financial markets and portfolio allocations (Kollias *et al*., 2013). This supports the view that when oil supply shocks concur with geopolitical tensions, the changing risk appetite of investors can lead to such results.

**6. Summary and Conclusion.**

Motivated by the importance of oil as a commodity to the world economy and especially the GCC bloc, this study characterises the links between oil price shocks and GCC stock markets. The analysis utilises the oil price decomposition of Ready (2018) and monthly data from February 2004 to December 2019. The results reveal that the type of shock is important for GCC markets. While the previous literature argues that supply-side shocks have a negative or negligible impact on global markets, our results support a significant positive effect on GCC stocks. Such a result reflects the heavy dependence on oil revenue and the structure of the GCC economies. That said, when examining the relation across the stock return distribution, we also find that oil demand shocks exhibit a positive relation with stock returns during a bull market, while the effect of the supply shock is more evident in bear market conditions.

From an academic[9] standpoint, this study provides a comprehensive and up-to-date examination of the oil-stock nexus for the GCC markets using decomposed measures of oil price innovations. The results convey important information to global investors, as the characterisation

[9] Error in variable is a potential issue in a two-step approach that we adopted in this paper. Using the quantile connectedness approach of Ando et al. (2018) can be a good avenue of future research.

of the links between individual GCC markets and oil shocks enhance our understanding of inter-market relations and the effects on portfolio compositions in an inter and intra-regional perspective. Moreover, given that portfolio diversification is achieved by investing in different classes of assets or investing in similar classes of assets in multiple markets through international diversification, the results here can improve decision making for asset allocation. Finally, future research can use these outcomes to provide additional insights in hedging strategies that involves oil, especially during phases of market turbulence.

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Table.1 Summary Statistics

| | Abu Dhabi | Bahrain | Dubai | Kuwait | Oman | Qatar | Saudi Arabia | World | GEPU |
|---|---|---|---|---|---|---|---|---|---|
| Mean | 0.005 | 0.001 | 0.005 | 0.000 | 0.002 | 0.005 | 0.003 | 0.005 | 0.000 |
| Median | 0.004 | 0.001 | -0.001 | 0.000 | 0.002 | 0.004 | 0.009 | 0.011 | -0.012 |
| Maximum | 0.359 | 0.092 | 0.382 | 0.139 | 0.162 | 0.260 | 0.187 | 0.096 | 0.769 |
| Minimum | -0.196 | -0.135 | -0.408 | -0.224 | -0.250 | -0.272 | -0.278 | -0.173 | -0.496 |
| Std. Dev. | 0.065 | 0.033 | 0.096 | 0.047 | 0.049 | 0.078 | 0.076 | 0.037 | 0.176 |
| Skewness | 0.586 | -0.404 | 0.052 | -0.912 | -0.575 | -0.304 | -0.694 | -1.112 | 0.730 |
| Kurtosis | 8.235 | 4.942 | 6.128 | 7.960 | 6.936 | 4.759 | 4.486 | 5.743 | 5.022 |
| Jarque-Bera | 229.013 | 35.225 | 77.940 | 222.227 | 133.837 | 27.569 | 32.897 | 99.253 | 49.487 |
| Probability | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| PP test | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

| | Oil demand shock | Oil supply shock | Oil risk shock | VIX | Oil | Oil volatility | GEPU |
|---|---|---|---|---|---|---|---|
| Mean | -0.103 | -0.467 | -0.027 | 0.001 | 0.003 | 0.011 | 0.000 |
| Median | -0.002 | -4.096 | 0.304 | -0.017 | 0.017 | 0.007 | -0.012 |
| Maximum | 11.317 | 73.905 | 19.859 | 0.853 | 0.297 | 0.110 | 0.769 |
| Minimum | -12.246 | -43.897 | -26.878 | -0.486 | -0.533 | 0.001 | -0.496 |
| Std. Dev. | 4.615 | 19.257 | 7.197 | 0.205 | 0.105 | 0.014 | 0.176 |
| Skewness | -0.045 | 1.000 | -0.653 | 0.619 | -1.234 | 3.755 | 0.730 |
| Kurtosis | 2.873 | 4.581 | 4.499 | 4.353 | 8.007 | 20.510 | 5.022 |
| Jarque-Bera | 0.193 | 51.731 | 31.444 | 26.773 | 247.968 | 2888.971 | 49.487 |
| Probability | 0.908 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| PP test | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

Notes. The sample period runs from February 2004 to December 2019 including 191[10] monthly observations. Std. Dev. and PP test stand for Standard deviation and Phillip-Perron test. GEPU is the Global Economic Policy Uncertainty. GCC national return series, MCSI world index, oil, VIX, and GEPU are calculated using the first logarithmic difference.

[10] An exception to this is the GCC spillover index where the sample runs from December 2009 to December 2019 generating 137 observations.

Table.2 GCC returns response[11] to oil price change and volatility

| Country | | C | Oil | Oil Vol | VIX | GEPU | World | Adj. R2 |
|---|---|---|---|---|---|---|---|---|
| Abu Dhabi | Coeff | 0.010 | 0.090 | -0.534 | -0.015 | -0.001 | 0.285 | 0.076 |
| | P Value | 0.082 | 0.022 | 0.248 | 0.502 | 0.967 | 0.029 | |
| | | | | | | | | |
| Bahrain | Coeff | 0.010 | 0.026 | -0.939 | 0.000 | 0.000 | 0.170 | 0.264 |
| | P Value | 0.000 | 0.138 | 0.000 | 1.000 | 0.958 | 0.006 | |
| | | | | | | | | |
| Dubai | Coeff | 0.012 | 0.178 | -0.912 | -0.024 | -0.013 | 0.682 | 0.177 |
| | P Value | 0.163 | 0.005 | 0.087 | 0.444 | 0.644 | 0.000 | |
| | | | | | | | | |
| Kuwait | Coeff | 0.009 | 0.038 | -0.981 | -0.022 | 0.014 | 0.390 | 0.271 |
| | P Value | 0.050 | 0.303 | 0.021 | 0.100 | 0.257 | 0.006 | |
| | | | | | | | | |
| Oman | Coeff | 0.008 | 0.094 | -0.753 | -0.023 | 0.004 | 0.340 | 0.237 |
| | P Value | 0.050 | 0.029 | 0.002 | 0.197 | 0.779 | 0.003 | |
| | | | | | | | | |
| Qatar | Coeff | 0.004 | 0.116 | -0.227 | -0.039 | 0.043 | 0.749 | 0.195 |
| | P Value | 0.602 | 0.224 | 0.528 | 0.128 | 0.236 | 0.005 | |
| | | | | | | | | |
| Saudi Arabia | Coeff | 0.002 | 0.141 | -0.243 | -0.055 | 0.022 | 0.690 | 0.205 |
| | P Value | 0.708 | 0.003 | 0.428 | 0.021 | 0.395 | 0.000 | |

Notes. The regressions above are generated by regressing oil returns, oil realised volatility, the VIX index, and Global Policy Uncertainty (GEPU) and the MSCI world portfolio on GCC equity returns. C, Coeff and Oil Vol stand for constant, coefficient and oil volatility, respectively. The equations runs as follows: GCC market return$_{i,t}$ = $C_{0,i} + \beta_1 Oil_{,t} + \beta_2 Oil\ Vol_{,t} + \beta_3 VIX_{,t} + \beta_4 GEPU_{,t} + \beta_5 World_{,t} + \varepsilon_{i,t}$. The P Value is based on the robust standard errors of Newey-West (1987). The sample ranges from February 2004 to December 2019 yielding a total of 191 observations.

[11] We acknowledge that the coefficients are small in value. This is in common in this stream of literature. For example, using the decomposition method of Kilian (2009), Ziadat et al. (2022) report significant results in the GCC context, yet, similar to our paper, the coefficients are small. Similar findings are reported by Apergis and Miller (2009).

Table.3 GCC returns response to oil price shocks

| Country | | C | Supply | Demand | Risk | GEPU | World | Adj. R2 |
|---|---|---|---|---|---|---|---|---|
| Abu Dhabi | Coeff | 0.003 | 0.002 | 0.000 | 0.000 | 0.004 | 0.486 | 0.071 |
| | P Value | 0.568 | 0.093 | 0.785 | 0.581 | 0.841 | 0.054 | |
| | | | | | | | | |
| Bahrain | Coeff | -0.001 | 0.001 | 0.001 | 0.000 | 0.003 | 0.370 | 0.171 |
| | P Value | 0.760 | 0.021 | 0.374 | 0.454 | 0.782 | 0.027 | |
| | | | | | | | | |
| Dubai | Coeff | 0.002 | 0.003 | 0.003 | 0.000 | -0.013 | 0.812 | 0.168 |
| | P Value | 0.859 | 0.083 | 0.070 | 0.985 | 0.658 | 0.066 | |
| | | | | | | | | |
| Kuwait | Coeff | -0.003 | 0.001 | 0.000 | 0.000 | 0.017 | 0.665 | 0.216 |
| | P Value | 0.513 | 0.042 | 0.516 | 0.325 | 0.213 | 0.023 | |
| | | | | | | | | |
| Oman | Coeff | 0.000 | 0.002 | 0.002 | 0.000 | 0.005 | 0.401 | 0.196 |
| | P Value | 0.994 | 0.011 | 0.124 | 0.783 | 0.729 | 0.036 | |
| | | | | | | | | |
| Qatar | Coeff | 0.002 | 0.002 | 0.004 | 0.000 | 0.034 | 0.849 | 0.240 |
| | P Value | 0.771 | 0.014 | 0.013 | 0.346 | 0.356 | 0.013 | |
| | | | | | | | | |
| Saudi Arabia | Coeff | 0.000 | 0.002 | 0.003 | 0.000 | 0.020 | 0.734 | 0.192 |
| | P Value | 0.978 | 0.013 | 0.129 | 0.746 | 0.440 | 0.001 | |

Notes. C, Coeff , Supply, Demand and Risk stand for constant, coefficient, oil supply shocks, oil demand shocks and oil risk shocks, respectively. Oil price shocks are measured using the method of Ready (2018). The rest of the variables are the VIX index, and Global Policy Uncertainty (GEPU) and the MSCI world portfolio and the dependent variable is the stock market return of each GCC nation. The equations runs as follows: GCC market $\text{return}_{i,t} = C_{0,i} + \beta_1 \text{Supply}_{,t} + \beta_2 \text{Demand}_{,t} + \beta_3 \text{Risk}_{,t} + \beta_4 \text{GEPU}_{,t} + \beta_5 \text{World}_{,t} + \varepsilon_{i,t}$. The P Value is based on the robust standard errors of Newey-West. The sample ranges from February 2004 to December 2019 yielding a total of 191 observations.

