Oil Prices and GCC Stock Markets: New Evidence from Smooth Transition Models

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Abstract

Our paper explores two possible sources of asymmetry in stock prices' reactions to oil prices in the Gulf Cooperation Council (GCC) region using nonlinear smooth transition regression (STR) models. Our results reveal little evidence that negative oil price changes exert larger impacts on stock returns than positive oil price changes. However, when considering the asymmetry with respect to the magnitude of oil price variation, we find that stock return sensitivity is significantly higher for large oil price changes than for small ones. Our results highlight the importance of economic stabilization and reform policies that can potentially reduce the sensitivity of stock returns to oil price changes, especially with regard to the existence of a "threshold effect" for a higher oil price change.

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I. INTRODUCTION

Over the last decade, many papers have been investigating the relationships between oil prices and macroeconomic variables. They provide evidence proving that oil price fluctuations exert large impacts on economic activity in developed and emerging economies (see Gronwald, 2008; Cologni and Manera, 2008; or Kilian, 2008). However, less emphasis has been placed on studying the link between oil price movements and stock markets. Furthermore, most of the existing papers have studied stock markets in developed economies, while developing and emerging market countries, including Gulf Cooperation Council (GCC) countries, have remained relatively unexplored. Additionally, most of these studies have relied on linear econometric frameworks for modelling the interactions between oil price shocks and stock markets, and it is now well established that overlooking potential nonlinearity can lead to misleading results (see Balcilar et al., 2015).

There are at least four reasons why studying the GCC region matters. First, these countries are large suppliers of oil for the global economy, so their stock markets may be influenced by oil price movements. Second, GCC markets are segmented from international markets and are very sensitive to regional political events. Third, GCC markets are unique and very promising places for international portfolio diversification. Fourth, only a few studies have investigated the nonlinear relationship between oil prices and stock markets in the GCC region.

Over the last decade, the crude oil market has experienced huge swings, such as the spectacular increase in oil prices in 2007 and early 2008, and the subsequent dramatic decline by the end of 2008. In conjunction with the dramatic change in the financial environment since the eruption of the US subprime crisis, the presence of structural breaks and regime shifts has revived the idea of an asymmetric, nonlinear relationship between oil prices and stock markets. A more rigorous understanding of this relationship will be especially valuable for policymakers in countries that are heavily reliant on oil for their export earnings and fiscal revenues, such as the GCC countries, which are seeking to predict and temper the impact of oil price change on the stock market more effectively. It could also serve to identify the macroeconomic stabilization and reform measures that are key to reducing stock market sensitivity to oil price change(s).

As is well known, the sign of the relationship between oil prices and stock indices depends on whether a country is a net oil-importing or oil-exporting economy.[1] The body of literature finds GCC stock markets and oil prices to be significantly and positively correlated. In a recent paper, Dutta et al. (2017) report a positive, significant relationship between oil prices and realized stock market uncertainties—even after controlling for global stock market uncertainty—for Saudi Arabia, Kuwait, the United Arab Emirates (UAE), and Qatar. Using a VAR-GARCH model, Al-Maadid et al. (2016) also find that GCC stock markets and oil prices are highly and positively correlated. Others have studied volatility spillovers between oil prices and GCC stock markets. Arouri et al. (2011) find/correlate return and volatility spillovers between oil prices and GCC stock markets. Almohaimeed and Harrathi (2013) report a significant volatility spillover between the Saudi stock market and oil prices. Jouini and Harrathi (2014) observe the volatility spillover running from oil market volatility to GCC stock price volatility, and vice versa.

[1] For instance, Park and Ratti (2008) revealed that oil price spikes have negative impacts on stock returns in the US and twelve European countries, whereas stock markets in Norway (an oil-exporting country) respond positively to oil price increases.

More recently, there has been an increasing interest in studying the potential asymmetric effects of oil price shocks on stock returns, although the number of studies is still relatively sparse. The existing empirical literature has paid more attention to the asymmetry arising from the direction of oil price change, in the sense that stock prices respond asymmetrically to oil price decreases and increases (see Park and Ratti, 2008; Sim and Zhou, 2015; Reboredo and Ugolini, 2016; and Mohanty et al., 2011).[2] However, in spite of its policy relevance, little is said about whether oil price shocks are asymmetric in *magnitude*, namely, if the effects of large oil price changes on stock prices could be different from the effects of smaller shocks. Furthermore, ad hoc methods have often been implemented to measure the asymmetric reactions of stock market returns to oil price changes. For instance, in a sample of GCC countries, Mohanty et al. (2011) introduce a dummy variable to capture the asymmetry with respect to oil price decreases and increases. While declines in oil prices negatively impact all GCC stock markets, Mohanty et al. (2011) reveal that oil price increases have mixed effects on stock returns. As linear and ad hoc approaches would potentially lead to counterintuitive, mixed results, we propose the use of a class regime-switching model, where the nonlinear dynamic is generated endogenously from the data.

Our paper aims to shed further light on the presence of asymmetries in the sensitivity levels of GCC stock markets to oil prices. We propose to implement a relevant econometric method that enables us to explore the two possible sources of asymmetry in stock price reactions, namely, one that accounts for both direction and magnitude of oil price change. We use the class of nonlinear smooth transition regression (STR) models, where different regimes can be identified with respect to estimated thresholds. To capture the asymmetry arising from the direction of oil price shock, we use a logistic specification of the STR model (LSTR), which is appropriate for separating oil price into positive and negative changes. However, for capturing asymmetric behavior with respect to the size of oil price's movement, an exponential form of the STR model (ESTR) is more suitable for distinguishing between large and small oil price changes. Our study is conducted for a sample of six GCC countries (Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the UAE), using monthly data over January 2004–December 2015. To the best of our knowledge, no other study has applied a nonlinear STR approach in this context.

To preview our results, when testing for the presence of asymmetry with respect to the direction of oil price change, our results reveal little evidence that negative oil price changes exert larger impacts on stock returns than positive oil price changes. Our LSTR models are not able to distinguish between positive and negative oil price deviations properly. However, when using an ESTR specification to examine the asymmetry relating to the degree of change in oil price, we find that stock return sensitivity is significantly higher for a large oil variation. This result applies to each of two GCC countries, namely, Oman and Qatar.

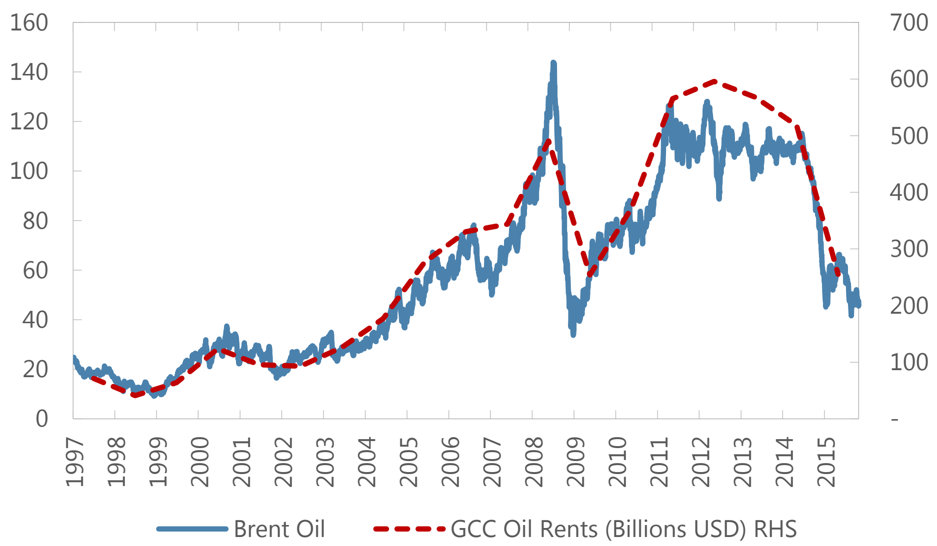
The paper proceeds as follows: Section 2 provides a short overview of GCC stock markets and discusses the role of oil in what?. Section 3 presents the data and their statistical properties, while section 4 describes the econometric methodology. Section 5 is devoted to the empirical results, and Section 6 discusses some policy implications for the GCC region. Finally, Section 7 offers some concluding remarks.

