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Oil, Foreign Exchange Swaps and Interest Rates in the GCC Countries

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ABSTRACT

We examine the relationship between oil prices, foreign exchange (FX) swaps and local interbank offered rates in the six Gulf Cooperation Council (GCC) countries. We also investigate the potential hedging and diversification benefits from adding oil positions to portfolios containing GCC FX swaps or interest rate positions. Our findings confirm that oil predicts, and in some cases causes, movements in the various GCC FX swaps and interbank offered rates. We also find that the Saudi FX swap market has the highest volatility spillover from the oil market compared to other markets in the region. Furthermore, our analysis shows a significant change in liquidity conditions in the GCC FX swap markets following a sudden shift in oil prices. Lastly, we document the presence of significant risk reduction benefits from adding oil exposure to portfolios of GCC FX swaps or interest rates with risk going down by at least half in the case of the GCC FX swaps.

KEYWORDS

GCC markets; oil; FX swaps; hedging; interest rates; volatility spillover

JEL

G11; G12; G15

1. Introduction

Oil plays a major role in the economies of the members of the Gulf Cooperation Council (GCC). Oil and oil-related exports account for more than two thirds of the GCC total exports and are considered to be the main sources of USD liquidity in the region. On top of that, income from oil represents the most important source of government funding and is a major driver of major projects and development initiatives. Further, due to its crucial role in the economy, a movement in oil price can have a significant impact on financial markets in the GCC. The relationship between oil and various GCC financial markets has been the subject of many studies in the literature. Past studies have reported the presence of significant links between oil prices and several markets and instruments in the GCC, such as equity markets (Fayyad and Daly 2011; Hammoudeh and Li 2008; Malik and Hammoudeh 2007), sovereign credit default swaps (Shahzad et al. 2017) and interest rates (Ibrahim 2019; Naifar and Al Dohaiman 2013). However, we are not aware of any study that examines the relationship between oil on one side and foreign exchange swaps (FX swaps) or interbank offered rates on the other. This is a significant gap, especially given the essential role played by oil in providing USD liquidity which is particularly important for FX swaps. FX swaps are a type of foreign exchange derivative. They are heavily used by banks and other financial institutions to manage liquidity and hedge foreign exchange exposure. Every day, trillions of US dollars' worth of FX swaps are traded in various markets around the world. In the GCC, FX swaps, along with plain vanilla lending and borrowing, are the two main liquidity management products traded in the interbank market. This means that understanding the potential influence of oil price movements on these two products is essential for explaining movements in the level and price of liquidity in the GCC market, as well as for managing risks arising from such movements.

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Using continuously compounded daily returns for the period between May 2005 and June 2020, we find that oil plays a major role in influencing GCC FX swap levels and interbank rates. More specifically, our results show that movements in oil prices predict movements in the various GCC FX swaps and interbank offered rates with varying degrees and lags. We also find that the Saudi FX swap market predicts other GCC FX swaps and interbank rates and has a high degree of interconnectedness with other global and regional markets. This can be explained by the regional significance of the Saudi economy and the fact that the Saudi FX swap market is the most active and liquid FX swap market in the region.

Our results also show that the Saudi FX swap market attracts more volatility spillover from the oil market than any other market in the region. This can be attributed to Saudi Arabia's role as one of the most important players in the oil market. Our analysis also shows significant changes in liquidity conditions in the GCC FX swap markets following sudden shifts in oil prices. Lastly, we report the presence of significant risk reduction benefits from adding oil exposure to portfolios of GCC FX swaps or interest rates, with risk going down by at least half in the case of the GCC FX swaps. We also find that other markets (e.g. gold, EUR FX swap and equity indices) may bring more hedging benefits to portfolios containing GCC FX swaps or interest rate instruments.

This study is the first to look at the relationship between oil and the GCC FX swaps and interbank rates. It expands the stream of research focusing on understanding the relationship between oil as a major exporting commodity for the GCC and several GCC markets and economic indicators (Fayyad and Daly 2011; Malik and Hammoudeh 2007; Naifar and Al Dohaiman 2013; Shahzad et al. 2017). The study makes several contributions to the literature and practice in the industry. First, it provides another confirmation that oil, as a major exporting commodity for the GCC countries, has a significant influence on the movements and prices of financial assets. The study does this by providing evidence of this influence on FX swaps and interbank rates for the first time. This suggests an important role for oil in impacting both the level and price of interbank liquidity in the GCC markets, and it adds to prior findings regarding oil's significant role in influencing the prices of several financial assets in the GCC (Hammoudeh and Li 2008; Ibrahim 2019; Shahzad et al. 2017).

Second, the results of the study also confirm the important role that oil futures can play in providing an effective risk management tool for FX swap and interest rate traders in the GCC region. The results suggest that adding oil futures to the portfolios of these traders may reduce volatility significantly by providing a hedge against unexpected movements in oil prices. This is in line with prior findings in the literature regarding the role of oil futures in hedging exposures to other asset classes in the GCC such as equity (Khalifa, Hammoudeh, and Otranto 2014; Maghyereh, Awartani, and Tziogkidis 2017). This finding is important due to the limited means available to banks and other financial institutions in the region to hedge domestic FX and interest rate exposures.

Last but not least, the results of this study enhance our understanding of the dynamics within the GCC regions' financial markets, the important role played by the Saudi Arabian economy inside the economic bloc and in the bloc's interactions with outside markets. This observation supports prior findings in the literature regarding the influence of the GCC's biggest economy on other markets in the region and helps explain how external volatility and economic shocks may travel to and within the economic bloc (Malik and Hammoudeh 2007).

The findings in this study have two important policy implications. First, they suggest central banks in the GCC have the potential to provide stability in the FX swap markets, especially during periods of high turbulence in the oil market. They can do this by providing USD liquidity and by acting as a market maker. Second, the findings also indicate that GCC central banks can play an important role in influencing domestic interbank rates through market-making activities in the FX swap markets. For the GCC central banks, participation in the FX swap market can serve as an effective monetary tool to stabilize domestic rates and influence liquidity.

The remainder of this study is organized as follows. We provide a quick introduction to FX swaps and GCC economies in the next two sub-sections. Section 2 provides a summary of relevant prior studies and outlines the main research questions. Sections 3 and 4 describe the sample and methodology used, respectively. Section 5 presents the results of our analysis while Section 6 presents the conclusion to the study.

1.1. Understanding the Forex Swaps Market and Its Role in the GCC

Foreign exchange swaps (henceforth, FX swaps) are one of the most important liquidity management instruments in today's financial world. FX swaps are forex derivates in which one counterparty agrees to sell and buy on two different dates a fixed amount of one currency in exchange for an equivalent amount of another currency which is determined based on pre-agreed exchanges rates. Put differently, FX swaps are a combination of two forex spot deals with opposite directions for which the rates are pre-determined at inception. FX swaps can also be seen as a form of secured borrowing/lending in which a counterparty which has excess liquidity in currency X can cover a liquidity shortage in currency Y through lending currency X and simultaneously borrowing an equivalent amount of currency Y from the same counterparty for the same period of time.

According to the Bank for International Settlements (BIS), the outstanding amounts of FX swaps at the end of December 2019 stood at USD 55 trillion, of which almost 45% or USD 25 trillion was denominated in non-G-7 currencies (BIS 2020). Banks and other financial institutions account for around 90% of the turnover in the FX swaps market. These institutions trade FX swaps for funding and hedging purposes, either for their own treasuries or on behalf of their clients. FX swaps are heavily used to fund USD assets by banks operating outside the United States (US) because they have limited direct access to USD liquidity (Schrimpf and Sushko 2019). In addition to revenue-driven trading, FX swaps are also widely used to construct offsetting hedges for other FX derivates such as FX forwards and currency swaps.