Table. 4 GCC returns dependence structure with oil price shocks

| | | Abu Dhabi | | Bahrain | | Dubai | | Kuwait | |
|---|---|---|---|---|---|---|---|---|---|
| | Q | Coeff | Prob. | Coeff | Prob. | Coeff | Prob. | Coeff | Prob. |
| | | | | | | | | | |
| Oil supply shock | 0.100 | 0.003 | 0.000 | 0.001 | 0.023 | 0.003 | 0.000 | 0.002 | 0.007 |
| | 0.200 | 0.001 | 0.098 | 0.001 | 0.120 | 0.002 | 0.065 | 0.001 | 0.007 |
| | 0.400 | 0.001 | 0.129 | 0.001 | 0.088 | 0.001 | 0.488 | 0.000 | 0.950 |
| | 0.600 | 0.001 | 0.139 | 0.000 | 0.239 | 0.001 | 0.213 | 0.000 | 0.393 |
| | 0.800 | 0.000 | 0.958 | 0.001 | 0.050 | 0.001 | 0.412 | 0.001 | 0.058 |
| | 0.900 | 0.001 | 0.426 | 0.001 | 0.048 | 0.001 | 0.832 | 0.002 | 0.077 |
| | | | | | | | | | |
| Oil Demand shock | 0.100 | -0.001 | 0.599 | 0.000 | 0.907 | 0.000 | 0.938 | -0.002 | 0.049 |
| | 0.200 | 0.001 | 0.679 | 0.000 | 0.817 | 0.003 | 0.031 | -0.001 | 0.488 |
| | 0.400 | 0.001 | 0.244 | 0.001 | 0.351 | 0.003 | 0.038 | 0.001 | 0.254 |
| | 0.600 | 0.002 | 0.120 | 0.001 | 0.446 | 0.002 | 0.216 | 0.001 | 0.020 |
| | 0.800 | 0.003 | 0.006 | 0.000 | 0.842 | 0.006 | 0.001 | 0.003 | 0.001 |
| | 0.900 | 0.003 | 0.014 | 0.002 | 0.127 | 0.009 | 0.001 | 0.002 | 0.380 |
| | | | | | | | | | |
| Oil Risk shock | 0.100 | 0.001 | 0.114 | 0.000 | 0.801 | 0.001 | 0.331 | 0.001 | 0.078 |
| | 0.200 | 0.000 | 0.764 | 0.000 | 0.688 | 0.000 | 0.514 | 0.000 | 0.294 |
| | 0.400 | 0.000 | 0.664 | 0.000 | 0.603 | -0.001 | 0.171 | 0.000 | 0.543 |
| | 0.600 | 0.000 | 0.921 | 0.000 | 0.492 | 0.000 | 0.817 | 0.000 | 0.644 |
| | 0.800 | 0.000 | 0.760 | 0.000 | 0.561 | 0.000 | 0.687 | 0.000 | 0.417 |
| | 0.900 | 0.000 | 0.748 | 0.000 | 0.935 | 0.000 | 0.828 | 0.000 | 0.846 |
| | | | | | | | | | |
| | | Oman | | Qatar | | Saudi Arabia | | | |
| | Q | Coeff | Prob. | Coeff | Prob. | Coeff | Prob. | | |
| | | | | | | | | | |
| Oil supply shock | 0.100 | 0.002 | 0.017 | 0.001 | 0.043 | 0.003 | 0.015 | | |
| | 0.200 | 0.001 | 0.062 | 0.001 | 0.052 | 0.002 | 0.076 | | |
| | 0.400 | 0.001 | 0.059 | 0.002 | 0.030 | 0.001 | 0.186 | | |
| | 0.600 | 0.001 | 0.281 | 0.001 | 0.076 | 0.001 | 0.220 | | |
| | 0.800 | 0.001 | 0.233 | 0.001 | 0.282 | 0.001 | 0.659 | | |
| | 0.900 | 0.001 | 0.396 | 0.001 | 0.339 | 0.002 | 0.121 | | |
| | | | | | | | | | |
| Oil Demand shock | 0.100 | 0.001 | 0.303 | 0.001 | 0.710 | 0.001 | 0.581 | | |
| | 0.200 | 0.002 | 0.281 | 0.003 | 0.090 | 0.002 | 0.262 | | |
| | 0.400 | 0.001 | 0.226 | 0.003 | 0.036 | 0.003 | 0.044 | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 0.600 | 0.001 | 0.359 | 0.004 | 0.020 | 0.005 | 0.002 | | |
| | 0.800 | 0.001 | 0.252 | 0.006 | 0.008 | 0.004 | 0.009 | | |
| | 0.900 | 0.003 | 0.075 | 0.007 | 0.001 | 0.004 | 0.026 | | |
| | | | | | | | | | |
| Oil Risk shock | 0.100 | 0.000 | 0.584 | 0.002 | 0.019 | 0.001 | 0.393 | | |
| | 0.200 | -0.001 | 0.265 | 0.001 | 0.025 | 0.001 | 0.413 | | |
| | 0.400 | 0.000 | 0.607 | 0.000 | 0.365 | 0.000 | 0.895 | | |
| | 0.600 | 0.000 | 0.373 | 0.000 | 0.594 | -0.001 | 0.248 | | |
| | 0.800 | 0.000 | 0.874 | 0.000 | 0.415 | 0.001 | 0.238 | | |
| | 0.900 | 0.000 | 0.891 | 0.000 | 0.643 | 0.000 | 0.852 | | |

Notes. The table depicts the quantile process coefficients estimated from quantile regression framework wherein stock returns are regressed on oil supply shocks, oil demand shocks, oil risk shocks, GEPU and world index. The latter two variables are controlled for but their results are not reported to conserve space. Q stands for quantile.

Re: Oil-Stock Nexus: The Role of Oil Shocks for GCC Markets
SEF-12-2021-0529

We would like to thank the reviewers for their thoughtful remarks towards refining our paper. We address comments specific to each reviewer below.

Editorial comments
1. The authors should provide a structured abstract (see SEF submission guidelines).

Reply:
The structured abstract is now provided.

2. Improve the introduction:

a) The second paragraph of the introduction should contain the contribution to the literature.

Reply:
Thanks for this, the Introduction has been enhanced to highlight the contribution in the second paragraph.

b) The last paragraph of the introduction should contain a remainder of the paper.

Reply:
A paragraph is added clarifying that is added at the end of the introduction.

3. Eq. (2): The error term should also contain the subscript "i".

Reply:
In revising this equation (and the same issue applies to equation (1)), the $i$ for the dependent variable is different to the $i$ attributed to the explanatory variables. The former refers to the different GCC markets and the latter to the alternative 'X' variables. Therefore, we have dropped the $i$ associated with the dependent variable and so a similar subscript is no longer required for the error term. The alternative would be to add a further subscript (e.g., $j$), however, we believe that this unnecessarily clutters the paper.

4. The literature review should provide some contributions from the recent literature that deal with oil price and financial market linkages, for example, Batten et al. (2019).

Reply:
The references mentioned, among other relevant ones, are incorporated into the revised version of the paper, notably in the Introduction and Literature Review.

5. The authors conclude that their analysis of the oil-stock nexus provides useful implications for portfolio management. The authors may mention additional economic benefits such as hedging (see Batten et al. 2021).

Reply:
The discussion regarding implications in the concluding section is enhanced by incorporating the potential hedging benefits.

Reviewer One

1. Statistically significant quantile regression coefficients both for oil supply and demand shocks are quite small overall. Is this related to the low average returns of GCC stock markets? In other words, you should explain why the quantile regression coefficients are quite small.

Reply:
We thank the referee for raising this point and note that such results are common in this stream of literature. For example, using the decomposition method of Kilian (2009), Ziadat et al. (2022) report significant results in the GCC context, yet, similar to our paper, the coefficients are small. This outcome is consistent with the findings of Apergis and Miller (2009).

2. Unlike previous studies, oil supply shocks affect positively and significantly stock returns based on the economic structure of the GCC bloc. Moreover, why oil price shocks (demand and supply shocks) impact stock returns positively at bear and bull markets should be explained at least with a few sentences.

Reply:
We argue that may arise due to the factors including the uniqueness of GCC market in terms of liquidity and available hedging instruments. We make note of this point in both the discussion of the results as well as the Abstract.

Reviewer Two

1. Abstract: Add a short sentence showing the methodology used

Reply:
This is adjusted in the new version of the paper

2. Introduction: Clearly provide the readers with an outline of the structure of the rest of the article.

Reply:
A paragraph supplying this information is added at the end of the Introduction.

3. Literature review; The literature review should provide a background and serve as a motivation for the objectives and hypothesis that guide your own research. Consider adding the theory and or conceptual framework. The theoretical framework introduces and describes the theory that explains why the research problem under study exists. This is missing from the literature review.

Reply:
The first paragraph of the Literature Review has been improved to incorporate discussion of the theory behind the links between oil and stocks.