[2] It is worth highlighting that a great deal of literature has studied the asymmetric effects of oil price shocks on economic activity (see Mork, 1989; Hamilton, 1996; and Sadorsky, 1999).

II. GCC STOCK MARKETS AND OIL PRICES

The GCC region holds 30 percent of the world's crude oil proven reserves, and represented roughly 34 percent of world oil exports in 2016.[3] Although GCC countries share similar economic and political characteristics, Bahrain, for example, is less reliant on oil than Saudi Arabia and Kuwait. Oil rents (the difference between the price of crude oil production and total cost of production) range from 2.6 percent of GDP for Bahrain to 38.5 percent of GDP for Kuwait, totaling $255 billion in oil rents for the region (18.3 percent of GDP) in 2015 (see Figure 1). Petrodollar accumulation, with the oil price nearly tripling from $50 in early 2007 to $147 before the global financial crisis (GFC), began to take hold in late 2008. This situation, along with the global investment of their sovereign wealth funds, and important economic reforms, such as financial liberalization, has given GCC countries greater exposure to international markets.

Figure 1. Brent Oil Prices vs. GCC Oil Rents

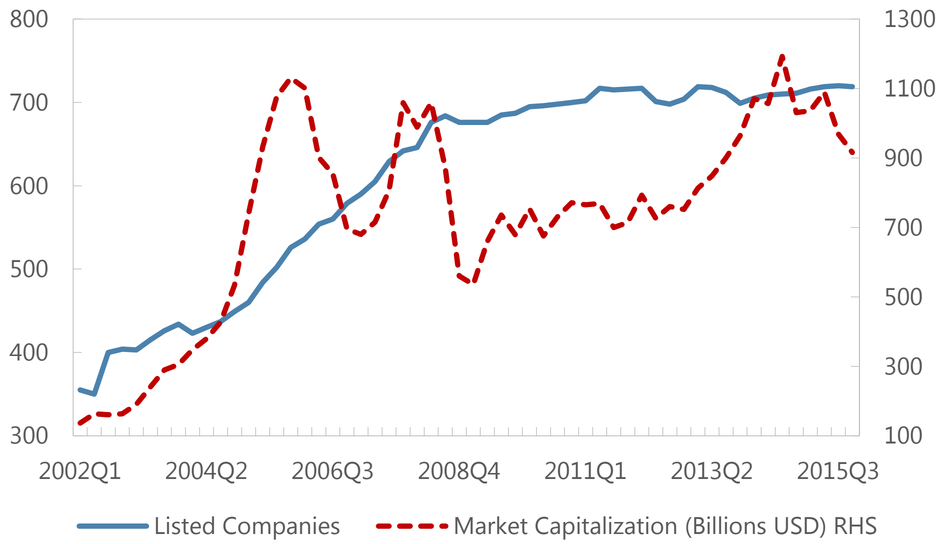


Source: Data are obtained from the EIA and the World Bank.

The first formal stock market in the GCC region was the Kuwait Stock Exchange, established in 1977. Saudi Arabia, Oman, and Bahrain followed in the 1980s, and Qatar followed in the 1990s. The UAE brought the total number of stock exchanges in the GCC region to seven, with the opening of both the Dubai Financial Market and the Abu Dhabi Securities Exchange in 2000. In more recent years, GCC countries have loosened restrictions for foreign investors and implemented a wide range of legal, regulatory, and supervisory changes to strengthen market transparency. This financial liberalization has contributed to the further development of formal stock markets in the region. Figure 2 shows the rapid increase of listed companies from 2002 to 2015.

[3] Data for crude oil proven reserves are from the US Energy Information Administration (EIA). Crude oil export statistics are from The World Factbook.

Figure 2. GCC Stock Market: Listed Companies and Market Capitalization



Source: Arab Monetary Fund.

The total market capitalization the of GCC stock markets was $916 billion in Q4 2015, an almost sevenfold increase from $137 billion in Q1 2002 (see Table 1). Saudi Arabia's stock market, the largest in the region, accounts for 46 percent of stock market capitalization in the GCC. The smallest stock market in the region is Bahrain's. In terms of number of listed companies, Kuwait has the largest number with 216, followed by Saudi Arabia (172), and then Oman (131).

Table 1. GCC Markets in 2015

	Listed companies	Market capitalization (USD Millions)	GDP (USD Millions)	Market cap./GDP
Bahrain	46	19.093	31.126	0.61
Kuwait	216	87.767	114.041	0.77
Oman	131	40.984	69.831	0.59
Qatar	42	151.892	164.641	0.92
Saudi Arabia	172	420.656	646.002	0.65
UAE	127	195.776	370.296	0.53

Notes: All figures were obtained from the Arab Monetary Fund and the World Bank.

III. Data and Their Properties

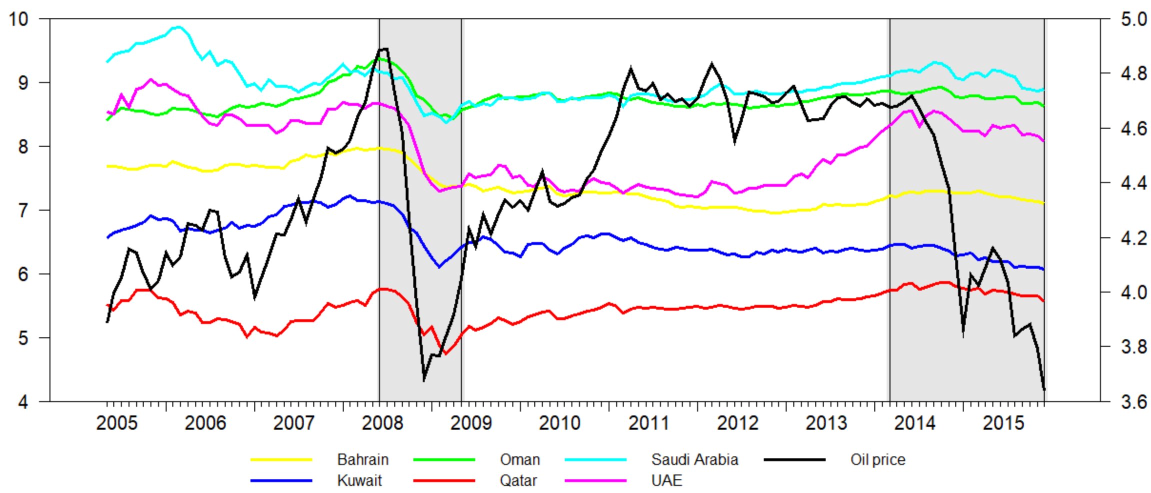
A. Data Description

This study examines the presence of asymmetries in the effects of oil price fluctuations on stock returns for the six GCC countries: Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the UAE. We select monthly data spanning the period of January 2004–December 2015, except for Kuwait, where data are only available starting from May 2005.

As for oil data, we use the monthly Brent spot prices to represent the international crude oil market. Oil prices are denominated in US dollars and available from the US Energy Information Administration (EIA). We compute oil returns using the first logarithmic difference of oil prices, or_t.[4] The stock market data are national stock price indices for the six GCC countries, expressed in US dollars, gathered from the Morgan Stanley Capital International (MSCI) database.[5] We use monthly returns, defined as the first logarithmic differences of monthly stock price indices sr_t. In addition, we include the monthly MSCI World Index returns, wr_t, and the US three-month treasury bill (T-bill) interest rate, i_t^{us}, as control variables for the empirical relationship between oil prices and stock markets.[6] These financial data are obtained from the MSCI database.