In the GCC, banks rely greatly on FX swaps as well as cash lending and borrowing to manage their liquidity due to the absence of any local interbank repo market and the limited availability of other FX or money market instruments. Since all GCC currencies are pegged to the US dollar, with the exception of the Kuwaiti dinar which is pegged to a currency basket that is believed to be dominated by USD, the vast majority of FX swaps involving GCC currencies also involve the exchange of USD as the second leg of the swap. With the exception of Islamic banks that have their own limited version of FX swaps, almost all conventional banks in the GCC, local and international, maintain active trading desks and relatively significant positions in the FX swap market. In addition, public debt markets in the GCC are relatively small and offer very limited funding opportunities compared to private funding provided by banks and other financial institutions. This means that understanding the dynamics of the local/regional FX swap market is a prerequisite to understanding the liquidity and funding conditions of the banking sector and the economy as a whole. While many of the world's central banks actively participate in the FX swap market to provide liquidity (mainly in USD) and/or support their currencies, all of the GCC central banks (except for the Central Bank of Bahrain) have no FX swap facilities or documented presence in such markets (Destais 2016; Fratzscher et al. 2019).[1] However, each central bank in the GCC offers an FX spot facility to locally operating banks to allow them to sell the local currency against USD.

1.2. GCC Economies and the Role of Oil

The Gulf Cooperation Council (GCC) was established in 1981 as a political and economic alliance between six Arab states in the Gulf. They are: Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates. The alliance was formed with the aim of promoting shared interests and strengthening economic, political, and cultural ties among its member states. GCC economies are heavily reliant on the hydrocarbon sector which represents a significant portion of the economic

Table 1. Key economic statistics for the GCC countries (as of 2018).

Currency	Country	GDP (PPP) – in USD billion	Fiscal surplus (deficit) – percentage of GDP	Oil revenues – percentage of total exports
AED	United Arab Emirates (UAE)	722	1.97%	75%
BHD	Bahrain	74	−11.94%	53%
KWD	Kuwait	301	9.05%	91%
OMR	Oman	200	−7.94%	75%
QAR	Qatar	352	5.18%	94%
SAR	Saudi Arabia	1862	−5.87%	77%

Source: International Monetary Fund, World Economic Outlook Database, April 2020.

activity and government funding. According to the International Monetary Fund (IMF), the oil sector represented around 42% of the GCC's GDP and accounted for 65% of the GCC's total exports in the period between 2000 and 2017 (IMF 2018). In addition, revenues from the oil sector represented, on average, around 80% of government revenues for the same period (IMF 2018). Table 1 provides a summary of key economic statistics for the GCC countries.

Given their large dependence on USD-denominated hydrocarbon revenues, GCC currencies have all been pegged to the US dollar since the 1980s, with the exception of the Kuwaiti dinar which is pegged to a currency basket that is believed to be dominated by USD. The pegs have allowed the GCC countries to outsource their monetary policy to the Federal Reserve which has been viewed as a vital sign of policy credibility. Despite major oil shocks and crises in recent decades, the pegs have served the GCC economies well through anchoring inflation and exchange rate expectations while also reducing transaction costs and balance sheet risks.

In recent years, the sharp decline in oil prices in 2014, and the prolonged periods of low prices and fluctuating demand and supply which followed, have pushed all GCC governments to ramp up their efforts to diversify away from oil as the key economic sector and the main source of government revenues. Nevertheless, for most GCC economies oil and oil related-commodities remain the key drivers of economic activity and the main source of liquidity in foreign currencies, predominantly the US dollar. This confirms the importance of studying and understanding the relationship between oil prices and the various equity, fixed income and foreign exchange markets in the GCC states (Fayyad and Daly 2011; Hammoudeh and Li 2008; Ibrahim 2019; Shahzad et al. 2017).[2]

2. Literature Review

FX swaps have received very limited attention in the literature with most studies on the FX market focusing on FX spots and other FX derivatives (Stenfors 2018). As highlighted by Stenfors (2018), mentions of FX swaps in the literature tend to be limited to its role in arbitrage (Akram, Rime, and Sarno 2008; Baba and Packer 2009) or interest rate parity conditions (Borio et al. 2018; Ivashina, Scharfstein, and Stein 2015). One interesting work relevant to the topic of our study is Baba, Packer, and Nagano (2008) who report that shortages in USD funding in non-US financial institutions during the second half of 2007 due to the turmoil in money markets resulted in a similar turmoil in the FX swap markets, as these institutions rushed to cover their funding needs through swapping their home currencies for USD. As a result, Baba et al. document a deviation from covered interest rate parity conditions and a deterioration in liquidity conditions in these markets during the studied period. These findings are supported by the results from Ivashina, Scharfstein, and Stein (2015) which document turmoil in the FX swap markets and a violation of covered interest rate parity conditions during the 2011 European debt crisis. Ivashina et al. report that the deterioration in the credit profile of many European banks has affected their access to USD funding through money markets and has forced many of these banks to cover their USD funding needs through swapping EUR for USD, causing a dislocation in prices and an impairment in liquidity conditions in the FX swap markets (see also Avdjiev et al. 2019; Borio et al. 2018). Overall, this confirms the role of the conditions of USD liquidity in determining the prices and conditions of the FX swap markets. This is essential to our work as we focus on oil as the main source of USD liquidity for GCC markets and thus as a major cause of movement in the GCC FX swap markets.

The link between oil prices and various exchange rates is the focus of many studies in the literature. For instance, Amano and Van Norden (1998) document the significant role oil price movements have played in influencing the US real exchange rate in recent decades. Similar findings are reported by Rautava (2004) in relation to the relationship between oil and the Russian ruble. Sari, Hammoudeh, and Soytas (2010), however, find no support for the presence of a long-run equilibrium relationship between the spot prices of several commodities, including oil, and movements in the EUR/USD exchange rate. They attribute the absence of such long-run equilibrium to the probability that the prices of the commodities included in their study may be affected by different sets of macroeconomic factors over time. These results contradict the findings of Zhang et al. (2008) who document the presence of a long-term relationship between oil prices and USD exchange rate, with USD causing long-term movements in oil prices. Further, Reboredo, Rivera-Castro, and Zebende (2014) report the presence of a contagion effect and negative dependence between oil and USD exchange rate which has increased following the global financial crisis in 2008. In a study covering oil-producing countries in the Middle East and North Africa, Eslamloueyan and Kia (2015) find that oil plays a major role in determining real exchange rates in these countries over the long run. Overall, the evidence in the literature points toward the presence of some kind of relationship, whether in the short-run or the long-run or both, between oil and various exchange rates.

In regards to the role of the oil market in influencing GCC financial markets, most of the evidence in the literature focuses on the relationship between oil prices and GCC equity markets, with some recent studies looking at other financial instruments such as GCC sovereign credit default swaps (e.g. Shahzad et al. 2017). Among the first studies to examine the relationship between the oil market and equity markets in the GCC is Malik and Hammoudeh (2007) who examine the volatility transmission between US equity, the global oil market, and the equity markets of Bahrain, Kuwait, and Saudi Arabia. Using a multivariate generalized autoregressive conditional heteroscedasticity (GARCH) model, Malik and Hammoudeh find significant evidence of a volatility transmission from the oil market and the US equity market to the three studied GCC equity markets, which can be linked to the high oil-dependence of the GCC economies as well as their trade ties with the US. Surprisingly, however, they also find evidence of a volatility spillover from the Saudi equity market to the oil market, which they link to Saudi's role as a major global exporter of crude oil. Malik and Hammoudeh also suggest the presence of a spillover from the Saudi financial markets to other oil-dependent markets in the region due to Saudi's important role in the global oil industry and its close economic ties with all GCC states. In a related study, Louis and Balli (2014) find that shocks to volatility in oil prices have more significant impacts on GCC equity markets than shocks to oil price returns.