4. Methodology; Investigate or test for endogeneity issues within the independent variable and heteroskedasticity.

Reply:
We thank the referee for this point. In the 'robustness' file, we run regressions using lags of the oil variables with the results remaining qualitatively similar. Hopefully, this answers the concerns regarding endogeneity and general robustness. Also, we use the Newey-West estimator, which is robust to the presence of heteroskedasticity.

5. You may introduce a robustness check to your analysis.

Reply:
In common with point #4, we include a 'robustness' file that hopefully captures this requirement.

6. Relate also your finding to the theory after introducing it in the literature review section.

Reply:
The fiscal channel to explain the links between oil and GCC equities is incorporated in page 14 to further explain the results.

7. There are implications for policymakers and other stakeholders such as employees in the oil industry. What are the limitations of your research? Make recommendations for future research.

Reply:
The implication section is enhanced. Concerning the limitations, we acknowledge that the 'error in variable' issue is potential concern in our two-step approach. Hence, using the quantile connectedness approach of Ando et al. (2018) can be a good contribution in this stream of research. This is now noted in the concluding section.

8. Other; A number of the in-text citation is missing from the reference section, for example, Kollias et al., 2013 on page 14, You et al 2017, Le and Zheng, 2011, Hammoudeh and Li, 2008

all on page 13, etc. Finally, your references have not all been drafted according to the Journals of Studies in Economics and Finance requirement.

Reply:
These issues are corrected in the new document.

## Robustness

The first robustness exercise involves using the lagged oil price shocks in the regressions. The results remain broadly similar to those reported in the paper. Moreover, these results relief potential endogeneity concerns.

Lagged oil price shocks

Table 1. Lagged oil price shocks for Saudi Arabia

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 0.001973 | 0.006341 | 0.311110 | 0.7561 |
| OIL_SUPPLY_SHOCK(-1) | 0.001762 | 0.000756 | 2.331203 | 0.0208 |
| OIL_DEMAND_SHOCK(-1) | 0.001375 | 0.001471 | 0.935065 | 0.3510 |
| OIL_RISK_SHOCK(-1) | 0.000527 | 0.000525 | 1.002909 | 0.3172 |
| GEPU(-1) | 0.004946 | 0.033397 | 0.148112 | 0.8824 |
| WORLD(-1) | 0.319555 | 0.247330 | 1.292017 | 0.1980 |
| R-squared | 0.053350 | | | |
| Adjusted R-squared | 0.027626 | | | |

Table 2. Lagged oil price shocks for Kuwait

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | -0.002204 | 0.003990 | -0.552384 | 0.5814 |
| OIL_SUPPLY_SHOCK(-1) | 0.001114 | 0.000728 | 1.531861 | 0.1273 |
| OIL_DEMAND_SHOCK(-1) | 0.001181 | 0.000763 | 1.546977 | 0.1236 |
| OIL_RISK_SHOCK(-1) | -8.97E-05 | 0.000147 | -0.611004 | 0.5420 |
| GEPU | 0.019198 | 0.014121 | 1.359602 | 0.1756 |
| WORLD | 0.475184 | 0.142760 | 3.328538 | 0.0011 |
| R-squared | 0.228760 | | | |
| Adjusted R-squared | 0.207802 | | | |

Table 3. Lagged oil price shocks for Qatar

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 0.004107 | 0.005989 | 0.685846 | 0.4937 |
| OIL_SUPPLY_SHOCK(-1) | 0.000736 | 0.000800 | 0.920436 | 0.3586 |
| OIL_DEMAND_SHOCK(-1) | 0.001650 | 0.001963 | 0.840526 | 0.4017 |
| OIL_RISK_SHOCK(-1) | -0.000200 | 0.000648 | -0.308788 | 0.7578 |
| GEPU(-1) | 0.007659 | 0.035544 | 0.215473 | 0.8296 |
| WORLD(-1) | 0.058438 | 0.372753 | 0.156775 | 0.8756 |
| R-squared | 0.022858 | | | |
| Adjusted R-squared | -0.003694 | | | |

Table 4. Lagged oil price shocks for Bahrain

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | -0.000402 | 0.003335 | -0.120440 | 0.9043 |
| OIL_SUPPLY_SHOCK(-1) | 0.000751 | 0.000533 | 1.407864 | 0.1609 |
| OIL_DEMAND_SHOCK(-1) | 0.000500 | 0.000554 | 0.901565 | 0.3685 |
| OIL_RISK_SHOCK(-1) | 1.46E-05 | 0.000205 | 0.071006 | 0.9435 |
| GEPU(-1) | 0.013070 | 0.015317 | 0.853259 | 0.3946 |
| WORLD(-1) | 0.234052 | 0.135842 | 1.722969 | 0.0866 |
| R-squared | 0.116291 | | | |
| Adjusted R-squared | 0.092277 | | | |

Table 5. Lagged oil price shocks for Oman

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 0.000624 | 0.004563 | 0.136799 | 0.8913 |
| OIL_SUPPLY_SHOCK(-1) | 0.002145 | 0.000622 | 3.451053 | 0.0007 |
| OIL_DEMAND_SHOCK(-1) | 0.000470 | 0.001034 | 0.454571 | 0.6500 |
| OIL_RISK_SHOCK(-1) | 7.45E-05 | 0.000379 | 0.196625 | 0.8443 |
| GEPU(-1) | 0.036083 | 0.017048 | 2.116508 | 0.0356 |
| WORLD(-1) | 0.257508 | 0.197186 | 1.305912 | 0.1932 |
| R-squared | 0.152962 | | | |
| Adjusted R-squared | 0.129945 | | | |

Table 6. Lagged oil price shocks for Dubai

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 0.002842 | 0.008713 | 0.326164 | 0.7447 |
| OIL_SUPPLY_SHOCK(-1) | 0.002496 | 0.001140 | 2.190022 | 0.0298 |
| OIL_DEMAND_SHOCK(-1) | 0.000874 | 0.001761 | 0.496220 | 0.6203 |
| OIL_RISK_SHOCK(-1) | -4.76E-05 | 0.000549 | -0.086737 | 0.9310 |
| GEPU(-1) | 0.064001 | 0.035349 | 1.810535 | 0.0718 |
| WORLD(-1) | 0.500146 | 0.369090 | 1.355078 | 0.1771 |
| R-squared | 0.097647 | | | |
| Adjusted R-squared | 0.073126 | | | |

Table 7. Lagged oil price shocks for Abu Dhabi

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 0.004706 | 0.006195 | 0.759720 | 0.4484 |
| OIL_SUPPLY_SHOCK(-1) | 0.001383 | 0.000830 | 1.666311 | 0.0974 |
| OIL_DEMAND_SHOCK(-1) | 0.001279 | 0.001658 | 0.771250 | 0.4415 |
| OIL_RISK_SHOCK(-1) | -9.89E-05 | 0.000421 | -0.235072 | 0.8144 |
| GEPU(-1) | 0.038500 | 0.025351 | 1.518671 | 0.1306 |
| WORLD(-1) | 0.155518 | 0.246528 | 0.630832 | 0.5289 |
| R-squared | 0.062972 | | | |
| Adjusted R-squared | 0.037509 | | | |

The second robustness test involves using the lagged oil return and volatility in the regressions. The results remain broadly similar to those reported in the paper.

Figure 8. Lagged oil return and volatility for Abu Dhabi

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 0.009967 | 0.005622 | 1.772764 | 0.0779 |
| WTI(-1) | 0.053543 | 0.059520 | 0.899575 | 0.3695 |
| WTI_VOLATILITY(-1) | -0.500464 | 0.360295 | -1.389040 | 0.1665 |
| VIX(-1) | -0.042156 | 0.019779 | -2.131406 | 0.0344 |
| GEPU(-1) | 0.037523 | 0.023426 | 1.601733 | 0.1109 |
| WORLD(-1) | 0.183175 | 0.120693 | 1.517686 | 0.1308 |
| R-squared | 0.074264 | | | |
| Adjusted R-squared | 0.049108 | | | |

Figure 9. Lagged oil return and volatility for Saudi Arabia

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 0.004705 | 0.007224 | 0.651254 | 0.5157 |
| WTI(-1) | 0.064002 | 0.050768 | 1.260667 | 0.2090 |
| WTI_VOLATILITY(-1) | -0.246538 | 0.465475 | -0.529648 | 0.5970 |
| VIX(-1) | -0.095990 | 0.034000 | -2.823222 | 0.0053 |
| GEPU(-1) | 0.004333 | 0.033482 | 0.129401 | 0.8972 |
| WORLD(-1) | 0.182859 | 0.207521 | 0.881158 | 0.3794 |
| R-squared | 0.088613 | | | |
| Adjusted R-squared | 0.063847 | | | |

Figure 10. Lagged oil return and volatility for Qatar

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 0.016560 | 0.007285 | 2.273167 | 0.0242 |
| WTI(-1) | 0.005524 | 0.047488 | 0.116327 | 0.9075 |
| WTI_VOLATILITY(-1) | -1.141601 | 0.549205 | -2.078642 | 0.0390 |
| VIX(-1) | -0.080246 | 0.031551 | -2.543346 | 0.0118 |
| GEPU(-1) | 0.008950 | 0.035212 | 0.254164 | 0.7997 |
| WORLD(-1) | 0.147810 | 0.192353 | 0.768433 | 0.4432 |
| R-squared | 0.093666 | | | |
| Adjusted R-squared | 0.069037 | | | |