In comparison to previous studies (see Arouri and Rault, 2012; Akoum et al., 2012; and Mohanty et al., 2011), our sample period is, to some extent, shorter, but more recent, which allows us to cover some major events, such as the spectacular increase in oil prices throughout 2007 and early 2008, as well as the dramatic change in the financial environment since the eruption of the subprime crisis in the summer of 2007. Also, as reported in Figure 3, after nearly five years of stability from 2010 until mid-2014, the Brent crude oil has fallen to its lowest level in 10 years. The time series plots of our six stock price indices reveal that the oil-boom-bust cycle of 2007–2009compounded by the spillover of the subprime crisis— has strongly impacted the GCC stock market. Significantly, the log levels of GCC stocks and Brent oil prices plotted in Figure 3 show common trending behaviors, which may be indicative of some interdependence between all markets. Over the same period, the stock market indices in GCC countries continue to increase (decrease) as the oil price continues to rise (fall).

Figure 3. GCC Stock Market Indicesand Brent Oil Prices over the Last Decade



Source: Data are obtained from the EIA and MSCI database.

[4] To check robustness, we employed other crude oil benchmarks, i.e., West Texas Intermediate (WTI) and OPEC spot prices. This did not significantly alter the results of our benchmark specifications.

[5] Stock price series are expressed in US dollars to gauge their homogeneous features consistently, and to avoid the impact of currency risks on empirical results.

[6] The MSCI World Index and the US three-month treasury bill interest rate are among the global factors that strongly influence GCC stock markets. Since GCC global investors are considering both local and world markets, GCC stock markets can be affected by World Index fluctuations. We used the US interest rate here as a proxy for the GCC interest rate, since GCC monetary policies follow US monetary policy, due to the links between their national currencies and the US dollar.

Table 2 presents some summary statistics on stock market indices and oil returns over 2004–2014. For example, monthly average returns on Bahrain's and Kuwait's national stock markets are negative in? throughout? our sample, which may indicate the effect of the oil price decline in late 2008, as well as that of the recent 2007–2009 GFC. For the rest of our GCC countries, we document positive average stock returns, with the UAE market showing the best performance (0.81 percent). Only Qatar's and the UAE's stock markets have performed better than the global equity market proxied by MSCI World Index (0.65 percent). At the same time, Qatari and Emirati markets are shown to have recorded the highest variabilities as measured by the standard deviation. Table 2 also reveals a positive average return of 0.13 percent for the Brent oil prices, and a higher volatility, which may be due to the last decade's boom-bust in oil prices.

Table 2. Descriptive Statistics for Stock and Crude Market Returns

	Mean (%)	**Min. (%)**	**Max. (%)**	**Std. Dev.**
Stock prices				
Bahrain	-0.04	-12.15	10.35	0.04
Kuwait	-0.39	-21.12	19.08	0.07
Oman	0.50	-25.76	15.93	0.05
Qatar	0.68	-28.83	39.61	0.09
Saudi Arabia	0.36	-25.38	18.02	0.08
UAE	0.81	-38.66	35.61	0.11
Brent oil prices	0.13	-31.10	19.60	0.09
MSCI World Index	0.65	-32.16	15.41	0.07

Note: Data are monthly returns on stock market indices and oil prices using first log differences of monthly series. Data are obtained from the EIA and MSCI database.

We also compute the pairwise return correlations for all pairs of indexes in our sample, as reported in Table 3. Of the six GCC countries, the highest positive correlation is found between Qatar and UAE stock indices (0.63). The lowest correlation coefficient in the stock market indices is observed between Bahrain and Kuwait (0.29). We note that the country pairs Bahrain/Qatar, Oman/Qatar, and Oman/UAE each exhibit the same positive correlation coefficient of 0.55. This is not surprising, as the major GCC stock markets were engaged in several financial liberalization reforms in the 1990s. Regarding the dependence between national stock indices and the MSCI global index, the relationships are positive and vary from 0.04 (Bahrain/world) to 0.45 (Kuwait/world). For the Brent oil index, very similar comovements are observed with the national stock indexes across most of the GCC countries. Each correlation coefficient is close to 0.40, except for Bahrain (0.18), suggesting that GCC stock markets move jointly with oil prices. Nevertheless, the positive correlations among national stock markets are still higher than those between equity returns and oil markets, indicating that GCC stock markets exhibit a significant degree of integration with one another. Finally, the US three-month treasury bill's interest rate, as a global factor, seems to influence GCC stock markets weakly. The same positive relationship is found in each country across the GCC region, but does not exceed 0.16 as a correlation coefficient.

Table 3. Cross-Correlation Coefficients Among Stock Markets and Oil Returns

	Bahrain	Kuwait	Oman	Qatar	Saudi Arabia	UAE	Brent oil	MSCI Index	US T-bill
Bahrain	1.00								
Kuwait	0.29	1.00							
Oman	0.58	0.36	1.00						
Qatar	0.55	0.32	0.55	1.00					
Saudi Arabia	0.41	0.24	0.49	0.52	1.00				
UAE	0.59	0.31	0.55	0.63	0.57	1.00			
Brent oil	0.18	0.35	0.40	0.35	0.37	0.36	1.00		
MSCI Index	0.04	0.45	0.21	0.13	0.13	0.09	0.38	1.00	
US T-bill	0.02	0.16	0.05	0.10	0.08	0.08	0.18	0.23	1.00

Note: The table reports correlation coefficients for six GCC stock returns (Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the UAE), the MSCI global return, and the Brent crude oil return. The sample period is between January 2004 and December 2015, except for Kuwait, where data are only available starting from May 2005.

B. Unit Root Tests

We examine the properties of our key variables by checking stationarity. We test for the presence of unit roots in the levels (price series in logarithm) and first differences (return series) of oil and stock market price indices.[7] We perform the DF-GLS test, proposed by Elliott et al. (1996), which is an augmented Dickey-Fuller test, where the time series is transformed via a generalized least squares (GLS) regression before performing the test. Elliott et al. (1996) have shown that this test has significantly greater power than the previous versions of the augmented Dickey-Fuller approach. Since our study period covers episodes of high fluctuations in oil and stock markets, structural change would occur in the oil and stock return series. Thus, a DF-GLS unit root test might not be powerful in the presence of a structural break in the considered series. To check whether our unit root test results are robust to the presence of potential structural breaks, we implement Zivot and Andrews's (1992) ZA test henceforth, and Lumsdaine and Papell's (1997) LP test henceforth, these being unit root tests that allow for possible breaks in series.[8] In constructing the unit root tests, the level variables were tested in the presence of both an intercept and a trend. The subsequent tests of first differences each included only an intercept, given the lack of trending behavior in the first difference series.

Summary results of these statistical tests for both price and return series are reported in Table 4. Our findings show that the null hypothesis of a unit root cannot be rejected for all variables across levels, except for the US three-month treasury bill, when using DF-GLS unit root tests. In fact, there was a dramatic fall in US interest rates following the recent financial crisis, which may indicate the presence of structural changes in the data. Thus, when using ZA and LP unit root tests, the US three-month treasury bill series are found to be nonstationary. For variables in first log differences, all unit root tests suggest that the null hypothesis of nonstationarity should be rejected.

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[7] Interest rates are in percentages; thus, the logarithm is defined as $log(1 + r/100)$.

[8] In the Zivot and Andrews (1992) and Lumsdaine and Papell (1997) unit root tests, break dates are endogenously determined within the models. Zivot and Andrews's (1992) unit root test allows for one single break under the alternative hypothesis. Lumsdaine and Papell's (1997) test is the extension of the Zivot and Andrews (1992) model, allowing for two structural breaks under the alternative hypothesis.

Table 4. Unit Root Tests

	DF-GLS test		ZA test		LP test	
	level	1st diff.	level	1st diff.	level	1st diff.
Stock prices						
Bahrain	-4.290	-6.299***	-4.290	-6.299***	-5.469	-6.662**
Kuwait	-4.697	-6.031***	-4.697	-6.031***	-5.508	-6.560**
Oman	-3.802	-5.701***	-3.802	-5.701***	-4.555	-5.927*
Qatar	-4.061	-9.801***	-4.061	-9.801***	-4.208	-10.125***
Saudi Arabia	-3.584	-11.074***	-3.584	-11.074***	-4.502	-11.580***
UAE	-4.518	-6.694***	-4.518	-6.694***	-5.067	-6.980***
Brent oil prices	-1.501	-5.607***	-1.761	-6.582***	-2.645	-6.681*
MSCI World Index	-1.866	-4.226***	-3.167	-10.958***	-3.614	-11.172**
US T-bill	-2.043**	-5.302***	-3.623	-7.292***	-5.165	-8.114**

Note: DF-GLS, ZA (Zivot and Andrews, 1992), and LP (Lumsdaine and Papell, 1997) tests are performed using log prices and return series. *, **, and *** denote rejection of the null hypothesis at the 10%, 5%, and 1% levels, respectively. The ZA test allows for one single break under the alternative hypothesis. The LP test allows for two structural breaks under the alternative hypothesis. Lag selection: Akaike (AIC). Maximum lag number = 8.