Moreover, Hammoudeh and Li (2008) document that GCC equity markets have been highly sensitive to shocks in the oil market such as the 1998 collapse in oil prices and the introduction of the new oil pricing mechanism by OPEC in 2000 (see also Hammoudeh and Choi 2007). Fayyad and Daly (2011) and Siddiqui, Mahmood, and Margaritis (2020) also report an increased sensitivity in some GCC equity markets to moves in oil prices post the 2008 financial crisis and the 2014–2016 slump in oil prices (see also Ma et al. 2014). Furthermore, Shahzad et al. (2017) report the presence of a significant directional predictability from oil market uncertainty to the spread of sovereign credit default swaps of four GCC countries (Bahrain, Qatar, Saudi Arabia and the United Arab Emirates) and other major oil producers. Their findings emphasize the significant role of oil market volatility in driving sovereign credit risk in major oil producers. Naifar and Al Dohaiman (2013) use a two-state Markov regime switching model (crisis regime and non-crisis regime) and find that the relationship between oil prices and GCC equity markets is regime-dependent, with significant tail dependence which indicates the probability of extreme co-movements and thus the possibility of large simultaneous losses in both markets. They also find a positive asymmetric dependence between oil markets and inflation rates in the GCC, as well as varying monetary policy sensitivity to oil prices. Further, Ibrahim (2019) employs dynamic panel VAR modeling to study the effects of oil price movements on several financial and economic indicators in the GCC states and finds evidence that increases in oil prices improve banks' profitability and increase both credit and output growth while decreases in oil prices lead to opposite results as well as a noticeable deterioration in credit quality.

There is also some evidence in the literature to support the role of oil derivatives as a hedging instrument for exposure to GCC equity markets. Using a Multi-Chain Markov Switching model (MCMS) to analyze change and the transmission of volatility across GCC equity markets, oil markets and the US equity market, Khalifa, Hammoudeh, and Otranto (2014) report that in comparison to the US equity market the oil market provides a cheaper and a more effective hedge to portfolios containing GCC equities. Khalifa et al. also show that the cost of the hedge is higher when it is executed during a turmoil in the hedged market (see also Basher and Sadorsky 2016; Jouini 2013). The findings are further supported by Maghyereh, Awartani, and Tziogkidis (2017) who document the presence of a significant volatility spillover from the oil market to the GCC equity markets using a DCC-GARCH model, but they report no similar relationship with regards to gold. Maghyereh et al. suggest that these observations support the role of oil and gold as cheap hedges for GCC equity markets (see also Al Janabi, Hatemi-J, and Irandoust 2010; Mensi et al. 2017).

2.1. Research Questions

This study has two main interconnected objectives, which are: 1) to examine the relationship between oil prices, FX swaps, and local interbank offered rates in the six GCC countries, and 2) to study the potential benefit from utilizing oil to hedge or diversify FX swap or interest rate positions.[3] As highlighted in earlier sections, the rationale for expecting the presence of a strong relationship between GCC FX swaps and oil prices lies in the fact that USD liquidity in GCC economies comes mainly from exporting oil, which also represents a significant share of GDP and government funding.[4] Furthermore, public investment funds, sovereign wealth funds, and government-related entities, which are major providers of liquidity to the local banking sector in the GCC, rely to a large extent on revenues from oil and oil-related activities. This means that one must also expect the relationship between oil on one side, and FX swaps and local liquidity as a whole on the other, to extend to the local interbank offered rates in the GCC markets, which are the prices of unsecured borrowing in the local currencies from the local banks. Our premise is further supported by previous empirical findings regarding the presence of a significant relationship between oil prices and several GCC financial markets and instruments, such as: local equity markets (Fayyad and Daly 2011; Hammoudeh and Li 2008; Malik and Hammoudeh 2007), sovereign credit default swaps (Shahzad et al. 2017) and interest rates (Ibrahim 2019; Naifar and Al Dohaiman 2013). On this basis, our first research question is:

1*. Do movements in oil prices influence GCC FX swaps and interbank offered rate levels and/or liquidity? If so, what is the nature of this influence?*

The second part of our study focuses on the potential hedging and diversification benefits obtained from adding oil to portfolios containing FX swaps and/or interest rate exposure. This is especially important for banks and other financial institutions in the region which hold significant FX swap and/or interest rate positions but have very limited instruments to hedge these positions. As discussed previously, earlier findings in the literature suggest that oil-linked derivatives can be used as effective hedging and diversification instruments for holdings in GCC equities (Basher and Sadorsky 2016; Khalifa, Hammoudeh, and Otranto 2014; Maghyereh, Awartani, and Tziogkidis 2017; Mensi et al. 2017). Based on the earlier discussion regarding the relationship between oil prices, FX swaps, and local interbank offered rates, as well as prior findings in the literature regarding similar benefits obtained from trading oil in portfolios containing other GCC assets, our second research question is:

2*. Can oil provide hedging or diversification benefits in portfolios containing FX swap positions and/or interest rate positions?*

3. Data

We use Datastream to extract daily closing prices for several financial assets for the period between May 2005 and June 2020. We limit our analysis to this period due the unavailability of GCC FX swap and/or interest rate data before this period. We calculate the continuously compounded daily returns as $\ln(P_t/P_{t-1}) \times 100$ where P_t is the daily closing price. Unless otherwise stated, our analyses throughout the study are based on these returns. We also extract closing ask/bid prices for our GCC FX swap series to calculate one of the liquidity measures in our study (explained later). Variables extracted include: three months FX swap levels for all GCC markets and EURO; three-month interbank offered rates for Saudi Arabia (SAIB3M), the United Arab Emirates (EIBO3M), and London interbank offered rates (USDL3M); spot and futures commodity prices (Oil/Gold); S&P 500 US equity index (SPX); and the MSCI Emerging Markets Index (MSCI-EM). Since FX swap prices are affected by the day count of the actual tenor (three months in our case) which varies from one day to another due to holidays or calendar effects (e.g., 90 or 93 days), we adjust the prices so that they are all calculated based on 91 days.[5] Moreover, we use the forward prices (i.e. the FX spot price adjusted for FX swap points) in our analysis instead of pure FX swap prices only because using the latter might distort the picture, especially in regard to estimating the magnitude of daily movements and returns.[6] Throughout this study, we refer to the FX swap variables in a short form that denotes the currency and the tenor e.g. AED3M (three-month AED FX swap). We focus our analysis on the three-month FX swap tenor as this is the most liquid and actively quoted/traded tenor in the FX swaps.[7] We also limit our analysis of local interbank offered rates to those in Saudi Arabia and the United Arab Emirates because interest rate derivatives are only quoted against these two rates and because of the absence of reliable and actively used interbank offered rates in other GCC markets.[8] The addition of other international variables (USDL3M/Gold/SPX/MSCI-EM) is done for the purpose of comparing the role of oil to those variables in relation to hedging GCC FX swap and interest rates exposure. The analysis encompasses some volatile periods for the oil market, including: the energy crisis and sharp rise in oil prices during the 2000s; the 2008 financial crisis; the 2010s oil glut and the rise of shale oil in the US; the Covid-19 pandemic and the price war between Russia and Saudi Arabia in 2020. Our final sample consists of 2,821 daily observations for the various variables.[9]

4. Methodology

4.1. Vector Autoregression (VAR) Models and Volatility Spillover

We begin our analysis by employing generalized vector autoregression (VAR) models which are widely used in the literature to analyze interdependencies between multiple time series. They are also used to analyze the impact of random shocks on the system of variables. In a VAR model, each variable is explained by its own lagged values and the lagged valued of other variables as well as an error term. In other words, a VAR model treats all variables as endogenous variables while treating only their lags as exogenous variables. VAR is represented by the following equation:

$$\left[Y_t^p\right] = \left[A_{pp}\right] \times [Y]_{t-k}^p + \ldots\ldots + \left[A'_{pp}\right] \times [Y]_{t-k}^p + \ldots\ldots + [e]_{pt} \tag{1}$$

where p and k are the numbers of variables and lags in the system, respectively, $[Y]_{t-k}^p$ is the $1 \times p$ vector of variables, $\left[A_{pp}\right]$ and $\left[A'_{pp}\right]$ are the $p \times p$ matrices of estimated coefficients, and $[e]_{pt}$ is the $1 \times p$ vector of stochastic error terms or shocks. The VAR system allows us to measure the impulse response by one market to the other, while the decomposition of the variance of the error term (e_{pt}) in the VAR system allows us to calculate the proportion of unexpected variation in each market return due to shock from other variables in the system.