Figure 11. Lagged oil return and volatility for Oman

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 0.009574 | 0.005578 | 1.716305 | 0.0878 |
| WTI(-1) | 0.056883 | 0.036144 | 1.573791 | 0.1173 |
| WTI_VOLATILITY(-1) | -0.776193 | 0.447022 | -1.736366 | 0.0842 |
| VIX(-1) | -0.057714 | 0.019538 | -2.953915 | 0.0035 |
| GEPU(-1) | 0.030233 | 0.016414 | 1.841878 | 0.0671 |
| WORLD(-1) | 0.159525 | 0.132845 | 1.200836 | 0.2314 |
| R-squared | 0.185656 | | | |
| Adjusted R-squared | 0.163527 | | | |

Figure 12. Lagged oil return and volatility for Kuwait

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 0.012352 | 0.005552 | 2.224536 | 0.0273 |
| WTI(-1) | 0.029460 | 0.028229 | 1.043617 | 0.2980 |
| WTI_VOLATILITY(-1) | -1.148908 | 0.552655 | -2.078889 | 0.0390 |
| VIX(-1) | -0.052172 | 0.019215 | -2.715224 | 0.0073 |
| GEPU(-1) | -0.008141 | 0.018239 | -0.446375 | 0.6559 |
| WORLD(-1) | 0.107743 | 0.123271 | 0.874030 | 0.3832 |
| R-squared | 0.207317 | | | |
| Adjusted R-squared | 0.185777 | | | |

Figure 13. Lagged oil return and volatility for Dubai

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 0.012192 | 0.008286 | 1.471399 | 0.1429 |
| WTI(-1) | 0.081438 | 0.074118 | 1.098758 | 0.2733 |
| WTI_VOLATILITY(-1) | -0.851561 | 0.560431 | -1.519476 | 0.1304 |
| VIX(-1) | -0.099293 | 0.027765 | -3.576181 | 0.0004 |
| GEPU(-1) | 0.057815 | 0.033282 | 1.737104 | 0.0840 |
| WORLD(-1) | 0.484941 | 0.228620 | 2.121170 | 0.0352 |
| R-squared | 0.135469 | | | |
| Adjusted R-squared | 0.111977 | | | |

Figure 14. Lagged oil return and volatility for Bahrain

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 0.008261 | 0.003230 | 2.557507 | 0.0113 |
| WTI(-1) | 0.020582 | 0.025737 | 0.799735 | 0.4249 |
| WTI_VOLATILITY(-1) | -0.744859 | 0.139913 | -5.323747 | 0.0000 |
| VIX(-1) | -0.025597 | 0.011813 | -2.166936 | 0.0315 |
| GEPU(-1) | 0.011330 | 0.014498 | 0.781446 | 0.4355 |
| WORLD(-1) | 0.162342 | 0.072581 | 2.236709 | 0.0265 |

| | |
|---|---|
| R-squared | 0.212548 |
| Adjusted R-squared | 0.191150 |

# Oil-Stock Nexus: The Role of Oil Shocks for GCC Markets


**Abstract**

Purpose: This study examines the links between oil price shocks and GCC stock markets from February 2004 to December 2019. Knowledge of such links is important to both investors and policymakers in understanding the transmission of shocks across markets.

Methodology: We employ the Ready (2018) oil price decomposition method and the quantile regression approach to conduct our analysis.

Findings: Initial results show a positive oil price change increases stock returns, while greater volatility decreases returns. The oil shock decomposition results reveal a significant positive impact of supply-side shocks on stocks. This contrasts with the literature that argues demand-side shocks are more important. While factors such as liquidity and the lack of hedging instruments can increase the vulnerability of GCC equities to oil price shocks, our result reflects the unique economic structure of the GCC bloc, notably, marked by dependency on oil revenues. In analysing quantile-based results, oil supply shocks mainly exhibit lower-tail dependence, while we do uncover some evidence of demand-side shocks affecting mid and upper-tail dependence.

Originality: Acknowledging the presence of endogeneity in the relation between oil and economic activity, this study is the first to combine the oil price decompositions of Ready (2018) with a quantile regression framework in the GCC context. Our results reveal notable difference to those previously reported in the literature.

**1. Introduction.**

The energy finance literature highlights important links between oil prices and stock markets (see, for example, Sadorsky, 1999; Papapetrou, 2001; Bjornland, 2009; Park and Ratti, 2008; Le and Chang, 2015; Wang *et al*., 2013; Batten *et al*., 2019; Batten *et al*., 2021). To better understand these links, a notable advance is presented in work that decomposes the oil price into its respective shocks (Hamilton, 2009; Kilian, 2009). Given the high dependence of the Gulf Cooperation Council (GCC[1]) countries on oil production,[2] the analysis of oil price shocks on GCC stocks is important to investors and policymakers, as well as academics interested in modelling financial market relations. Thus, this paper seeks to examine the impact of oil price shocks using the decomposition of Ready (2018) on GCC stock returns.

As relatively young stock markets, those of the GCC are understudied. Moreover, the markets, classified as either emerging or frontier (Balcilar *et al*., 2015), have witnessed considerable efforts to enhance efficiency (Benlagha, 2020) and have undergone economic and financial liberalisation (Bley and Chen, 2006; Al-Khazali *et al*, 2006; Akoum *et al*., 2012). This includes, for example, structural reforms to allow foreign investors to channel funds towards GCC financial markets and so improving liquidity (Al Janabi *et al*., 2010; Arouri and Rault, 2012). Consequently, in 2014, the MSCI re-categorised the markets of the UAE and Qatar to emerging market status, while Saudi Arabia followed in 2019. The markets of Kuwait, Oman and Bahrain remain categorised as frontier. Nonetheless, the GCC markets generally enjoy many macroeconomic fundamentals equivalent to developed nations (Awartani and Maghyereh, 2013), and the inclusion of GCC markets improves diversification in a cross-country portfolio (Arouri and Rault, 2010; Mimouni *et al*., 2016). Acknowledging these features, we contribute to the existing literature by detailing the dependence structure between oil and GCC stocks using the Ready (2018) decomposition and quantile regression frameworks.

Recently, and in pursuit of diversification, investors began to regard the oil market as a suitable alternative destination leading to the so-called financialization of oil markets (Silvennoinen and Thorp, 2013). McMillan *et al*. (2021) argue that this financialisation of oil is



[1] Established in 1981, The Cooperation Council for the Arab States of the Gulf is a regional organisation of six members: Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates.
[2] The GCC bloc holds 30.6% of proven oil reserves (BP Statistical Review of World Energy 2019). Moreover, Khalifa et al. (2014) note that the oil industry constitutes 35% of the GCC economies.

linked with higher comovements of GCC stocks with their US counterparts. Moreover, together with the recent instability in oil prices, this motivates a new examination of the oil-stock nexus.

The literature on the links between oil prices and the economy can be traced back to the work of Hamilton (1983). Subsequently, a wave of research sought to establish a link between oil prices and financial markets using Vector Autoregressive (VAR) models. Examples include the work of Sadorsky (1999), Papapetrou (2001), Bjornland (2009), Park and Ratti (2008) and Le and Chang (2015). Hamilton (2009) argues that oil price shocks are not uniquely instigated by supply shortages, but also by innovations on the demand side. Moreover, Kilian and Park (2009) note, studies that do not recognise the causes of oil shocks will be predisposed to uncover trivial links between oil prices and stocks.

In a notable development, Kilian[3] (2009) suggests that a rise in oil price should be attributed to its underlying cause and identifies three distinctive sources of oil price increases: supply-side shocks caused by a shortfall in oil production, demand-side shocks due to global economic expansion, and precautionary demand shocks triggered by expectations of future oil supply shortfalls. In a further significant study, Ready (2018) proposes a technique to disentangle oil price shocks based on the traded asset price data of oil-producing firms. Ready (2018) argues that while oil producers benefit from price increases due to oil demand, they remain numb to supply disruptions (for example, when extraction complications arise, oil producers will sell less but at higher prices). Empirically, Ready (2018) identifies demand shocks as returns to an index of oil-producing firms that are orthogonal to innovations in the VIX index, and supply shocks as oil price changes that are orthogonal to demand shocks and to changes in VIX.

Subsequently, a number of studies examine the impact of oil price shocks on stocks. Earlier work, such as Kilian and Park (2009) and Abhyankar *et al*. (2013) concentrate on the major developed markets of the US and Japan, while Kang and Ratti (2015) examine the impact of oil price shocks and economic policy uncertainty on Chinese stocks. Further studies include the work of Wang *et al*. (2013), Kang and Ratti (2013) and Apergis and Miller (2009). However, despite

[3] Within this framework, Kilian (2009) reports that supply and demand shocks account for 4% of the monthly variation in the oil price. Precautionary demand shocks, which are unspecified by this procedure account for 77% of the variation, which lead to some criticism. Kolodzej and Kaufmann (2014) argue that the Kilian (2009) index of global real economic activity captures little more than transportation costs such that the identified demand shock is not sufficient. Elaborating, Ready (2018) reveals that the measure will not capture anticipated variation in aggregate demand, leaving these to the precautionary demand. Likewise, Demirer et al. (2020) document the over emphasis of Kilian's (2009) decomposition on precautionary demand shocks.

the importance of oil to the GCC economies, as well as the strong role they play in the oil market, examining the link between oil price shocks and GCC markets remains largely neglected.

Focusing on oil exporters and using the approach of Kilian and Murphy (2014), Basher *et al*. (2018) study the influence of oil shocks on Canada, Mexico, Norway, Russia, the UK, Kuwait, Saudi Arabia, and the UAE. Using a two-state Markov-switching model, they show that both oil aggregate demand shocks and oil precautionary demand shocks have a significant impact on stock returns in Norway, Russia, Kuwait, Saudi Arabia, and the UAE. While oil supply shocks influence stocks in the UK, Kuwait, and the UAE. Using a sample that incorporates the GCC markets and the Kilian (2009) methodology, Ziadat *et al*. (2022) examine the impact of oil shocks on equities in both oil-importing and exporting nations. They distinguish the market feedback to oil shocks during bull, normal and bear phases. Their results show that oil-exporters are stimulated by precautionary demand shocks. Also, among oil-exporters, the GCC markets are predominantly impacted during bear market conditions.