IV. EMPIRICAL METHODOLOGY

A. Econometric Model

Several studies suggest the presence of nonlinear linkages between oil and economic activity (see Mork, 1989 and Hamilton, 1996). Oil price increases are found to be much more influential than oil price decreases, indicating an asymmetric relationship between oil price and output level. More recently, a number of papers have examined the potential asymmetric relationships between crude oil market and other asset prices, such as stock prices or stock returns. For example, Bittlingmayer (2005) found that oil price changes stemming from war risks, and those related to other causes, exhibit asymmetric effects on stock price dynamics.

In fact, ignoring nonlinearity can lead to problematic results. Balcilar et al. (2015) argue that a linear framework would lead to mixed results, with an unexpected positive relationship between US crude oil and stock market prices. The authors have considered the asymmetric effects of positive and negative oil price shocks on stock returns by using Granger and Yoon’s (2002) concept of hidden cointegration. Balcilar et al. (2015) provide strong evidence of asymmetry, with negative oil price shock exerting a positive larger effect. However, the result is counterintuitive for positive oil shocks, since they do not reduce stock prices. Moreover, some ad hoc methods have been implemented to differentiate between stock market responses to oil price increases and stock market responses to falling oil prices. For example, in a given/particular sample of GCC countries, Mohanty et al. (2011) introduce a dummy variable to capture the asymmetry with respect to oil price decrease and increase. The dummy variable takes the value of unity if the change in the oil price is positive and zero otherwise. While declines in oil prices negatively impact all GCC stock markets, Mohanty et al. (2011) reveal that oil price increases have mixed effects on stock returns.

In this paper, we adopt a different econometric approach, based on the implementation of regime-switching models, where it is possible to model two sources of asymmetry. On the one hand, we analyze the asymmetric effects of positive and negative oil price variations on stock returns. On the other hand, we check whether large shocks have more pronounced effects than small ones. We use a class of nonlinear regime-switching models, namely, STR models.[9] The STR model takes the following general form:

$$y_t = \theta_1 x_t + \theta_2 x_t G(s_t; \gamma, c) + u_t, \qquad (1),$$

where $u_t \sim \text{iid}(0, \sigma^2)$, and θ_1 and θ_2 are linear and nonlinear coefficients, respectively. $G(s_t; \gamma, c)$ is the transition function that controls the nonlinear dynamic of the STR model. $G(s_t; \gamma, c)$ is a continuous function bounded between 0 and 1, depending on the value of the transition variable, s_t; the speed of transition across regimes, γ; and the threshold level (or location parameter), c. A popular choice for the transition function is the logistic specification that is given by

$$G(s_t; \gamma, c) = [1 + exp\{-\gamma(s_t - c)\}]^{-1} \qquad (2).$$

Under the logistic transition function, equation (1) corresponds to the LSTR model. The implied nonlinear dynamics in the LSTR specification depends on whether the transition variable is below or above the level of threshold c. In other words, the parameters of the model change monotonically from θ_1 to $(\theta_1 + \theta_2)$ as s_t increases. Indeed, if $(s_t - c) \to -\infty$, and $G(s_t; \gamma, c) \to 0$, the model's coefficient corresponds to θ_1. If $(s_t - c) \to +\infty$. If $G(s_t; \gamma, c) \to 1$, the coefficient becomes $(\theta_1 + \theta_2)$. Finally, if $s_t = c$, and $G(s_t; \gamma, c) = 0.5$, the coefficient will be equal to $(\theta_1 + \theta_2/2)$.

Another popular choice of the transition function, which is often used in the literature, is the exponential specification

$$G(s_t; \gamma, c) = 1 - exp\{-\gamma(s_t - c)^2\} \qquad (3),$$

where the pattern formed jointly by equations (1) and (3) is called the ESTR model. The implied nonlinear dynamics are drastically different under exponential and logistic functions. In the ESTR model, the dynamic is symmetric with respect to negative or positive deviations of s_t from the threshold level. The exponential form is appropriate in situations where the dynamic behavior is different for large and small values of s_t. What matters is the magnitude or the size of shock, i.e., whether it is large or small. Thus, the parameters of the model change depend on whether s_t is close to, or far away from, the threshold, c, regardless of whether the difference $(s_t - c)$ is positive or negative. As $(s_t - c) \to \pm\infty$, if the exponential transition function is $G(s_t; \gamma, c) \to 1$, the model coefficients will be equal to $(\theta_1 + \theta_2)$. If $s_t = c$, then $G(s_t; \gamma, c) \to 0$, and the coefficients will correspond to θ_1.

Since LSTR and ESTR models allow for different nonlinear behaviors, we must be careful when implementing these specifications in our analyses of oil price changes' impacts on stock returns. The use of LSTR would be appropriate in accounting for asymmetry with respect to the direction of oil price change, i.e., the asymmetry between negative or positive oil shocks, especially when the threshold value is close to zero $c \simeq 0$.[10] (On the other hand,) the/The exponential form would be more useful in capturing asymmetry with respect to the magnitude of oil price change, i.e., whether an oil shock is small or large.

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[9] The univariate case of the STR model is known as the smooth transition autoregressive (STAR) model (see Teräsvirta, 1994).

[10] LSTR models have frequently been implemented for modelling business cycles. By considering an indicator of economic activity as a transition variable, the logistic model enables us to distinguish between periods of positive and negative economic growth, i.e., between expansions and contractions (see van Dijk et al., 2002).

B. Empirical Specification

In our study, we consider the following nonlinear STR model in order to investigate the asymmetric effects of oil price changes on stock markets:

$$sr_t = \alpha + \sum_{j=1}^{N} \lambda_j sr_{t-j} + \sum_{j=0}^{N} \psi_j wr_{t-j} + \sum_{j=0}^{N} \delta_j i_{t-j}^{us} + \sum_{j=0}^{N} \beta_j or_{t-j} + \left(\sum_{j=0}^{N} \phi_j or_{t-j}\right) G(s_t; \gamma, c) + \varepsilon_t, \qquad (4),$$

where oil return is used as a transition variable, $s_t = or_{t-j}$. All variables included in equation (4) are return series and, as discussed above, are stationary in first differences.[11] According to equation (4), the long-run impact of oil price change is given by the following time-varying coefficients: $\left[\sum_{j=0}^{N} \beta_j + \sum_{j=0}^{N} \phi_j\, G(s_t; \gamma, c)\right] / \left[1 - \sum_{j=1}^{N} \lambda_j\right]$.[12]

As we experiment with both transition functions, $G(s_t; \gamma, c)$ would take the form of a logistic or exponential function. For the LSTR specifications, the effects of oil prices on stock markets would take different values depending on whether the transition variable or_{t-j} is below or above the threshold of $c \simeq 0$. If $\left(or_{t-j} - c\right) \to -\infty$ (for a negative oil shock), the impact on stock price corresponds to $\sum_{j=0}^{N} \beta_j / \left(1 - \sum_{j=1}^{N} \lambda_j\right)$. If $\left(or_{t-j} - c\right) \to +\infty$ (for a positive oil shock), oil effect becomes $\left(\sum_{j=0}^{N} \beta_j + \sum_{j=0}^{N} \phi_j\right) / \left(1 - \sum_{j=1}^{N} \lambda_j\right)$. In the case of the ESTR model, oil price change's impact depends on whether or_{t-j} is close to, or far away from, the threshold c, regardless of whether the difference $\left(or_{t-j} - c\right)$ is positive or negative. Therefore, if $\left(or_{t-j} - c\right) \to \pm\infty$ (for a large oil shock), the effect on the stock market will be equal to $\left(\sum_{j=0}^{N} \beta_j + \sum_{j=0}^{N} \phi_j\right) / \left(1 - \sum_{j=1}^{N} \lambda_j\right)$. If $or_{t-j} = c$ (for a small oil shock), oil price's impact will become $\sum_{j=0}^{N} \beta_j / \left(1 - \sum_{j=1}^{N} \lambda_j\right)$.