For the purposes of this study, we use a VAR system with four lags ($k = 4$) which is the system that achieves the smallest score in both the Akaike information criterion (AIC) and the Schwarz information criterion (SIC). Next, we utilize the volatility spillover index proposed by Diebold and Yilmaz

(2012, 2015) to measure the spillovers between the different markets in our study based on the forecast error variance decomposition (FEVD) from our VAR models. This index is preferred over other methods due to its flexible and dynamic construction which allows us to measure the magnitude and direction of the average spillovers between various markets.[10] The computation follows the generalized VAR framework which accounts properly for correlated shocks and generates stable decomposition. For the purposes of our study, we calculate the dynamic total return and volatility spillovers based on a forecast horizon of 10 steps ahead using 200-days rolling windows. We also employ the Granger causality test to analyze the lead (lag) relationships between the various markets covered in our study.

4.2. Liquidity

Due to the lack of sufficient data about levels or volumes of executed FX swap trades in the GCC, we utilize two widely-accepted quote-based measures to assess changes in liquidity in the GCC FX swap market as a result of movements in the oil market (Mancini, Ranaldo, and Wrampelmeyer 2013). The first measure is the bid-ask spread (or SPR), which represents the potential cost of executing a trade in the market. A market is viewed as liquid when this spread is low and illiquid when the spread is wide. The bid-ask spread is calculated using the forward bid and ask prices as follows[11]:

$$SPR_t = \frac{(Ask_t - Bid_t)}{(Ask_t + Bid_t)/2} \tag{2}$$

Our second measure of liquidity is the market-efficiency coefficient (MEC) introduced by Hasbrouck and Schwartz (1988). The MEC is based on the premise that price movements tend to be more continuous in liquid markets even when new information affects the equilibrium price. Thus, the transitory changes to a new price in a liquid market should be minimal. The MEC captures these transitory changes by comparing the variance in the asset price over a long period to an equivalent variance over a short period, as follows:

$$MEC_t = \frac{VAR(R_t)}{(T \times VAR(r_t))} \tag{3}$$

where $VAR(R_t)$ is the variance of returns over the long-period (one month), $VAR(r_t)$ is the variance of returns over the short-period (one week) and T is the number of short periods in each long period (i.e. four).[12] A liquid and resilient market should have an MEC score close to one. A deviation from unity indicates poor resilience and liquidity conditions. In order to assess the potential shifts in liquidity due to sudden changes in the oil market, we first apply the Bai and Perron (2003) procedure to identify sudden shifts in the price of oil over the studied period.[13] Next, we test if there are significant differences in the means of our liquidity proxies (*SPR and MEC*) before and after the shifts. We calculate the means for the 40 observations surrounding the identified shift (20 before and 20 after).

4.3. Hedging and Diversification

In order to answer our second research question regarding the hedging and/or diversification benefits obtained by adding oil exposure to a portfolio of GCC FX swaps or interest rate positions, we employ the dynamic conditional correlation generalized autoregressive conditional heteroskedasticity (DCC-GARCH) model introduced by Engle (2002) to obtain the estimates needed to calculate our portfolio weights and hedging ratios (explained later). GARCH models are widely used in the literature to estimate time varying correlations/volatilities which are typical characteristics of financial time series. The DCC-GARCH model proposed by Engle (2002) offers a parsimonious, less complex, and easier-to-compute process of estimating correlations compared to alternative multivariate GARCH models. In addition to allowing the estimation of large correlation matrices, the DCC-GARCH model provides competitive estimation performance compared to other GARCH models. Ku, Chen, and Chen (2007) finds that DCC-GARCH models have the best hedging effectiveness performance in comparison to traditional multivariate GARCH models, ordinary least square models, and error correction models.

We begin our analysis by estimating several DCC-GARCH models with various specifications with regards to using AR(1) in the mean equation as well as using various distributions. The model that gives us the lowest scores for both the Akaike information criterion (AIC) and the Schwarz information criterion (SIC) is a DCC-GARCH (1,1) model with AR(1) in the mean equation and a multivariate Student t distribution.[14] The addition of AR(1) is supported by the well-documented presence of autocorrelation, volatility clustering and fat tails in asset returns. The results of the DCC-GARCH model (unreported) confirm the presence of time-varying conditional volatility of returns as well as the persistence of volatility clustering in the various financial series examined.

Next, we estimate the diversification effect of adding oil futures to a portfolio that includes one of the GCC FX or interest rate swaps. We utilize the equation introduced by Kroner and Ng (1998) to estimate the weight of oil exposure in the various FX swaps or interest rate only portfolios:

$$w_t^{oil} = \frac{h_t^{Swap} - h_t^{OilfSwap}}{h_t^{Oil} - 2h_t^{OilfSwap} + h_t^{Swap}}, with w_i^{oilf} = \begin{cases} 0 w_t^{oilf} < 0 \\ 0 \le w_t^{oilf} \le 1 \\ 1 w_t^{oilf} > 1 \end{cases} \tag{4}$$

where h_t^{Oilf}, h_t^{Swap} are the conditional volatilities of the three months oil futures and FX swaps/interest rate markets respectively, and $h_t^{OilfSwap}$ is the conditional covariance between both markets at time t. The portfolio weight of the hedged assets (FX swaps or interest rate) is given by: $w_t^{Swap} = 1 - w_t^{oilf}$. w_t^{oilf}. This represents the investment in oil futures that is expected to minimize the original singe-asset portfolio's risk while keeping the original expected return the same.

We also calculate the hedging weights using the beta hedge approach introduced by Kroner and Sultan (1993). The beta hedge formula (provided below) calculates how much β_t^{Swap} USD short position (sell) in oil futures is needed to hedge a one USD long position (buy) in FX swaps/interest rate:

$$\beta_t^{Swap} = \frac{h_t^{OilSwap}}{h_t^{Swap}} \tag{5}$$

Lastly, we assess the hedging effectiveness of our various combined portfolios by comparing the variance of the hedged portfolio with that of the unhedged one. Following Ku, Chen, and Chen (2007) we use the following ratio:

$$HedgingEffectiveness(HE) = 1 - \frac{Variance_{Hedged}}{Variance_{Unhedged}} \tag{6}$$

where $Variance_{Hedged}$ is the variance of the combined portfolio (FX swaps/interest rate and oil futures) and $Variance_{Unhedged}$ is the variance of the original portfolio (FX swap/interest rate only). A higher HE ratio indicates a higher reduction in risk and thus a more effective hedge. For the sake of comparison, we also add four additional hedging/diversification markets: EUR/USD FX swap (EUR3M), gold, S&P 500 US equity index (SPX), and MSCI Emerging Markets Index (MSCI-EM).

5. Results and Discussion

5.1. Descriptive Statistics and Preliminary Analysis

Table 2 presents the descriptive statistics of the various return series used in our study. First of all, we notice that the FX swap returns have much higher volatilities than all other return series. Further, the properties of the distributions of all return series suggest non-normal distributions with all series,

Table 2. Summary statistics of the daily returns.