Building on the work of Basher *et al*. (2018) and Ziadat *et al*. (2022), this paper exploits the Ready (2018) decomposition of oil innovations on stock return. We also incorporate all GCC markets as we believe that heterogeneity exists in terms of their economic structure and oil dependence. For instance, while Kuwait has the highest level of dependence on oil, the UAE has an increasingly diversified economy based on tourism and services. In this regard, Fenech and Vosgha (2019) argue that the dependence structure between oil and GCC stock exchanges varies. Moreover, Alqahtani *et al*. (2019) maintain that the link between oil price uncertainty and GCC markets differs significantly with the smaller markets of Bahrain and Oman being less susceptible to oil shocks than their Saudi and Emirati counterparts. Furthermore, Mokni and Youssef (2019) show that the Saudi market displays the largest degree of persistence in the dependence with oil prices. Thus, examining the heterogeneity among GCC nations in their interactions with oil shocks is an enhancement to the current literature.

Therefore, we examine the impact of oil price shocks on the GCC stocks markets using the method of Ready (2018). In extending this, we further examine the dependence structure between oil price shocks and GCC stocks using the quantile regression of Koenker and Bassett (1978). Specifically, we first consider the standard linear relation between stocks with oil returns and volatility. Oil volatility is included in this initial analysis as it may capture risk in the oil market. Although that analysis is then subsumed in the next stage that considers oil price shocks. Second, we then decompose oil price changes according to their source as supply, demand and risk shocks. Third, we consider whether the relation varies across different quantiles of the returns process. In examining the impact of oil innovations on GCC stock returns, we control for global factors using the VIX index, Global Economic Policy Uncertainty (GEPU) and the MSCI world portfolio. Controlling for these variables is essential to ensure the accuracy of results. According to Dickinson (2000) and Rigobon and Sack (2003), asset prices are intertwined, therefore, analysing a single market in segregation overlooks important information about its behaviour. The MSCI world portfolio is designed to capture common fundamentals that steer global equity returns. Oil price shocks are believed to be related with both VIX and GEPU as argued by Antonakakis *et al*. (2013) and Kang and Ratti (2013). These variables can influence stock prices by affecting expected cash flows and discount rates. Moreover, oil price increases caused by supply-side factors may be associated with higher GEPU with the opposite for demand-side factors (Kang and Ratti, 2013).

This study contributes to the literature from several angles. First, we apply the Ready (2018) oil price decomposition methodology to the GCC markets, detailing the dependence structure of the oil-stock nexus. Second, we include all GCC countries, hence, we highlight the heterogeneities among them. This latter point could carry important information for portfolio managers interested in intra-regional diversification. Third, we consider heterogeneity across the stock return distribution and whether the relation with oil shocks depends on the state of the stock market, notably whether it is in a bullish or bearish phase. Our results point to the importance of oil supply shocks in explaining the changes in GCC equity returns, especially during bear market phases.

The remainder of this paper is structured as follows. Section 2 provides a brief literature review from which the research hypotheses are developed. This is followed by Section 3 that introduces the study method, and Section 4 providing a description of our data collection and variable definitions. Empirical results and discussion are presented in Section 5. The final section concludes the paper and indicates its limitations.

## 2. Literature Review.

Oil prices and financial markets are linked through their effects on, and from, the wider economy. In considering the theoretical transmission mechanisms, Mohanty and Nandha (2011) argue that oil price changes impact a firm's future cash flows, positively or negatively, depending on whether it is an oil-consumer or oil-producer. As rising oil prices amplify production costs, Basher and Sadorsky, (2006) argue that as policymakers increase short-term interest rates in response to higher inflationary pressures, this increases borrowing costs and reduces company cash flows. Brown and Yücel (2002) argue that rising oil prices cause greater uncertainty in the real economy, reducing investment and future expected cash flows. While economic theory proposes that the current stock price reflects its discounted future cash flow (Huang *et al.*, 1996), uniquely, in the context of oil exporting nations, we can explain the links between oil and the macroeconomy via the fiscal channel. Within this, Degiannakis *et al*. (2018) and Bjornland (2009) argue that, in oil-exporting nations, rising oil prices increase government and individual consumption. In this environment, higher cash flows are expected in enhance firm profitability. The latter, in turn, is anticipated to stimulate the stock market of oil exporting nations.

In the GCC context, early research explores the long-term relations between oil and stock prices. Maghyereh and Al-Kandari (2007) use a non-linear cointegration approach with daily data from 1996 to 2003. They support the existence of non-linear linkages between the stock markets of Bahrain, Kuwait, Oman, and Saudi Arabia and an oil price index. Arouri and Rault (2012) use both panel cointegration and Seemingly Unrelated Regression (SUR) frameworks and provide evidence of long-run dependence across GCC and oil markets. The SUR results show that higher oil prices have a positive impact on GCC markets, except for Saudi Arabia. Using the NARDL method of Shin *et al*. (2014), which allows for short- and long-run asymmetric adjustment, Siddiqui *et al*. (2019) report that during the 2014 - 2016 oil price fall, negative oil price changes had a larger effect than positive changes. Akoum *et al*. (2012) use a wavelet approach for weekly data from 2002 to 2011 and show that GCC stock returns display comovement over the long term with oil returns.

A further direction for research considers volatility spillovers between oil and stock markets. Using daily data from September 30, 2005, to October 24, 2016, Al-Yahyaee *et al*. (2019) examine volatility spillovers between commodity futures and GCC stock markets. Relying on dynamic equicorrelation (DECO) models and the spillover index of Diebold and Yilmaz (2012), they report that oil is a considerable transmitter of volatility to the GCC markets. Arouri *et al*. (2011) use a VAR–GARCH model and reveal significant volatility spillovers from oil, particularly during market turbulence. Awartani and Maghyereh (2013) use the Diebold and Yilmaz (2009, 2012) spillover index for returns and volatility between oil and GCC stocks from 2004 to 2012.

They report that return and volatility transmission is more pronounced after the financial crisis. The authors argue that despite evidence of bi-directional causality, oil constitutes the larger source of spillovers. Likewise, Bouri and Demirer (2016) report volatility transmissions from oil prices to Kuwait, Saudi Arabia and UAE. Khalifa *et al*. (2014) use weekly data from 2004 to 2011 to investigate the volatility transmission among oil, the MSCI-world portfolio and US and GCC markets. Using the Multi-Chain Markov Switching approach of Gallo and Otranto (2008), they find evidence of interdependence between oil and the stocks of Kuwait and Abu Dhabi. Additionally, spillovers from oil to Dubai are reported, with no linkages between oil and the Saudi, Qatari and Omani markets.

Ashfaq *et al*. (2019) use daily data from 2009 to 2018 for three oil-exporting countries (Saudi Arabia, United Arab Emirates, Iraq) and four oil-importing countries (China, Japan, India, South Korea). They measure correlations and spillovers between oil and stock prices using DCC and BEKK GARCH models. They conclude that the sensitivity of stock returns to oil shocks is higher in oil-exporting nations than oil-importing nations. Using the Kilian (2009) method, Ziadat *et al*. (2022) find that oil exporters display susceptibility to oil precautionary demand shocks. The effect is positive and important in all market conditions in the oil exporters of Canada, Norway and Russia. In the GCC market of Saudi Arabia, Abu Dhabi, Dubai, Bahrain, Oman and Qatar, the impact is positive and significant during bear market phases.

McMillan *et al*. (2021) use the Asymmetric DCC GARCH model and monthly data from 2003 to 2019 to investigate the impact of oil on the interdependence of the GCC and US stocks. They find that oil returns and volatility significantly explain changes in the US-GCC correlation. Parallel to that, Ziadat and McMillan (2021) establish a link between oil price shocks on the connectedness among GCC markets.

Overall, despite the limited application of oil price decompositions in examining the relation with GCC stock returns, the literature, using a variety of empirical designs, documents a significant impact of oil prices on the GCC markets. However, the heterogeneity of links between oil and individual GCC markets remains a matter of debate.

**3. Methodology.**

To examine the impact of oil shocks on GCC market returns, we use the following regression:

$$r_t = \alpha_0 + \Sigma_i \beta_i x_{i,t} + \varepsilon_t \qquad (1)$$

Where $r_t$ refers to the stock return series at time period $t$, $x_{i,t}$ are the $i$ explanatory variables and $\varepsilon_t$ is a random error term. The explanatory variables include oil returns, oil volatility and oil shocks as well as the control variables, MSCI world index return, VIX and GEPU.

*Oil Price Decomposition*

Ready (2018) introduces a methodology to decompose oil price changes into supply, demand and risk shocks. Following Ready (2018), we use the World Integrated Oil and Gas Producer Index as a proxy for oil producing firms stock returns, one-month crude oil futures returns on the second nearest maturity contract on the New York Mercantile Exchange to reflect oil price changes, and the VIX index.

Based on the view that the return to oil producers is affected by the level of demand and risk shocks, risk shocks are identified as the residuals from an ARMA(1,1) model on VIX.[4] Demand shocks are measured as the segment of current returns to oil producing firms that is orthogonal to risk shocks. Supply shocks are defined as that portion of the current oil return that is orthogonal to both demand and risk shocks. Oil supply, demand and risk shocks are normalised and constrained to sum to the total oil price change.

*Quantile regression*

The quantile regression, developed by Koenker and Bassett (1978), estimates the effect of the explanatory variables on the conditional quantile of the dependent variable. This presents information on average dependence as well as the upper and lower tail dependence and is robust to both outliers and non-normality.