As a first step in the modelling strategy, using the STR model, we test for nonlinearity to select the appropriate lagged oil return as a threshold variable, and the most suitable form of the transition function, namely, the logistic or exponential specification. The linearity tests are conducted for each lagged oil return, or_{t-j}, with $j = 1, \cdots, 6$. Next, the parameters of our STR equation (4) are estimated using the nonlinear least squares (NLS) estimation technique, which provides estimators that are consistent and asymptotically normal. As a final step, we check the quality of our estimated model using some misspecification tests. Of the most frequently used tests in the STR literature, we implement the Lagrange Multiplier (LM) test of

[11] As variables in levels are integrated of order one, we have tested for the presence of a possible long-run relationship. We have implemented Gregory and Hansen's (1996) cointegration test, which explicitly incorporates a break in the cointegrating relationship. Our results reveal that a long-run cointegrating relationship exists only for Saudi Arabia. However, this finding is not robust to a modification of the significance level considered. Results from Gregory and Hansen's (1996) cointegration tests are not reported here in order to save space, but are available upon request. Note that the first differences variables (return series) are considered here when estimating the impacts of oil prices on stock prices for all GCC countries, as in equation (4).

[12] Following van Dijk et al. (2002), the lag lengths of the variables entering equation (4) are determined by adopting a general-to-specific approach to select the final specifications. We start with a model with a maximum lag length of $N = 6$, and then sequentially drop the lagged variables for which the t-statistic of the corresponding parameter is less than 1.0 in absolute value.

no error autocorrelation, an LM-type test of no ARCH, the LM test of no remaining nonlinearity, and an LM-type test of parameter constancy.[13]

V. Empirical results

Over the last decade, oil prices and stock prices have been very volatile following the GFC. These have revived the idea of the presence of a nonlinear relationship between oil and stock prices. In this paper, we investigate the presence of asymmetric behaviors in the impacts of oil prices on GCC stock markets. We pretend that a nonlinear model should be more appropriate to account for structural instability, and to capture the existence of potential asymmetry. As discussed above, there are two types of asymmetry that can be modeled using nonlinear STR models. On the one hand, asymmetry may arise with respect to a shift in the direction of oil price change (difference between negative and positive oil shocks). On the other hand, there is a second type of asymmetry related to the magnitudesof oil prices shocks (whether oil prices changes are small or large) that does what?.

Following the modeling strategy of Teräsvirta (1994, 1998), we begin by conducting linearity tests to select the appropriate lagged transition variable, or_{t-j}. Also, no remaining nonlinearity tests are conducted after the estimation of our choice of transition variable. The transition variables to be selected should provide the strongest rejection of both the null of linearity (against the STR alternative), and of no additive nonlinearity after the estimation of the nonlinear model. As reported in Table 5, linearity tests reveal strong evidence for the presence of nonlinearity in our six GCC countries, except for the UAE. Accordingly, there is potential asymmetry in the transmission of oil price changes to stock markets. Once linearity has been rejected, the next step is to employ the sequence of the null hypotheses for selecting the relevant transition function, (logistic or exponential). In Table 5, the best specifications in terms of rejection of linearity, and of no additive nonlinearity, are indicated in bold.

As discussed in the STR literature, the increases in computational power have made the decision rule—based on testing a sequence of nested null hypotheses—less important in practice (Van Dijk et al., 2002). Therefore, it would be more convenient to estimate both LSTR and ESTR models, and choose between them at the evaluation stage through/by implementing misspecification tests. In addition, economic intuition must be considered in selecting the adequate transition function. In our study, we aim to explore the two possible sources of asymmetry with respect to both the direction and magnitude of oil price shocks. Then, we estimate both LSTAR and ESTAR models for each of our GCC countries. This is a sensible way to check what kind of asymmetry really drives the impact of oil price on the stock market. In each case, the best specification is selected with respect to the misspecification test, (no error autocorrelation, no conditional heteroscedasticity, parameter constancy, and no remaining nonlinearity).

[13] See Eitrheim and Teräsvirta (1996) for a detailed discussion of misspecification tests.

Table 5. Linearity Tests

Country	Transition variable	H_0	H_{04}	H_{03}	H_{02}	Specification
Bahrain	or_{t-1}	0.035	0.142	0.399	0.006	LSTR
	or_{t-2}	0.576	0.985	0.205	0.014	Linear
	or_{t-3}	0.377	0.926	0.237	0.005	Linear
	or_{t-4}	0.012	0.054	0.639	0.001	LSTR
	or_{t-5}	0.581	0.935	0.313	0.035	Linear
	$\boldsymbol{or_{t-6}}$	**0.000**	**0.003**	**0.015**	**0.065**	**LSTR**
Kuwait	or_{t-1}	0.226	0.316	0.125	0.651	Linear
	or_{t-2}	0.020	0.328	0.029	0.006	LSTR
	or_{t-3}	0.477	0.457	0.684	0.220	Linear
	$\boldsymbol{or_{t-4}}$	**0.005**	**0.051**	**0.057**	**0.023**	**LSTR**
	or_{t-5}	0.186	0.245	0.700	0.041	Linear
	or_{t-6}	0.063	0.220	0.024	0.486	Linear
Oman	$\boldsymbol{or_{t-1}}$	**0.003**	**0.251**	**0.002**	**0.025**	**ESTR**
	or_{t-2}	0.346	0.887	0.684	0.001	Linear
	or_{t-3}	0.010	0.083	0.020	0.225	ESTR
	or_{t-4}	0.011	0.203	0.006	0.164	ESTR
	or_{t-5}	0.062	0.285	0.007	0.756	Linear
	or_{t-6}	0.024	0.056	0.080	0.382	LSTR
Qatar	or_{t-1}	0.115	0.155	0.143	0.562	Linear
	or_{t-2}	0.001	0.025	0.016	0.024	ESTR
	or_{t-3}	0.001	0.241	0.000	0.039	ESTR
	$\boldsymbol{or_{t-4}}$	**0.000**	**0.287**	**0.005**	**0.000**	**LSTR**
	or_{t-5}	0.004	0.122	0.151	0.001	LSTR
	or_{t-6}	0.096	0.585	0.171	0.008	LSTR
Saudi Arabia	or_{t-1}	0.197	0.629	0.378	0.011	Linear
	or_{t-2}	0.037	0.157	0.030	0.394	ESTR
	or_{t-3}	0.033	0.378	0.001	0.613	ESTR
	or_{t-4}	0.029	0.185	0.039	0.154	ESTR
	or_{t-5}	0.033	0.231	0.007	0.504	ESTR
	$\boldsymbol{or_{t-6}}$	**0.001**	**0.004**	**0.143**	**0.040**	**LSTR**
UAE	or_{t-1}	0.778	0.521	0.992	0.212	Linear
	or_{t-2}	0.443	0.522	0.242	0.580	Linear
	or_{t-3}	0.275	0.153	0.742	0.414	Linear
	or_{t-4}	0.780	0.833	0.383	0.585	Linear
	or_{t-5}	0.460	0.329	0.591	0.597	Linear
	or_{t-6}	0.334	0.214	0.384	0.851	Linear

Note: Numbers are p-values of F-versions of the LM linearity tests. Third column shows the test of linearity against the alternative of STR nonlinearity. From the forth column until the sixth, we report the p-values of the sequential tests for choosing the adequate transition function. The decision rule is the following: If the test of H_{03} yields the strongest rejection of the null hypothesis, we choose the ESTR specification. Otherwise, we select the LSTR model. The last column gives the selected model.