	Mean	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Jarque–Bera	Ljung-Box	ADF	PP
AED3M	0.051	55.215	−58.579	5.245	0.011	2.603	49000***	385.222***	−36.854***	−117.251***
BHD3M	0.027	27.546	−24.849	3.905	0.047	1.449	16000***	420.583***	−40.583***	−120.024***
KWD3M	−0.032	38.632	−50.087	4.140	−0.049	2.816	56000***	319.869***	−39.431***	−86.867***
OMR3M	0.017	38.286	−40.943	3.749	0.013	2.602	56000***	294.201***	−41.986***	−106.005***
QAR3M	−0.031	31.355	−37.297	3.968	−0.003	1.749	22000***	228.500***	−39.259***	−83.046***
SAR3M	0.004	32.581	−52.983	4.994	−0.029	1.606	1400***	386.667***	−25.734***	−93.138***
EUR3M	−0.002	33.124	−37.644	2.782	−0.083	5.483	24000***	332.763***	−18.866***	−74.434***
SAIB3M	−0.044	8.434	−43.144	1.585	−14.661	320.124	120000***	591.694***	−13.933***	−55.340***
EIBO3M	−0.054	27.971	−37.895	2.459	−3.143	72.637	26000***	622.204***	−7.508***	−69.674***
USDL3M	−0.084	18.320	−27.264	1.807	−4.216	73.459	37000***	1873.033***	−19.680***	−47.262***
Oil	−0.007	19.077	−37.493	2.754	−1.342	23.558	22000***	49.509***	−54.211***	−54.211***
Gold	0.051	10.392	−14.302	1.350	−0.374	12.788	9234***	53.070***	−55.208***	−55.176***
SPX	0.035	12.404	−13.461	1.439	−0.770	15.893	8859***	92.630***	−61.382***	−61.427***
MSCI-EM	0.022	10.691	−22.233	1.565	−1.597	23.975	7480***	136.352***	−30.453***	−46.634***

This table presents summary statistics of the daily returns and changes in the various financial series. The Jarque–Bera statistic tests the null hypothesis that the skewness and kurtosis of the distribution of daily returns match that of a normal distribution. The Ljung-Box statistic, also called Q(20), tests the null hypothesis of no autocorrelation of returns. ADF and PP are the t-statistics for the Augmented Dickey-Fuller and Phillips and Perron unit root tests, respectively. ADF and PP both test the null hypothesis for the presence of a unit root (non-stationary). Lags for ADF and PP are selected based on the SIC criterion. *Significant at the 10% level. **Significant at the 5% level. ***Significant at the 1% level.

except for AED and OMR FX swaps, having negative skewness. Also, all kurtosis values exceed three which suggests that all return series have leptokurtic distributions. These observations are in line with the highly significant values of the Jarque–Bera statistic which leads us to reject the null hypothesis that the skewness and kurtosis of the distribution of daily returns match that of a normal distribution. Moreover, the significant values for the Ljung-Box statistic indicate the presence of significant autocorrelation of returns in all series. Lastly, the results of both the Augmented Dickey-Fuller and the Phillips and Perron unit root tests show that all series are stationery.[15]

Table 3 presents the correlations between the different return series. We notice the presence of relatively higher positive correlations among the various commodity (oil/gold) and equity markets (MSCI-EM and S&P500). We also document a positive association between oil return and AED, KWD, OMR and QAR FX swaps. However, a negative link exists between oil and SAR and BHD FX swaps. Further, oil is negatively correlated with the Saudi interbank offered rate (SAIB3M) and

Table 3. Pearson's correlations of the daily returns.

	AED 3 M	BHD 3 M	KWD 3 M	OMR 3 M	QAR 3 M	SAR 3 M	EUR 3 M	SAIB 3 M	EIBO 3 M	USDL 3 M	Oil	Gold	SPX	MSCI-EM
AED3M	1.000													
BHD3M	0.013	1.000												
KWD3M	0.018	0.010	1.000											
OMR3M	−0.006	0.041	−0.021	1.000										
QAR3M	0.046	0.018	−0.004	−0.012	1.000									
SAR3M	0.036	−0.014	0.023	0.036	−0.006	1.000								
EUR3M	0.013	−0.004	0.011	0.005	−0.006	0.006	1.000							
SAIB3M	0.005	−0.027	−0.006	−0.006	0.004	0.007	−0.004	1.000						
EIBO3M	0.004	−0.006	−0.017	−0.010	0.034	0.003	−0.036	0.222	1.000					
USDL3M	−0.012	−0.018	−0.015	−0.024	−0.004	0.027	−0.074	0.110	0.160	1.000				
Oil	0.150	−0.220	0.150	0.137	0.102	−0.202	0.227	0.122	−0.116	0.075	1.000			
Gold	0.164	0.159	−0.092	0.213	0.130	0.079	0.036	−0.038	0.169	−0.100	0.228	1.000		
SPX	−0.051	−0.083	0.093	0.080	0.089	−0.141	0.153	0.031	−0.052	−0.046	0.372	0.100	1.000	
MSCI-EM	−0.074	0.107	−0.089	0.064	−0.005	−0.109	0.116	0.062	−0.092	−0.186	0.398	0.216	0.565	1.000

This table presents the Pearson correlation coefficient between the various daily returns series covered in the study.

positively correlated with the Emirates interbank offered rate (EIBO3M). The relatively low magnitude of correlations between oil and the various GCC FX swaps and interbank offered rates indicates the presence of hedging/diversification benefits.

5.2. Oil and GCC FX Swaps and Interest Rates

The results of the generalized vector autoregression (VAR) system explained in the methodology section are reported in Table 4. Due to space constraints we only report results of interest to our study. Our results show that oil prices can predict movements in all GCC FX swaps and interbank offered rates, except for KWD, at different lags. At the fourth lag, oil can predict AED, QAR and OMR FX swaps as well as the two interbank offered rates (SAIB3M and EIBO3M). Further, both BHD and SAR FX swaps are predicted by the third lag of oil price, with SAR also being predicted by the first lag. Lastly, the SAR FX swap predicts both SAIB3M and EIBO3M at the fourth and third lags, respectively. It is worth noting that the SAR FX swap also significantly predicts other GCC FX swaps, except KWD, at different lags. This is largely explained by the fact that the SAR FX swap market is the largest and most liquid market in the GCC and is thus more likely to lead other smaller markets in the GCC.

Table 5 shows the total volatility spillover index values following Diebold and Yilmaz (2012, 2015) based on the forecast error variance decomposition from our VAR model. Each value represents the contribution, or the innovations spillover, from the market specified in the column (termed 'From market') to the forecast error variance of the variable specified in the row (termed 'To market'). The column labeled 'From Others' sums the directional contributions from all markets (row sum) excluding own contribution (diagonal figures). The row labeled 'To Others' sums the directional contributions to all markets (column sum) excluding own contribution (diagonal figures). Among the various markets covered in our study, oil appears to have the highest contribution to other markets (85.40) followed by SPX (36.50) and USDL3M (27.40). Among the GCC FX swap markets, the SAR FX swap market is the one with the highest spillover to other markets (4.00). One important observation is that the spillover from the oil market to the GCC FX swap markets is highest for the SAR FX swap market (17.20). Being the most active market in the region and the one with the highest number of participants, the SAR FX swap market is more likely to closely follow fluctuations in the oil market. Another important observation is that GCC interbank offered rates (SAIB3M and EIBO3M) are mostly connected with oil and USDL3M, with relatively high spillover from these two markets to both SAIB3M and EIBO3M. The relationship of SAIB3M and EIBO3M with USDL3M is expected given the strong link between the monetary policies of the GCC and the US. It is also interesting to see that the spillover from SAIB3M to EIBO3M is higher than that from oil to EIBO3M. This can be explained by the regional significance of the Saudi economy and its interbank market.

Table 4. Vector autoregression estimates.