The quantile regression therefore extends the linear model in equation (1) by allowing a different coefficient for each specified quantile:

$$r_t = \alpha^{(q)} + \Sigma_i \beta_i^{(q)} x_{i,t} + \varepsilon_t \qquad (2)$$

where $\alpha^{(q)}$ represents the constant term for each estimated quantile $(q)$, $\beta^{(q)}$ is the slope coefficient that reveals the relation between the correlation and the explanatory variable at each quantile, and $\varepsilon_t$ is the error term.

[4] Bollerslev et al. (2009) note the risk premium captured by the VIX index correlates negatively with stock returns and has the ability to forecast them. Therefore, supporting the argument of Ready regarding the ability of VIX to capture changes in risk.

## 4. Data.

Following Ready (2018), we use the WTI benchmark as a measure of oil prices, which is obtained from the EIA website. For the volatility of oil, we apply the realised volatility approach of Schwert (1989) by summing the daily squared oil returns. To construct the oil price shocks using the approach of Ready (2018). Thus, we obtain data on the world integrated oil and gas producer index to represent oil producers stock price, the second nearest maturity of the NYMEX WTI futures contract and the VIX index.

All-share indexes are obtained for Dubai, Saudi Arabia, Abu Dhabi, Qatar, Oman, Bahrain, and Kuwait. Except where noted, the data is from DataStream and sampled monthly from February 2004 to December 2019. The stock return series are denominated in US dollars to be comparable across countries and to be regarded as more pertinent for global investors. Returns are generated by applying the natural logarithmic difference. This study incorporates a set of global factors including the MSCI world index (following Demirer *et al*., 2020), the VIX index (Whaley, 1993) and Global Economic Policy Uncertainty index (GEPU). The GEPU Index (Davis, 2016), is a GDP-weighted average of national Economic Policy Uncertainty indices (EPU) for 16 countries that account for two-thirds of global output.

Table 1 presents summary statistics for our data. The GCC stock return series exhibit a positive mean for returns, except for Kuwait, while Dubai has the highest standard deviation. With the exception of the oil demand shock, the Jarque-Bera test reveals that all series display non-normality. The Philip-Perron unit root test shows that stationarity holds for all sampled data.

## 5. Empirical Results.[5]

*Oil Price changes and GCC markets*

As much of the literature on the oil-stock nexus focuses on the effect of the oil price returns and volatility on stocks, we first examine these to provide comparability.

Table 2 presents the results of regressing GCC stock returns on oil price changes, oil volatility, VIX, GEPU and the World portfolio. The results indicate that oil, either the return or volatility, affects the stock markets of all GCC countries, except for Qatar, for which gas is the

[5] As robustness checks against the results presented in this section, including any potential issues arising from endogeneity, we re-estimate the models presented in Section 3 using lagged values of the explanatory variables. These results are qualitatively similar to those reported below and are available upon request.

main export commodity. Across the seven GCC countries, there is a positive relation between stocks and oil returns and a negative relation between stock returns and oil volatility. The positive stock and oil return relation is statistically significant for Saudi Arabia, Dubai, Oman and Abu Dhabi, with the highest coefficient magnitude for Dubai and Saudi Arabia. The negative relation between stock returns and oil volatility is significant for Bahrain, Kuwait and Oman.

Given that higher oil prices are expected to boost wealth, economic activity and firm cash flows in oil-exporting nations (Bjørnland, 2009), the previous literature establishes a positive link between oil and stocks. For example, Park and Ratti (2008) and Ramos and Vega (2013) argue that oil price increases boost the stock market of oil-exporting countries, and harm those of oil-importing countries. In the GCC context, Mokni and Youssef (2019) show that the GCC markets have a positive relation with oil prices. Mokni and Youssef (2019) and Mohanty *et al*. (2011) argue that, except for Kuwait, GCC stocks have positive exposures to oil price innovations. Thus, our results are broadly consistent with these findings, in that we note a positive relation as well as the Kuwaiti market isolation from oil shocks. As noted, the insignificant result for Qatar may arise as gas is its main export, while for Bahrain, the oil industry is comparatively small. Nonetheless, our findings do contrast with those of Fayyad and Daly (2011) who argue that Qatar and the UAE exhibit the highest sensitivity to oil shocks in the GCC bloc. Equally, the results contrast with Al Janabi *et al*. (2010), who find that the relation between oil prices and GCC stock markets is weak. Further, it is of interest to note that the large oil producers, Saudi Arabia and Abu Dhabi, are not affected by oil price volatility despite the positive oil return relation. For the UAE this may arise from its increased economic diversification with recently established service and tourism industries (see Callen *et al*, 2014). Equally, the large nature of the Saudi Arabian market, with 50% of total GCC market capitalisation, may provide some resilience to oil price swings. Conversely, the smaller GCC markets in Bahrain and Oman are more vulnerable to oil return volatility.

In regard of the other coefficients, the signs of VIX and GEPU are negative but not significant (except the VIX for Saudi Arabia). The world portfolio is strongly positive especially in the markets of Dubai and Qatar where the coefficient is twice as large as its Kuwaiti, Omani and Bahraini counterparts. Such results hint at higher levels of global integration in the markets of Dubai and Qatar (see Ziadat *et al*, 2020).

*Oil shocks and GCC markets*

Having conducted an initial examination of the effect of oil price changes on stock returns, we now consider the impact of different oil price shocks. The oil price shocks are intended to capture unexpected oil price innovations. For this, we use the decomposition of Ready (2018) and examine the effect of supply, demand, and risk shocks. We consider this first in the usual linear regression before turning to the quantile regression framework.

Table 3 illustrates the impact of the different oil price shocks on the GCC markets while controlling for the influence of GEPU and the MSCI world index.[6] The results presented here suggest an interesting pattern of influence emerges and one that appears to contradict the results of similar and recent analysis across global markets. Notably, where research finds the influence of shocks is significant and negative (see Ready, 2018; Demirer *et al*., 2020), our results support a positive effect arising only from oil supply shocks.

Demirer *et al*. (2020), Wang *et al*. (2013), Guntner (2014) and Jung and Park (2011) show that oil price increases, triggered by stronger global demand for oil, are associated with higher stock market returns across all countries, regardless of the classification of the country as an exporter/importer of oil. However, our results do not share such a conclusion. Although the coefficient on demand shocks is positive throughout, it is only significant for Qatar (and marginally for Dubai). Given that oil demand shocks constitute good news for the global economy, the relative high integration of Qatar and Dubai (when compared with the rest of GCC markets) into the world economy, might explain this result. A further channel to this effect may arise through spillovers from global financial markets given the integration of Qatar and Dubai (see Ziadat *et al*., 2020).

The strongest factor influencing GCC stock returns is evidently oil supply shocks. The influence is positive and significant in all GCC markets, albeit only at the 10% significance level for the UAE markets of Dubai and Abu Dhabi. This result run counter to the literature that relies on the Kilian (2009) decomposition method (see, Kilian and Park, 2009; Abhyankar *et al*., 2013; Kim and Vera, 2019) where the findings point to only a trivial impact of oil supply shocks. Using the Ready (2018) decomposition, Demirer *et al*. (2020) find that supply shocks have a significant and negative effect on stock market returns for the majority of 21 countries examined. Interestingly, Demirer *et al*. (2020) incorporate the oil-exporters of Canada, Mexico and Norway in their analysis. However, they only find positive links between oil supply shocks and Canadian stocks whereas, similar to oil-importers, a negative effect is found for Mexico and Norway.

[6] The effect of VIX is now captured within the oil price shocks.

Accordingly, the positive link between oil supply shocks and stocks appears to be a unique feature of the GCC region.

In the method of Ready (2018), the oil supply shock is obtained as the residual after incorporating both the demand and risk shocks. Ready reports that this shock is responsible for 80% of the change in oil prices. Hence, the results reported here may stem from a broad range of underlying variables. For instance, Malik and Umar (2019) argue that oil supply shocks could be triggered by issues linked to unexpected changes in proven reserves, technologies related to oil well completions and oil recovery. Clements *et al*. (2019) argue that the oil supply shocks, defined by Ready (2018), can be linked to an exogenous measure of precautionary demand, reflecting future oil supply uncertainty rather than contemporaneous supply changes. In seeking to understand the results for the GCC markets, while acknowledging the strong ties between the GCC economies as well as the impact of supply shocks on the price of oil, Filis and Chatziantoniou (2014) argue that the magnitude of the stock market reaction to oil price shocks is higher for new or less liquid stock markets, which will apply to several GCC markets. Further, the lack of hedging instruments in emerging markets can increase their sensitivity to oil shocks (Balcilar *et al*., 2019).

*Oil price shocks and the state of the market*

While the above results examine the links between oil price shocks and GCC stock markets in a linear model, here, we consider the impact of oil shocks across different market states. Developed by Koenker and Bassett (1978), the quantile regression estimates the effects of explanatory variables on the conditional quantile of the dependent variable. Therefore, in addition to the average (median) dependence, the quantile regression offers information regarding tail dependence. There are several advantages in using the quantile regression approach, for example, Baur (2013) notes the ability of the model to capture the changing nature of dependence across different market conditions, from bullish to bearish. Moreover, this allows examination of the whole return distribution rather than, for example, two or three market states in a regime switching model. Further, quantile regression estimators are robust to heteroskedasticity and skewness of the dependent variable (Koenker and Hallock, 2001).

Table 4 depicts the quantile coefficient estimates for oil supply, demand and risk shocks for each GCC market. The first two quantiles correspond to a bear market phase, the upper quantiles reflect bull market conditions, with the middle quantiles representing normal market states. As a general observation, the coefficients of oil demand shocks tend to increase with the quantiles, while those for oil supply shocks decrease and with no clear pattern for the risk shock. An interesting pattern also develops in the statistical significance of the demand and supply shocks over the quantiles, with the demand shocks typically significant at higher (bull market) quantiles and supply shocks significant at lower (bear market) quantiles.