A. Asymmetry Between Positive and Negative Oil Price Changes

We begin by investigating whether stock returns in GCC countries respond asymmetrically to oil price decreases and increases. To capture the asymmetry arising from the direction of oil price shock, we implement the LSTR specification, which is appropriate for separating oil price into positive and negative changes. We expect negative oil price changes to have larger impacts on stock returns than their positive counterparts (Sim and Zhou, 2015 and Mohanty et al., 2011). This is valid for oil-exporting countries. The higher sensitivity of stock returns to negative oil shocks can be explained by the lower corporate earnings caused by the decline in industrial production activity.

The NLS estimates of our LSTR equations? are reported in Table 6. We indicate a coefficient for each of the two extremes regimes, i.e., for negative oil shock when $G(s_t;\gamma.c) = 0$, and for positive oil shock when $G(s_t;\gamma.c) = 1$. Full results from all STR models are presented in Table A1 and Table A2 in the Appendix.[14] We compute the sum of the squared residual ratio SSR_{ratio} between the LSTR model and the linear specification, which provides a better fit for the nonlinear model. We also check the quality of the estimated LSTR models by conducting several misspecification tests. In most cases, the selected LSTR models pass the main diagnostic tests (no error autocorrelation, no conditional heteroscedasticity, parameter constancy, and no remaining nonlinearity).[15] In Table 6, we provide results only for countries where the linearity is rejected, namely, all GCC countries, except the UAE.

The results related to the asymmetries between the impacts of oil price increases and decreases on stock returns in GCC countries are summarized as follows: According to Table 6, the estimated threshold values of oil returns are highly significant for all GCC countries, except Saudi Arabia. Also, they are quite similar for the pairs Bahrain/Kuwait (threshold of around $c \simeq -0.10$) and Oman/Qatar (threshold of around $c \simeq 0.10$).

Regarding the estimated long-run effects of oil price changes, we find that stock return responses are not statistically significant in Bahrain and Saudi Arabia across the two regimes, (for negative and positive oil price changes). Moreover, Table 6 shows/reveals that negative (or small positive) oil price changes have significant effects on the stock market returns of Kuwait, Oman, and Qatar. For instance, when an oil variation is below the threshold of 9 percent ($c \simeq 0.09$), the response of Qatar's stock return to a 1 percent oil change is equal to 0.42 percent. For Oman, stock return increases by 0.59 percent for a negative or small oil price deviation, being below the threshold of 10 percent ($c \simeq 0.10$). For Kuwait, when the oil return decreases by over 10 percent ($c = -0.10$), the response of the stock return, following a 1 percent oil price change, is equal to 0.66 percent.

[14] Lags on MSCI World Index returns and US three-month T-bills are found to be statistically insignificant across different estimated models. Hence, we retain only contemporaneous coefficients on MSCI index returns and the three-month T-bill in the selection of our final specification.
[15] The best selected specifications in Table 6 and Table 7 are, to some extent, different from those indicated by the sequential linearity tests in Table 5. As explained above, at this stage of estimation, the best specification is selected with respect to the misspecification test (no error autocorrelation, no conditional heteroscedasticity, parameter constancy, and no remaining nonlinearity).

Table 6. Estimated Impacts of Oil Returns on GCC Stock Markets Using LSTR Specifications

	Bahrain	Kuwait	Oman	Qatar	Saudi Arabia
Transition variable (s_t)	or_{t-4}	or_{t-4}	or_{t-6}	or_{t-6}	or_{t-3}
Threshold ($\boldsymbol{c}$)	-0.095***	-0.100***	0.099***	0.091***	0.040
	(0.019)	(0.012)	(0.019)	(0.011)	(0.034)
Speed of transition ($\boldsymbol{\gamma}$)	6.766	8.654	7.341	14.052	4.032
	(7.401)	(13.941)	(5.747)	(16.130)	(4.492)
Negative oil changes: $G(s_t;\gamma.c)=0$					
Long-run effect	0.116	0.663***	0.587***	0.419***	0.418
	(0.406)	(0.161)	(0.166)	(0.132)	(0.286)
Positive oil changes: $G(s_t;\gamma.c)=1$					
Long-run effect	-0.108	0.330**	0.133	0.220	0.178
	(0.168)	(0.159)	(0.361)	(0.509)	(0.484)
R^2	0.464	0.422	0.402	0.444	0.458
SSR_{ratio}	0.715	0.700	0.693	0.683	0.716
$pLM_{AR(6)}$	0.488	0.654	0.351	0.937	0.923
$pLM_{ARCH(6)}$	0.539	0.805	0.984	0.358	0.007
pLM_C	0.547	0.276	0.387	0.343	0.295
pLM_{RNC}	0.397	0.237	0.339	0.268	0.226

Note: Table reports the impacts of oil price changes on GCC stock returns over 2004–2015. Results are obtained from the STR equation (4) using the LSTR. Numbers in parentheses are the standard errors. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. R^2 denotes the coefficient of determination. SSR_{ratio} is the ratio of the sum of squared residuals between the LSTR model and the linear specification. The following rows correspond to the misspecification tests: $pLM_{AR(6)}$ is the p-value of the LM test of no error autocorrelation up to the sixth order. $pLM_{ARCH(6)}$ is the p-value of the LM test of no ARCH effects up to the sixth order. pLM_C is the p-value of the LM test of parameter constancy, and pLM_{RNC} is the p-value of the LM test of no remaining nonlinearity.

It is important to note that, in our sample of GCC countries, only Kuwait shows a significant reaction to stock price (about 0.33 percent), when oil price change is above the estimated threshold, such as, when oil shock is positive (or slightly negative, with a decrease of less than 10 percent). According to Table 6, Kuwait's stock market exposures to oil price changes are significantly unequal across the two regimes. On the contrary, for Oman and Qatar, when the oil price changes are higher than the estimated thresholds, the responses of stock price returns are weak and insignificant. Only Kuwait confirms that the impact of oil price variation is somewhat asymmetric, with negative price changes having more pronounced effects than positive (small negative) price changes.

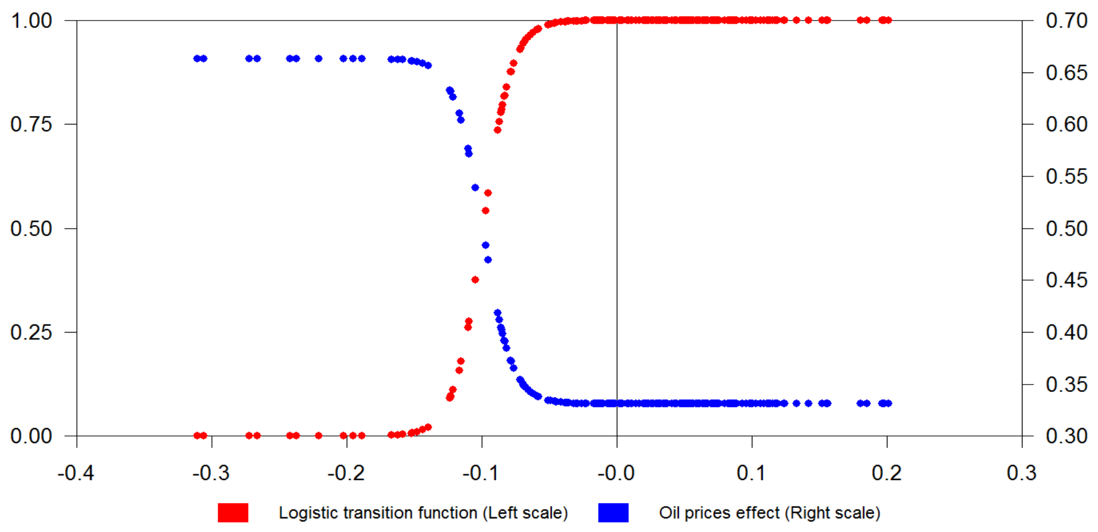
To clarify the picture in Kuwait's case, we have plotted both the estimated logistic functions and the stock return responses as functions of the lagged oil returns ($s_t = or_{t-j}$) in Figure 4.[16]

The plotted logistic transition function is an increasing function of the transition variable, $s_t = or_{t-j}$, and is obtained using the estimated value of $\hat{c}$ and $\hat{\gamma}$ as $G\left(or_{t-j};\hat{\gamma},\hat{c}\right) = \left[1+exp\left\{-\hat{\gamma}(or_{t-j}-\hat{c})\right\}\right]^{-1}$. Similarly, the stock return response depends on the value taken by $s_t = or_{t-j}$, and is calculated using the formula for the long-run impact of oil return:

[16] Plots for Bahrain, Oman, and Qatar are not displayed because long-run coefficients are not significant for positive oil price deviations.