	AED3M	BHD3M	KWD3M	OMR3M	QAR3M	SAR3M	SAIB3M	EIBO3M
Oil (−1)	−0.123	−0.280	−0.160	−0.088	0.013	−0.005***	0.010	−0.025
Oil (−2)	−0.513	−0.282	0.080	−0.212	−0.431	0.000	−0.018	0.000
Oil (−3)	0.112	−0.095**	−0.183	0.229	−0.223	−0.005***	−0.019*	−0.035**
Oil (−4)	−0.233**	−0.158	−0.146	−0.556**	0.048**	0.002	0.049***	−0.068***
AED3M (−1)	−0.473***	0.002	−0.008	0.023*	−0.025*	−0.009	0.001	0.000
AED3M (−2)	−0.311***	−0.018	−0.003	0.026*	−0.032*	−0.030	0.001*	0.000
AED3M (−3)	−0.18***	0.003	−0.013	0.017	0.000	−0.002	0.000	−0.001
AED3M (−4)	−0.091***	−0.013	−0.023	−0.001	0.005	−0.003	0.000	−0.001
SAR3M (−1)	0.026	0.012	0.005	−0.020	0.018	−0.391***	0.000	−0.001
SAR3M (−2)	0.000	0.003	−0.001	−0.022*	0.032**	−0.130***	0.001	0.000
SAR3M (−3)	0.040*	0.011	0.011	0.011	0.006	−0.083***	0.001	0.002**
SAR3M (−4)	0.008	0.030**	−0.019	0.000	−0.006	−0.084***	0.001**	0.001

This table shows the vector autoregression (VAR) system explained in the text with four lags (total observations: 2,821). The number within the bracket indicates the lag (e.g.-1 is the first lag). Due to space constraints we only report the results with potential interest to our study (the remaining results can be obtained from the authors). *Significant at the 10% level. **Significant at the 5% level. ***Significant at the 1% level.

Table 5. Total volatility spillover/connectedness.

	From Market														
To Market	AED 3 M	BHD 3 M	KWD 3 M	OMR 3 M	QAR 3 M	SAR 3 M	EUR 3 M	SAIB 3 M	EIBO 3 M	USDL 3 M	Oil	Gold	SPX	MSCI-EM	From Others
AED3M	94.1	0.1	0.2	0.2	0.3	0.3	0.1	0.0	0.0	0.1	4.1	0.1	0.1	0.3	5.9
BHD3M	0.2	90.9	0.1	0.0	0.3	0.2	0.0	0.3	0.1	0.2	7.5	0.1	0.1	0.0	9.1
KWD3M	0.1	0.2	96.6	0.3	0.2	0.2	0.1	0.0	0.1	0.1	1.9	0.0	0.1	0.1	3.4
OMR3M	0.1	0.6	0.2	91.0	0.4	0.2	0.2	0.1	0.0	0.1	6.7	0.1	0.3	0.0	9.0
QAR3M	0.3	0.5	0.1	0.2	92.0	0.1	0.0	0.0	0.8	0.1	5.3	0.1	0.2	0.3	8.0
SAR3M	0.3	0.1	0.3	0.4	0.2	80.2	0.1	0.1	0.1	0.3	17.2	0.3	0.2	0.2	19.8
EUR3M	0.2	0.1	0.0	0.0	0.1	0.4	97.6	0.0	0.1	0.1	0.3	0.6	0.4	0.1	2.4
SAIB3M	0.1	0.1	0.0	0.3	0.1	0.3	0.3	79.2	0.2	12.3	5.2	0.1	1.6	0.2	20.8
EIBO3M	0.1	0.1	0.0	0.0	0.5	0.2	0.5	1.6	83.8	9.7	3.0	0.0	0.3	0.2	16.2
USDL3M	0	0.1	0.0	0.2	0.4	0.3	1.5	1.4	0.6	91.6	1.5	0.1	2.2	0.1	8.4
Oil	0.1	0.1	0.1	0.3	0.1	0.6	0.9	1.3	0.6	1.8	92.9	0.8	0.2	0.2	7.1
Gold	0.2	0.1	0.0	0.2	0.2	0.1	1.0	0.3	0.1	0.4	5.4	91.0	0.6	0.4	9.0
SPX	0.1	0.3	0.0	0.2	0.2	0.8	1.3	1.9	0.3	1.0	13.2	0.8	79.5	0.4	20.5
MSCI-EM	0.1	0.3	0.2	0.2	0.1	0.3	2.2	0.5	0.4	1.3	14.1	2.3	30.2	47.8	52.2
To Others	1.9	2.7	1.2	2.5	3.1	4.0	8.2	7.5	3.4	27.5	85.4	5.4	36.5	2.5	191.8

This table shows the volatility spillover index proposed by Diebold and Yilmaz (2012); Diebold and Yılmaz (2015) based on the forecast error variance decomposition (FEVDs) from our VAR model. The dynamic total return and volatility spillovers are calculated based on a forecast horizon of 10 steps ahead using 200-days rolling windows. The column labeled 'From Others' sums the directional contributions from all markets (row sum) excluding own contribution (diagonal figures). The row labeled 'To Others' sums the directional contributions to all markets (column sum) excluding own contribution (diagonal figures). The total spillover/ connectedness is 10.4%.

Our observations from the volatility spillover index are further confirmed by the Granger causality tests reported in Table 6. When we test for the Granger causality between all GCC FX swaps, GCC interbank offered rates, and oil, we notice that oil Granger causes, with different significance levels, all the GCC FX swaps (except for KWD) as well SAIB3M and EIBO3M. This relationship is most significant (at the 1% significance level) between SAR3M and oil. We also find that SAR FX swap Granger causes SAIB3M, albeit less significantly. Overall, the results from this analysis suggest that oil significantly influences the various GCC FX swap markets and the two studied interbank offered rates

Table 6. Granger causality tests for the daily returns.

Variable	Causality direction	Variable	Test Statistic
Oil	→	AED3M	8.543*
	←		1.451
Oil	→	BHD3M	10.245**
	←		1.358
Oil	→	KWD3M	5.497
	←		2.581
Oil	→	OMR3M	9.801**
	←		1.408
Oil	→	QAR3M	9.392*
	←		2.693
Oil	→	SAR3M	18.156***
	←		7.646
Oil	→	SAIB3M	17.193***
	←		5.117
Oil	→	EIBO3M	13.275***
	←		4.379
SAR3M	→	SAIB3M	8.195*
	←		2.531
AED3M	→	EIBO3M	1.909
	←		0.452

This table shows the results of the Granger causality tests for the daily returns based on the VAR system used throughout the study (refer to the text for details). → and ← indicate the direction of the causality. *Significant at the 10% level. **Significant at the 5% level. ***Significant at the 1% level.

in Saudi Arabia and UAE. The Saudi economy is the largest in the GCC and relies heavily on oil and oil-related industries in its economy, which explains this significant relationship with the oil market. Our results also show that the SAR FX swap market influences other GCC FX swap markets to varying degrees. This is largely attributed to the regional importance of the Saudi economy which represents almost half of the GCC's gross domestic product. Similar relationships were also detected in the equity markets where the Saudi equity market was found to have some spillover effect to other markets in the region (Malik and Hammoudeh 2007). Our findings in this section are largely confirmed by the results (unreported) of a dynamic panel analysis utilizing the least squares dummy variable (LSDV) estimator.[16] The results suggest a significant role for oil prices in influencing movements in the six GCC FX swap markets and interbank rates. They also show a significant role for the Saudi FX swap market in influencing other regional markets.

5.3. Oil and GCC FX Swaps Liquidity

In order to answer the second part of our first research question regarding the potential impact on the liquidity in the GCC FX swap markets due to fluctuations in the oil market, we investigate the changes in two measures of liquidity and market resilience around sudden movements in oil price. As highlighted in the methodology section, the two measures used are: the bid-ask spread (SPR) and the market efficiency coefficient (MEC). We employ the Bai and Perron (2003) procedure to identify five sudden shifts in the price of oil over the studied period. These five shifts are marked on Figure 1. The shifts correspond to the following events:

- Period 1: Rise in oil prices caused by political and military tensions in various important countries around the world (Nigeria, Turkey and North Korea).
- Period 2: Drop in oil prices due to the lifting of ban on oil drilling in the United States which also coincided with the beginning of the global financial crisis in 2008.
- Period 3: Oil glut caused by the rise in shale oil production and the decline in demand from China and Europe.
- Period 4: Rise in oil prices as a result of production cuts by OPEC + Russia and supply disruptions in Libya and the North Sea.
- Period 5: Decline in oil prices as a result of Covid-19 pandemic and the price war between Russia and Saudi Arabia in 2020.