Oil demand shocks exhibit mid and upper tail dependence with the stock return conditional distribution in Saudi Arabia, Qatar, Kuwait and Dubai, while upper-tail[7] only dependence is reported for Abu Dhabi. This leaves the markets of Oman and Bahrain for which oil demand shocks are wholly insignificant. An oil demand shock is associated with higher demand for oil due to expansion in the global economy and the findings here are consistent with those of Ready (2018) in supporting a positive link between stock markets and oil demand shocks.[8]

The quantile process estimates show clear evidence of lower-tail dependence between oil supply shocks and GCC returns. For the first quantile (Q1), which represents a bear market phase, oil price shocks exert a significant positive impact on all GCC markets. When comparing our results with those of Ziadat *et al*. (2022), they report lower tail dependence between oil precautionary demand shocks and GCC markets. The discrepancy is a result of the different approach in constructing oil shocks. Nonetheless, our results appear consistent with the view of Balcilar *et al*. (2019) who state that financial market responses to oil shocks are stronger during extreme market conditions. Moreover, given the general view in the literature, which points to a negative impact of oil supply shocks on stocks, among oil importers and some oil exporters, the results here convey important insights for the potential of cross-regional diversification.

You *et al*. (2017) and Le and Zheng (2011) report that the impact of oil price shocks on stocks mainly occurs when stock markets are in a bull or bear phase, indicating that the relation between stocks and oil shocks are governed by investor (optimistic or pessimistic) sentiment. Furthermore, citing factors related to less sophisticated investors in emerging markets, You *et al*. (2017) and Lee and Zeng (2011) argue that investors might display irrational behaviour when facing instabilities in oil markets. This argument is therefore applicable to the GCC markets given

[7] The markets of Dubai and Kuwait also exhibit lower-tail dependence with oil demand shocks.

[8] The lack of significance for Bahrain and Oman may arise from their relatively small market capitalisation (Oman and Bahrain combined constitute only 4% of total GCC market capitalisation as of 2016). While smaller firms are likely to be less globally connected, the low capitalisation is also associated with poor liquidity, which will be less attractive to global investors. Indeed, we can see only a small response to changes in the world portfolio (see Table 3) when compared with other GCC markets.

GCC investor profiles and the importance of oil to GCC economies. Thus, the positive oil price supply shock may be an indicator of improving economic conditions (possibly via the aforementioned fiscal channel) in GCC economies, thus, boosting their confidence in future stock market behaviour.

To further elaborate on the lower-tailed dependence between oil supply shocks and GCC markets, we consider the role of geopolitical factors. This is motivated by the fact that a considerable share of global oil supply is produced in the region, which has experienced a history of conflict and wars. Cheikh *et al*. (2021) report substantial sensitivity of GCC markets to geopolitical stress. Antonakakis *et al*. (2017) maintain that aggregate demand shocks transmit most of the information to stock markets during periods characterised by economic–driven events, while supply and oil precautionary demand shocks prevail during periods of geopolitical unrest. Such events can trigger change in both financial markets and portfolio allocations (Kollias *et al*., 2013). This supports the view that when oil supply shocks concur with geopolitical tensions, the changing risk appetite of investors can lead to such results.

## 6. Summary and Conclusion.

Motivated by the importance of oil as a commodity to the world economy and especially the GCC bloc, this study characterises the links between oil price shocks and GCC stock markets. The analysis utilises the oil price decomposition of Ready (2018) and monthly data from February 2004 to December 2019. The results reveal that the type of shock is important for GCC markets. While the previous literature argues that supply-side shocks have a negative or negligible impact on global markets, our results support a significant positive effect on GCC stocks. Such a result reflects the heavy dependence on oil revenue and the structure of the GCC economies. That said, when examining the relation across the stock return distribution, we also find that oil demand shocks exhibit a positive relation with stock returns during a bull market, while the effect of the supply shock is more evident in bear market conditions.

From an academic standpoint, this study provides a comprehensive and up-to-date examination of the oil-stock nexus for the GCC markets using decomposed measures of oil price innovations. The results convey important information to global investors, as the characterisation of the links between individual GCC markets and oil shocks enhance our understanding of inter-market relations and the effects on portfolio compositions in an inter and intra-regional perspective. Moreover, given that portfolio diversification is achieved by investing in different classes of assets or investing in similar classes of assets in multiple markets through international diversification, the results here can improve decision making for asset allocation. Likewise, hedging is of interest to investors and policymakers. In particular, the severe global uncertainties of recent years have experienced a resurgence of extreme losses in financial markets and provide and impetus to the need for having the tools to predict them. Within this, the potential for empirical frameworks to foresee extreme events is dependent on their ability to account for tail dependencies, which typically portray financial returns.

Finally, in terms of limitations, we acknowledge that the 'error-in-variables' issue is a potential concern in the two-step approach adopted in this paper. Moreover, given that the impact of oil shocks can be contingent on the nature of the industry, a natural extension to our study may involve a sectoral examination of the links between oil price shocks and GCC markets.

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Table.1 Summary Statistics

| | Abu Dhabi | Bahrain | Dubai | Kuwait | Oman | Qatar | Saudi Arabia | World | GEPU |
|---|---|---|---|---|---|---|---|---|---|
| Mean | 0.005 | 0.001 | 0.005 | 0.000 | 0.002 | 0.005 | 0.003 | 0.005 | 0.000 |
| Median | 0.004 | 0.001 | -0.001 | 0.000 | 0.002 | 0.004 | 0.009 | 0.011 | -0.012 |
| Maximum | 0.359 | 0.092 | 0.382 | 0.139 | 0.162 | 0.260 | 0.187 | 0.096 | 0.769 |
| Minimum | -0.196 | -0.135 | -0.408 | -0.224 | -0.250 | -0.272 | -0.278 | -0.173 | -0.496 |
| Std. Dev. | 0.065 | 0.033 | 0.096 | 0.047 | 0.049 | 0.078 | 0.076 | 0.037 | 0.176 |
| Skewness | 0.586 | -0.404 | 0.052 | -0.912 | -0.575 | -0.304 | -0.694 | -1.112 | 0.730 |
| Kurtosis | 8.235 | 4.942 | 6.128 | 7.960 | 6.936 | 4.759 | 4.486 | 5.743 | 5.022 |
| Jarque-Bera | 229.013 | 35.225 | 77.940 | 222.227 | 133.837 | 27.569 | 32.897 | 99.253 | 49.487 |
| Probability | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| PP test | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

| | Oil demand shock | Oil supply shock | Oil risk shock | VIX | Oil | Oil volatility | GEPU |
|---|---|---|---|---|---|---|---|
| Mean | -0.103 | -0.467 | -0.027 | 0.001 | 0.003 | 0.011 | 0.000 |
| Median | -0.002 | -4.096 | 0.304 | -0.017 | 0.017 | 0.007 | -0.012 |
| Maximum | 11.317 | 73.905 | 19.859 | 0.853 | 0.297 | 0.110 | 0.769 |
| Minimum | -12.246 | -43.897 | -26.878 | -0.486 | -0.533 | 0.001 | -0.496 |
| Std. Dev. | 4.615 | 19.257 | 7.197 | 0.205 | 0.105 | 0.014 | 0.176 |
| Skewness | -0.045 | 1.000 | -0.653 | 0.619 | -1.234 | 3.755 | 0.730 |
| Kurtosis | 2.873 | 4.581 | 4.499 | 4.353 | 8.007 | 20.510 | 5.022 |
| Jarque-Bera | 0.193 | 51.731 | 31.444 | 26.773 | 247.968 | 2888.971 | 49.487 |
| Probability | 0.908 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| PP test | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

Notes. The sample period runs from February 2004 to December 2019 including 191[9] monthly observations. Std. Dev. and PP test stand for Standard deviation and Phillip-Perron test. GEPU is the Global Economic Policy Uncertainty. GCC national return series, MCSI world index, oil, VIX, and GEPU are calculated using the first logarithmic difference.

[9] An exception to this is the GCC spillover index where the sample runs from December 2009 to December 2019 generating 137 observations.

Table.2 GCC returns response[10] to oil price change and volatility

| Country | | C | Oil | Oil Vol | VIX | GEPU | World | Adj. R2 |
|---|---|---|---|---|---|---|---|---|
| Abu Dhabi | Coeff | 0.010 | 0.090 | -0.534 | -0.015 | -0.001 | 0.285 | 0.076 |
| | P Value | 0.082 | 0.022 | 0.248 | 0.502 | 0.967 | 0.029 | |
| | | | | | | | | |
| Bahrain | Coeff | 0.010 | 0.026 | -0.939 | 0.000 | 0.000 | 0.170 | 0.264 |
| | P Value | 0.000 | 0.138 | 0.000 | 1.000 | 0.958 | 0.006 | |
| | | | | | | | | |
| Dubai | Coeff | 0.012 | 0.178 | -0.912 | -0.024 | -0.013 | 0.682 | 0.177 |
| | P Value | 0.163 | 0.005 | 0.087 | 0.444 | 0.644 | 0.000 | |
| | | | | | | | | |
| Kuwait | Coeff | 0.009 | 0.038 | -0.981 | -0.022 | 0.014 | 0.390 | 0.271 |
| | P Value | 0.050 | 0.303 | 0.021 | 0.100 | 0.257 | 0.006 | |
| | | | | | | | | |
| Oman | Coeff | 0.008 | 0.094 | -0.753 | -0.023 | 0.004 | 0.340 | 0.237 |
| | P Value | 0.050 | 0.029 | 0.002 | 0.197 | 0.779 | 0.003 | |
| | | | | | | | | |
| Qatar | Coeff | 0.004 | 0.116 | -0.227 | -0.039 | 0.043 | 0.749 | 0.195 |
| | P Value | 0.602 | 0.224 | 0.528 | 0.128 | 0.236 | 0.005 | |
| | | | | | | | | |
| Saudi Arabia | Coeff | 0.002 | 0.141 | -0.243 | -0.055 | 0.022 | 0.690 | 0.205 |
| | P Value | 0.708 | 0.003 | 0.428 | 0.021 | 0.395 | 0.000 | |

Notes. The regressions above are generated by regressing oil returns, oil realised volatility, the VIX index, and Global Policy Uncertainty (GEPU) and the MSCI world portfolio on GCC equity returns. C, Coeff and Oil Vol stand for constant, coefficient and oil volatility, respectively. The equations runs as follows: GCC market $\text{return}_{i,t}$ = $C_{0,i} + \beta_1 \text{Oil}_{,t} + \beta_2 \text{Oil Vol}_{,t} + \beta_3 \text{VIX}_{,t} + \beta_4 \text{GEPU}_{,t} + \beta_5 \text{World}_{,t} + \varepsilon_{i,t}$. The P Value is based on the robust standard errors of Newey-West (1987). The sample ranges from February 2004 to December 2019 yielding a total of 191 observations.