$\left[\sum_{j=0}^{N} \beta_j + \sum_{j=0}^{N} \phi_j \, G\left(or_{t-j}; \hat{\gamma}, \hat{c}\right)\right] / \left[1 - \sum_{j=1}^{N} \lambda_j\right]$. As shown in Figure 4, it is clear that the transition between both extreme regimes, $G(s_t; \gamma. c) = 0$ and $G(s_t; \gamma. c) = 1$, is smooth for Kuwait. Also, after a visual inspection of Figure 4, we point out that the reaction of the stock market is higher in case of negative oil returns in Kuwait.

Figure 4. Logistic Functions and Long-Run Effects of Oil Prices



Kuwait

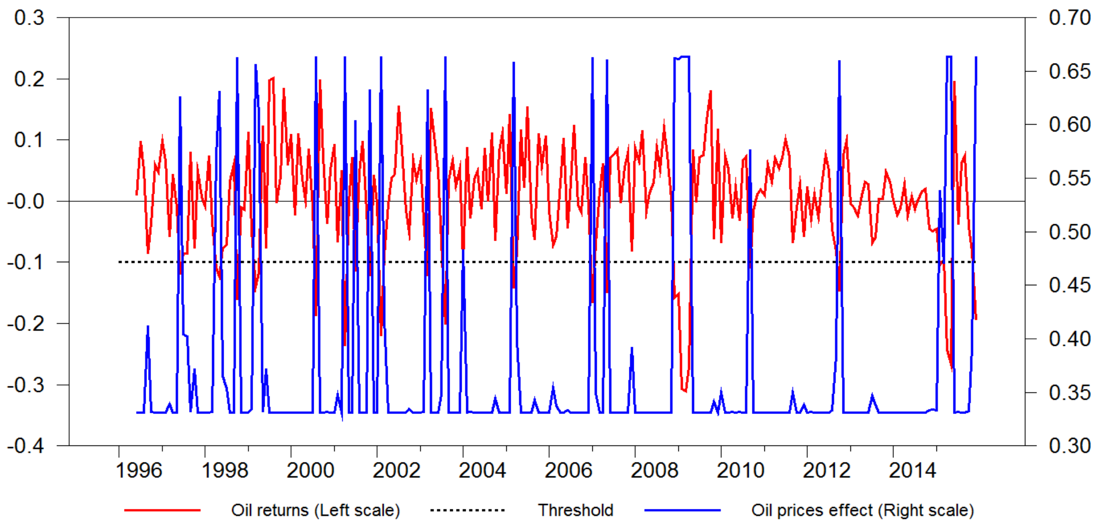
Note: The estimated logistic functions and long-run oil return impacts on stock markets are plotted on the y-axis. The x-axis features/includes the different values taken by the transition variable, $s_t = or_{t-j}$. The estimated logistic function is calculated using $G\left(or_{t-j}; \hat{\gamma}, \hat{c}\right) = \left[1 + exp\{-\hat{\gamma}(or_{t-j} - \hat{c})\}\right]^{-1}$. The long-run oil impact on stock return is obtained from the following formula: $\left[\sum_{j=0}^{N} \beta_j + \sum_{j=0}^{N} \phi_j \, G\left(or_{t-j}; \hat{\gamma}, \hat{c}\right)\right] / \left[1 - \sum_{j=1}^{N} \lambda_j\right]$.

To gain further insight into the responses of GCC stock returns to oil price decreases and increases, we provide the plots of long-run oil effect estimates over time in Figure 5, with the estimated threshold levels superimposed. In Figure 5, the long-run oil effect is a time-varying coefficient that depends on the evolution of oil returns, $s_t = or_{t-j}$, over time: $\left[\sum_{j=0}^{N} \beta_j + \sum_{j=0}^{N} \phi_j \, G\left(or_{t-j}; \hat{\gamma}, \hat{c}\right)\right] / \left[1 - \sum_{j=1}^{N} \lambda_j\right]$. The displayed plots reveal that each time the oil return falls below a given threshold, the stock return's reaction is more pronounced in Kuwait.

Indeed, when using the LSTR specification, the estimated threshold should be very close to zero ($c \simeq 0$) in order to determine whether an oil price change is positive or negative. However, in most of cases, our LSTR models provide estimated thresholds that are, to some degree, different form the expected threshold level of $c \simeq 0$, ranging from $c = -0.10$ in Kuwait to $c \simeq 0.10$ in Oman. This might explain why we do not find significant asymmetric effects for positive and negative oil price changes on stock returns for most of our GCC countries.

Overall, in our sample of six GCC countries, there are a few pieces of evidence regarding the presence of asymmetry with respect to oil price direction. To some extent, only Kuwait corroborates the conventional wisdom that negative oil price changes have larger impacts on stock returns than positive oil price changes do. For Oman and Qatar, stock returns are only significant for negative or small positive deviations, but for Bahrain and Saudi Arabia, the reaction of the stock market is not significant for either regime. In the next step, we investigate whether the ESTR specification could be more effective at capturing the presence of asymmetry and regime-switching behavior with respect to the size of oil price change in the GCC region.

Figure 5. Time-Varying Long-Run Impacts of Oil Prices on Stock Returns Using LSTR Specifications



Kuwait

Note: The y-axis shows time-varying long-run oil price effects (right scale), oil returns (left scale), and threshold levels (right scale). X-axis: the monthly time index from 2004–2015. Time-varying long-run oil impacts on GCC stock returns are obtained using the following formula: $\left[\sum_{j=0}^{N}\beta_j + \sum_{j=0}^{N}\phi_j\, G\left(or_{t-j};\hat{\gamma},\hat{c}\right)\right]/\left[1-\sum_{j=1}^{N}\lambda_j\right]$, with $G\left(or_{t-j};\hat{\gamma},\hat{c}\right) = \left[1+exp\left\{-\hat{\gamma}\left(or_{t-j}-\hat{c}\right)\right\}\right]^{-1}$.

B. Asymmetry Between Small and Large Oil Price Changes

Now, we test whether the effects that large oil price shocks exert on stock prices could be different from the effects that are due to smaller shocks. In this case, the ESTR specification is more suitable for capturing asymmetric behavior with respect to the *magnitude* of oil price movements. Stock prices are expected to respond asymmetrically to changes in oil prices, in the sense that large oil prices are associated with higher stock price responses, while small oil price changes would impact less stock returns.

As discussed before, in the ESTR specification, the dynamic would be different than what?, depending on whether oil change as a transition variable ($s_t = or_{t-j}$) is close to, or far away from, a certain threshold. The NLS estimates of our ESTR equations are reported in Table 7, and the results related to the possible asymmetric effects of small and large oil price changes on stock returns in GCC countries can be summarized as follows: First, the estimated threshold values of oil returns do not differ considerably across our sample in absolute value, ranging from 2 percent in Oman to 5.2 percent in Bahrain, with exception of Kuwait, which shows a threshold level close to zero ($|c| = 0.003$). The threshold levels turn out to be significant for only three GCC countries (Bahrain, Oman, and Qatar), but not for Kuwait or Saudi Arabia. With respect to the long-run effects of oil price changes, three out of six of our GCC countries exhibit significant nonlinear dynamic behaviors with respect to the magnitude of oil price change. In Bahrain, however, the of stock prices' long-run responses to substantial oil price changes turn out to be statistically insignificant. This counterintuitive result may be explained by the fact that we are working at an aggregate level, where composition effects may arise.