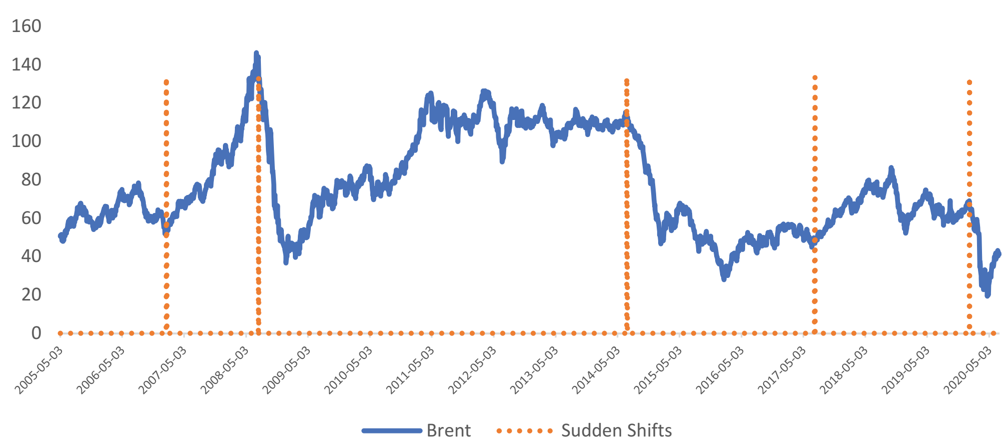

Figure 1. Evolution of oil price (Brent) – in USD.

The graph shows the evolution of the price of Brent oil over the studied period. The dotted orange lines highlight the five sudden shifts in the price of oil that were identified using the Bai and Perron (2003) procedure. An explanation of the events leading to these shifts in oil price is provided in the text.

Table 7 presents the results of the tests of the differences in the means of our liquidity proxies (SPR and MEC) in the periods surrounding the five shifts in the price of oil. The means are calculated for the 40 observations surrounding the identified shift (20 before and 20 after). First of all, we notice that SPR and MEC levels in different periods and markets change significantly as a result of a sudden shift in oil prices. For instance, the mean SPR increases significantly during period 2 in four FX swap markets (AED, KWD, OMR and QAR), while MEC shows a significant decrease in five markets (BHD, KWD, OMR, QAR and SAR).

One important observation is that SPR tends to increase following a sudden decrease in oil prices and vice versa. As mentioned earlier, a decrease in oil prices is likely to lead to less USD liquidity being injected into the GCC FX swap markets and thus is likely to result in an increase in the bid-ask spread (SPR) which is a classic symptom of a deterioration in liquidity conditions. Another important observation is that MEC appears to decrease following a sudden change in oil prices in any direction. This is expected given that any sudden shift in oil prices is likely to lead to an increase in the short-term volatility of the FX swap market (the denominator in Equation (3)) compared to the longer-term one (the numerator in Equation (3)). Overall, our results confirm that oil plays a significant role in influencing liquidity and resilience conditions in all GCC FX swap markets. An increase in oil prices is likely to lead to an influx of USD liquidity which will improve the liquidity conditions and hence reduce the bid-ask spread. Further, any sudden change in oil prices is likely to lead to an increase in short-term volatility and a lower market resilience.

5.4. Diversification/hedging Benefits of Oil for GCC FX Swaps and Interest Rates

To answer our second research question regarding the hedging or diversification benefits that can be obtained from adding oil futures to portfolios containing FX swap positions and/or interest rate positions, we employ DCC-GARCH models to estimate the parameters needed to calculate such benefits. As highlighted in the methodology section, DCC-GARCH models have the best hedging effectiveness performance in comparison to other traditional models (Ku, Chen, and Chen 2007). We report the results of our analysis in Table 8 with the various ratios defined in the methodology sections. The first column ($w_t^{HedgingMarket}$) corresponds to the weight of the hedging market (e.g. oil) in the hedged portfolio that achieves the same level of return on the hedged asset (e.g. AED3M) albeit with a lower risk. The risk reduction gains are measured by the hedging

Table 7. Tests for changes in liquidity proxies due to sudden shifts in oil price.

Period	Proxy	AED	BHD	KWD	OMR	QAR	SAR
Period 1	SPR	−0.017***	−0.044***	−0.023	−0.106***	−0.015	−0.008
18/01/2007	MEC	−0.681***	−0.011***	−0.558***	−0.191	−0.307	−0.022***
Period 2	SPR	0.089***	0.072	0.151**	0.214**	0.191***	0.004
15/07/2008	MEC	0.067	−0.114***	−0.418*	−0.062**	−0.102***	−0.109**
Period 3	SPR	0.006	0.040*	0.065***	0.001	0.001	0.009*
26/06/2014	MEC	−0.152*	−0.012	−0.102***	−0.675	0.003	−0.705***
Period 4	SPR	−0.010*	−0.016	−0.118***	−0.139***	−0.028	−0.133**
10/07/2017	MEC	−0.057**	−0.833*	−0.108	0.001	0.037	−0.388
Period 5	SPR	0.006	0.041	0.006	0.014	0.039*	0.011**
07/01/2020	MEC	−0.330***	−0.301**	−0.015**	−0.150***	−0.741**	−0.463***

This table shows the results of the tests of the differences in the means of our liquidity proxies (SPR and MEC) in the periods surrounding a sudden shift in the price of oil (identified using Bai and Perron (2003) procedure). The means are calculated for the 40 observations surrounding the identified shift (20 before and 20 after). The dates reported for each period are the dates of the identified shifts. The values reported are for the differences in means (After minus before) between the two periods. The t-tests are based on Welch's approximation and assume unequal variances. *Significant at the 10% level. **Significant at the 5% level. ***Significant at the 1% level.

Table 8. Hedge/diversification portfolio weights and effectiveness.

Portfolio (hedged/hedging market)	$w_t^{Hedgingmarket}$	$\beta_t^{Hedgedmarket}$	$Variance_{Hedged\ portf.}$	HE
AED3M/Oilf	0.706	−0.001	9.837	0.706
BHD3M/Oilf	0.657	−0.021	8.969	0.671
KWD3M/Oilf	0.459	−0.008	6.363	0.463
OMR3M/Oilf	0.777	0.016	11.017	0.765
QAR3M/Oilf	0.617	0.008	8.672	0.612
SAR3M/Oilf	0.723	−0.017	9.917	0.735
SAIB3M/Oilf	0.133	0.019	1.887	0.130
EIBO3M/Oilf	0.226	0.023	3.228	0.221
Selective Portfolios for SAR and AED				
SAR3M/EUR3M	0.898	−0.004	2.175	0.901
SAIB3M/EUR3M	0.471	0.019	1.167	0.462
SAR3M/USDL3M	0.949	0.007	1.264	0.943
SAIB3M/USDL3M	0.638	0.099	0.922	0.575
SAR3M/Gold	0.635	0.005	8.107	0.632
SAIB3M/Gold	0.148	−0.018	1.843	0.150
SAR3M/MSCI-EM	0.707	−0.033	5.935	0.730
SAIB3M/ MSCI-EM	0.203	−0.029	1.716	0.209
SAR3M/SPX	0.823	−0.022	3.514	0.840
SAIB3M/ SPX	0.334	−0.023	1.429	0.342
AED3M/EUR3M	0.934	0.002	2.273	0.932
EIBO3M/EUR3M	0.628	−0.012	1.510	0.636
AED3M/USDL3M	0.962	0.000	1.273	0.962
EIBO3M/USDL3M	0.793	0.080	1.118	0.730
AED3M/Gold	0.729	0.011	9.361	0.721
EIBO3M/Gold	0.242	0.027	3.166	0.236
AED3M/MSCI-EM	0.797	0.005	6.959	0.792
EIBO3M/ MSCI-EM	0.326	−0.032	2.748	0.337
AED3M/SPX	0.884	−0.001	3.863	0.885
EIBO3M/SPX	0.486	0.018	2.164	0.478