[10] We acknowledge that the coefficients are small in value. This is in common in this stream of literature. For example, using the decomposition method of Kilian (2009), Ziadat et al. (2022) report significant results in the GCC context, yet, similar to our paper, the coefficients are small. Similar findings are reported by Apergis and Miller (2009).

Table.3 GCC returns response to oil price shocks

| Country | | C | Supply | Demand | Risk | GEPU | World | Adj. R2 |
|---|---|---|---|---|---|---|---|---|
| Abu Dhabi | Coeff | 0.003 | 0.002 | 0.000 | 0.000 | 0.004 | 0.486 | 0.071 |
| | P Value | 0.568 | 0.093 | 0.785 | 0.581 | 0.841 | 0.054 | |
| | | | | | | | | |
| Bahrain | Coeff | -0.001 | 0.001 | 0.001 | 0.000 | 0.003 | 0.370 | 0.171 |
| | P Value | 0.760 | 0.021 | 0.374 | 0.454 | 0.782 | 0.027 | |
| | | | | | | | | |
| Dubai | Coeff | 0.002 | 0.003 | 0.003 | 0.000 | -0.013 | 0.812 | 0.168 |
| | P Value | 0.859 | 0.083 | 0.070 | 0.985 | 0.658 | 0.066 | |
| | | | | | | | | |
| Kuwait | Coeff | -0.003 | 0.001 | 0.000 | 0.000 | 0.017 | 0.665 | 0.216 |
| | P Value | 0.513 | 0.042 | 0.516 | 0.325 | 0.213 | 0.023 | |
| | | | | | | | | |
| Oman | Coeff | 0.000 | 0.002 | 0.002 | 0.000 | 0.005 | 0.401 | 0.196 |
| | P Value | 0.994 | 0.011 | 0.124 | 0.783 | 0.729 | 0.036 | |
| | | | | | | | | |
| Qatar | Coeff | 0.002 | 0.002 | 0.004 | 0.000 | 0.034 | 0.849 | 0.240 |
| | P Value | 0.771 | 0.014 | 0.013 | 0.346 | 0.356 | 0.013 | |
| | | | | | | | | |
| Saudi Arabia | Coeff | 0.000 | 0.002 | 0.003 | 0.000 | 0.020 | 0.734 | 0.192 |
| | P Value | 0.978 | 0.013 | 0.129 | 0.746 | 0.440 | 0.001 | |

Notes. C, Coeff , Supply, Demand and Risk stand for constant, coefficient, oil supply shocks, oil demand shocks and oil risk shocks, respectively. Oil price shocks are measured using the method of Ready (2018). The rest of the variables are the VIX index, and Global Policy Uncertainty (GEPU) and the MSCI world portfolio and the dependent variable is the stock market return of each GCC nation. The equations runs as follows: GCC market $return_{i,t} = C_{0,i} + \beta_1 Supply_{,t} + \beta_2 Demand_{,t} + \beta_3 Risk_{,t} + \beta_4 GEPU_{,t} + \beta_5 World_{,t} + \varepsilon_{i,t}$. The P Value is based on the robust standard errors of Newey-West. The sample ranges from February 2004 to December 2019 yielding a total of 191 observations.

Table. 4 GCC returns dependence structure with oil price shocks

| | | Abu Dhabi | | Bahrain | | Dubai | | Kuwait | |
|---|---|---|---|---|---|---|---|---|---|
| | Q | Coeff | Prob. | Coeff | Prob. | Coeff | Prob. | Coeff | Prob. |
| | | | | | | | | | |
| Oil supply shock | 0.100 | 0.003 | 0.000 | 0.001 | 0.023 | 0.003 | 0.000 | 0.002 | 0.007 |
| | 0.200 | 0.001 | 0.098 | 0.001 | 0.120 | 0.002 | 0.065 | 0.001 | 0.007 |
| | 0.400 | 0.001 | 0.129 | 0.001 | 0.088 | 0.001 | 0.488 | 0.000 | 0.950 |
| | 0.600 | 0.001 | 0.139 | 0.000 | 0.239 | 0.001 | 0.213 | 0.000 | 0.393 |
| | 0.800 | 0.000 | 0.958 | 0.001 | 0.050 | 0.001 | 0.412 | 0.001 | 0.058 |
| | 0.900 | 0.001 | 0.426 | 0.001 | 0.048 | 0.001 | 0.832 | 0.002 | 0.077 |
| | | | | | | | | | |
| Oil Demand shock | 0.100 | -0.001 | 0.599 | 0.000 | 0.907 | 0.000 | 0.938 | -0.002 | 0.049 |
| | 0.200 | 0.001 | 0.679 | 0.000 | 0.817 | 0.003 | 0.031 | -0.001 | 0.488 |
| | 0.400 | 0.001 | 0.244 | 0.001 | 0.351 | 0.003 | 0.038 | 0.001 | 0.254 |
| | 0.600 | 0.002 | 0.120 | 0.001 | 0.446 | 0.002 | 0.216 | 0.001 | 0.020 |
| | 0.800 | 0.003 | 0.006 | 0.000 | 0.842 | 0.006 | 0.001 | 0.003 | 0.001 |
| | 0.900 | 0.003 | 0.014 | 0.002 | 0.127 | 0.009 | 0.001 | 0.002 | 0.380 |
| | | | | | | | | | |
| Oil Risk shock | 0.100 | 0.001 | 0.114 | 0.000 | 0.801 | 0.001 | 0.331 | 0.001 | 0.078 |
| | 0.200 | 0.000 | 0.764 | 0.000 | 0.688 | 0.000 | 0.514 | 0.000 | 0.294 |
| | 0.400 | 0.000 | 0.664 | 0.000 | 0.603 | -0.001 | 0.171 | 0.000 | 0.543 |
| | 0.600 | 0.000 | 0.921 | 0.000 | 0.492 | 0.000 | 0.817 | 0.000 | 0.644 |
| | 0.800 | 0.000 | 0.760 | 0.000 | 0.561 | 0.000 | 0.687 | 0.000 | 0.417 |
| | 0.900 | 0.000 | 0.748 | 0.000 | 0.935 | 0.000 | 0.828 | 0.000 | 0.846 |
| | | | | | | | | | |
| | | Oman | | Qatar | | Saudi Arabia | | | |
| | Q | Coeff | Prob. | Coeff | Prob. | Coeff | Prob. | | |
| | | | | | | | | | |
| Oil supply shock | 0.100 | 0.002 | 0.017 | 0.001 | 0.043 | 0.003 | 0.015 | | |
| | 0.200 | 0.001 | 0.062 | 0.001 | 0.052 | 0.002 | 0.076 | | |
| | 0.400 | 0.001 | 0.059 | 0.002 | 0.030 | 0.001 | 0.186 | | |
| | 0.600 | 0.001 | 0.281 | 0.001 | 0.076 | 0.001 | 0.220 | | |
| | 0.800 | 0.001 | 0.233 | 0.001 | 0.282 | 0.001 | 0.659 | | |
| | 0.900 | 0.001 | 0.396 | 0.001 | 0.339 | 0.002 | 0.121 | | |
| | | | | | | | | | |
| Oil Demand shock | 0.100 | 0.001 | 0.303 | 0.001 | 0.710 | 0.001 | 0.581 | | |
| | 0.200 | 0.002 | 0.281 | 0.003 | 0.090 | 0.002 | 0.262 | | |
| | 0.400 | 0.001 | 0.226 | 0.003 | 0.036 | 0.003 | 0.044 | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 0.600 | 0.001 | 0.359 | 0.004 | 0.020 | 0.005 | 0.002 | | |
| | 0.800 | 0.001 | 0.252 | 0.006 | 0.008 | 0.004 | 0.009 | | |
| | 0.900 | 0.003 | 0.075 | 0.007 | 0.001 | 0.004 | 0.026 | | |
| | | | | | | | | | |
| Oil Risk shock | 0.100 | 0.000 | 0.584 | 0.002 | 0.019 | 0.001 | 0.393 | | |
| | 0.200 | -0.001 | 0.265 | 0.001 | 0.025 | 0.001 | 0.413 | | |
| | 0.400 | 0.000 | 0.607 | 0.000 | 0.365 | 0.000 | 0.895 | | |
| | 0.600 | 0.000 | 0.373 | 0.000 | 0.594 | -0.001 | 0.248 | | |
| | 0.800 | 0.000 | 0.874 | 0.000 | 0.415 | 0.001 | 0.238 | | |
| | 0.900 | 0.000 | 0.891 | 0.000 | 0.643 | 0.000 | 0.852 | | |

Notes. The table depicts the quantile process coefficients estimated from quantile regression framework wherein stock returns are regressed on oil supply shocks, oil demand shocks, oil risk shocks, GEPU and world index. The latter two variables are controlled for but their results are not reported to conserve space. Q stands for quantile.