This table shows the results of calculating the weight of the hedging market, the hedge beta, the variance of the hedged portfolio and the hedging effectiveness (all variables are defined in the text). Oilf is the 3 months brent futures. We use DCC-GARCH (1,1) model with AR(1) in the mean equation and a multivariate Student t distribution to estimate the various variables needed to construct the portfolios.

effectiveness (HE) ratio which compares the variance of the hedged portfolio to the unhedged one (Equation (6)). The most interesting observation is that hedging effectiveness is highest when oil is used to hedge OMR, SAR or AED FX swap portfolios. Another important observation is that oil makes up half or more of the hedged portfolios for all GCC FX swaps, except for KWD, suggesting that portfolio managers should aim to hold more than half of their portfolios in oil to maximize their risk/return outcomes. Further, the low weight (less than 30%) for oil in the hedged portfolios of GCC interbank offered rates (SAIB3M and EIBO3M) is not surprising given the higher volatility spillover reported earlier from the oil market to both markets.

The beta hedge ratio ($\beta_t^{HedgedMarket}$) reported in Table 8 calculates how much USD short position (sell) in the hedging market (e.g. oil) is needed to hedge a one USD long position (buy) in the hedged market (e.g. EIBO3M). For instance, in the case of EIBO3M and oil, a one USD long position in EIBO3M can be hedged with a 2.3 cents short position in oil futures. A negative sign for the beta hedge ratio indicates that a one USD long position in the hedged market is hedged by another long position in the hedging market. For example, in the case of SAR3M and oil, a long position in oil futures of USD 1.7 cents is required to hedge a one USD long position in SAR3M. The interpretations for all other observations follow the same logic and therefore we will not discuss them in detail. Nevertheless, it is worth mentioning that other hedging markets mentioned in the lower part of Table 8 such as gold, EUR FX swap and equity indices, appear to have better hedging effectiveness and thus bring more value in terms of risk reduction to portfolios containing GCC FX swaps or interest rate instruments.

6. Conclusion

This study examines the relationship between oil prices, FX swaps, and local interbank offered rates in the six GCC countries. It also assesses the potential hedging and diversification benefits from adding oil to portfolios containing GCC FX swaps or interest rates instruments. Oil and oil-related exports represent the main source of USD liquidity in GCC economies. Oil exports also represent a significant share of GDP and government funding in all GCC countries. Our findings confirm that oil prices predict movements in the various GCC FX swaps and interbank offered rates. Our results also show that similar relationships exist with the SAR FX swap market which is able to predict other GCC FX swaps and interbank rates. We attribute this observation to the important role played by the Saudi economy, and as a result by the SAR FX swap market, in the GCC region.

Our analysis of the volatility spillover index shows the SAR FX swap has the highest interconnectedness with other markets among the GCC FX swap markets. We also find that the SAR FX swap market has the highest spillover from the oil market compared to other markets in the region. Saudi Arabia has been the largest exporter of oil in the world for most of the period covered in our study, which largely explains the high degree of spillover from the oil market to its FX swap market. Further, our analysis of the causal relationships between the various markets covered in our study revealed that oil causes significant movements in the GCC FX swap markets and the two studied GCC interbank rates. Our results also show a significant change in liquidity and market resilience levels in the GCC FX swaps markets following sudden shifts in oil prices.

Finally, we utilize DCC-GARCH models to estimate the parameters needed to measure the potential diversification and hedging benefits from combining oil futures positions with positions in GCC FX swaps or interest rates. Our results show that oil futures positions can reduce the risk profile of portfolios containing one of the GCC FX swaps significantly. Our observations suggest that portfolio managers should aim to hold more than half of their portfolios in oil futures to maximize their risk/return outcomes. However, we also notice that other markets (e.g. gold, EUR FX swap and equity indices) bring more hedging benefits to portfolios containing GCC FX swaps or interest rate instruments.

This study is the first to look at the relationship between oil and the GCC FX swaps and interbank rates. The study contributes to the stream of research focusing on understanding the relationship between oil as a major exporting commodity for the GCC and several GCC markets and economic indicators (Fayyad and Daly 2011; Malik and Hammoudeh 2007; Naifar and Al Dohaiman 2013; Shahzad et al. 2017). The insights from this study help inform various trading and risk management decisions by FX swap and interest rate traders in the GCC market, and they contribute to a better understanding of the dynamics of such instruments. The study confirms the role of oil as an effective hedging instrument in a market where the presence of effective hedging instruments is fairly limited. Future research could delve more deeply into the relationship between oil and GCC FX swaps and interest rate markets during hard and good times. This will enhance our understanding of the hedging benefits suggested in this study. Future research could also examine the impact of using multiple assets (e.g. oil and gold) to hedge GCC FX swap and interest rate positions.

Notes

1. As of the time of writing this study, the Central Bank of Bahrain priced its FX swap facility far from the prevailing market rates with the implicit intention of receiving USD liquidity rather than injecting it through such facility.
2. We discuss the current literature about the relationship between oil and financial markets in the GCC in the literature review below.
3. We focus our analysis on FX swaps and not FX spots because most of the GCC currencies are pegged to the USD and fluctuate within a relatively tight range.
4. As discussed earlier, USD is the second leg in all FX swaps involving GCC currencies.
5. The adjustment is done through dividing the FX swap price by the number of days applicable on that day and then multiplied by 92 days.

6. For instance, a 1 pip increase in the price of FX swap from 1 to 2 pips might sound like a 50% increase, whereas it is a marginal increase in the price of FX swap and implied interest rates especially considering the tenor used in our study (three months).
7. The conclusions are the same using the one-year FX swaps and interbank offered rates.
8. For instance, interbank offered rates are published in Kuwait and Qatar, however no derivatives or commercial activities are indexed against such rates.
9. The results of the study with regards to FX swaps and interbank offered rates remain unchanged when considering observations during the Covid-19 pandemic only. This is likely a result of the liquidity injection and stabilizing efforts by the various central banks.
10. The index was adopted by several similar studies (Awartani, Maghyereh, and Shiab 2013: Maghyereh, Awartani, and Bouri 2016; McMillan and Speight 2010) and is also called the directional connectedness measure. A full explanation of the measure is available from Diebold and Yilmaz (2012, 2015) and Maghyereh, Awartani, and Bouri (2016).
11. Following the convention in the market and the literature we use the highest bid and the lowest ask to calculate the spread.
12. We calculate MEC using a one-month moving average. We use 20 (5) trading days to calculate the one-month (one-week) variance.
13. Following Bai and Perron (2003), we allow up to five breaks and use a 15% trimming, which means that each segment has at least 15% of the data. We also allow error distributions to differ across segments and account for serial correlation using lagged variables. All five breaks are significant at 5%.
14. Full results of the model are available with the authors and can be provided upon request.
15. We arrive at the same conclusion when applying the Lagrange multiplier unit root test with two structural breaks proposed by Lee and Strazicich (2003).
16. The models are run with the individual FX swap market as a dependent variable while all other GCC markets as well as the lagged value of the dependent variable are included as explanatory variables. We use LSDV instead of the generalized method of moments (GMM) because the former provides more consistent estimates in models with large time series and small cross-sectional data (Mensi et al. 2017). The results are available from the authors and can be provided upon request.

Disclosure Statement

No potential conflict of interest was reported by the author(s).

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