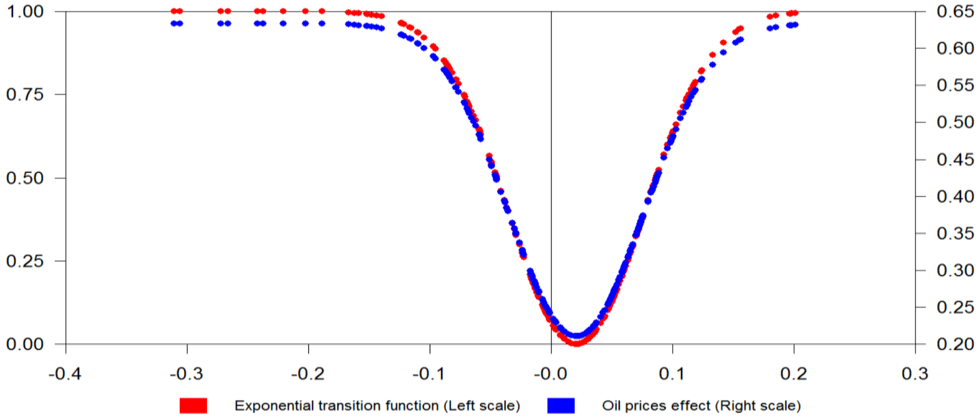
Table 7. Estimated Impacts of Oil Returns on GCC Stock Markets Using ESTR Specifications

	Bahrain	Kuwait	Oman	Qatar	Saudi Arabia
Transition variable (s_t)	or_{t-4}	or_{t-4}	or_{t-6}	or_{t-5}	or_{t-6}
Threshold ($\boldsymbol{c}$)	0.052*	-0.003	0.020*	-0.045***	-0.032
	(0.032)	(0.012)	(0.013)	(0.010)	(0.025)
Speed of transition ($\boldsymbol{\gamma}$)	0.185	0.318	1.347	1.181*	1.545
	(0.242	(0.317)	(1.221)	(0.686)	(2.043)
Small oil changes: $G(s_t;\gamma.c) = 0$					
Long-run effect	0.459**	-0.011	0.210*	0.605	0.320
	(0.238	(0.101)	(0.140)	(0.434)	(0.379)
Large oil changes: $G(s_t;\gamma.c) = 1$					
Long-run effect	0.810	0.542**	0.633***	0.890**	0.867*
	(0.757)	(0.278)	(0.278)	(0.446)	(0.519)
R^2	0.433	0.403	0.307	0.310	0.414
SSR_{ratio}	0.745	0.722	0.803	0.952	0.774
$pLM_{AR(6)}$	0.996	0.962	0.760	0.791	0.896
$pLM_{ARCH(6)}$	0.449	0.810	0.854	0.043	0.000
pLM_C	0.141	0.439	0.376	0.754	0.218
pLM_{RNC}	0.368	0.317	0.266	0.262	0.444

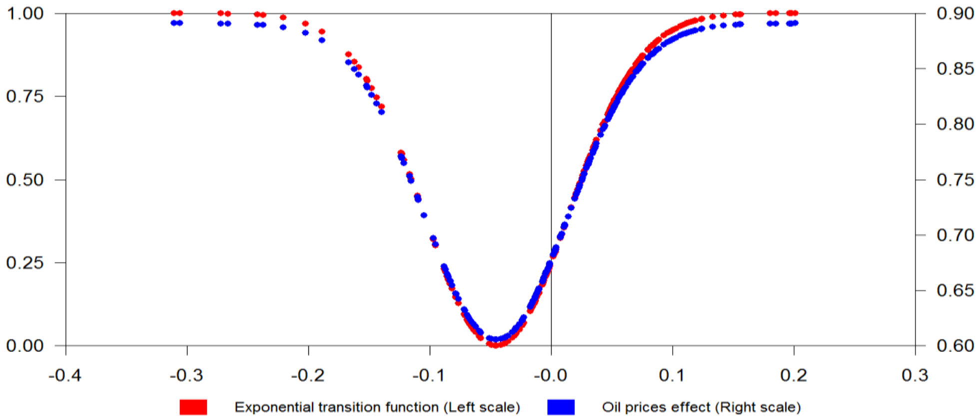
Note: Table reports the impacts of oil price changes on GCC stock returns over 2004–2015. Results are obtained from the STR equation (4) using the ESTR. Numbers in parentheses are the standards errors. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively. R^2 denotes the coefficient of determination. SSR_{ratio} is the ratio of the sum of squared residuals between the LSTR model and the linear specification. The following rows correspond to the misspecification tests: $pLM_{AR(6)}$ is the p-value of the LM test of no error autocorrelation up to the sixth order. $pLM_{ARCH(6)}$ is the p-value of the LM test of no ARCH effects up to the sixth order. pLM_C is the p-value of the LM test of parameter constancy, and pLM_{RNC} is the p-value of the LM test of no remaining nonlinearity.

Our estimations provide evidence for a positive correlation between stock return response and the magnitude of oil price change in Oman and Qatar. More specifically, as reported in Table 7, following a 1 percent oil price change, the long-run impact on Oman's stock market is equal to 0.21 percent when oil change in absolute value, $|or_{t-6}|$, is small and close to 2 percent (the threshold being $c = 0.02$). For (a) higher oil price change, $|or_{t-6}| > 2\%$, Oman's stock return reaction is 0.63 percent. For Qatar, the long-run impact of Brent oil prices is insignificant when changes are small and close to 4.5 percent (threshold of $c \simeq 0.045$). This is not surprising, since stock returns could be insensitive to small/minor oil price deviations. However, with considerable price variations (far from the threshold level of 4.5 percent), oil price changes exert larger, significant long-run effects on Qatar's stock returns of 0.89 percent.

Figure 6. Exponential Functions and Long-Run Effects of Oil Prices



Oman



Qatar

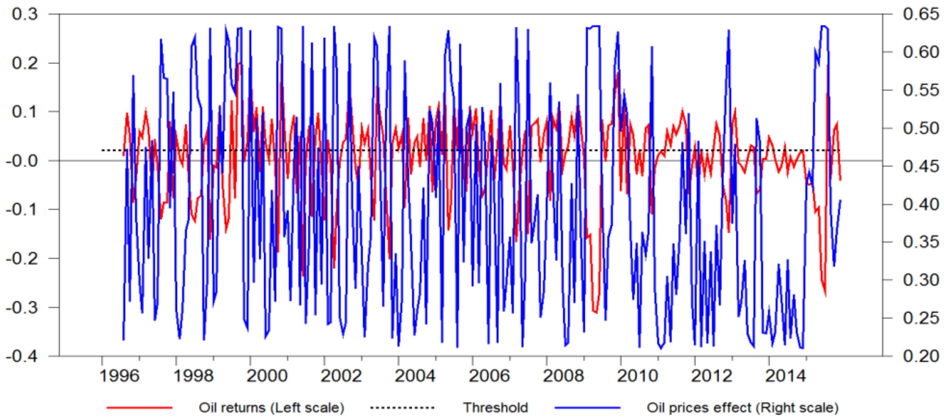
Note: The impacts of the estimated exponential functions and long-run oil returns on the stock markets are plotted on the y-axis. The x-axis includes the different values taken by the transition variable, $s_t = or_{t-j}$. The estimated exponential function is calculated using $G(or_{t-j};\hat{\gamma},\hat{c}) = 1 - exp\{-\hat{\gamma}(or_{t-j} - \hat{c})^2\}$. The long-run oil impacts on stock returns are obtained from the following formula: $[\sum_{j=0}^{N}\beta_j + \sum_{j=0}^{N}\phi_j\, G(or_{t-j};\hat{\gamma},\hat{c})]/[1 - \sum_{j=1}^{N}\lambda_j]$.

Figure 6 provides additional evidence for the presence of asymmetry arising from the degree of oil price variation.[17] That is, high oil price changes in absolute values elicit greater reactions from equity prices than small oil price variations do. Finally, to get more insight into the relationship between stock return and the magnitude of oil price change, we plot the time-varying coefficients over the period 2004–2015 in Figure 7. As our study covers the episode of dramatic oil price increase(s) throughout 2007 and early 2008, it can be observed that stock return sensitivity was largely higher than what it was during periods of small price changes.

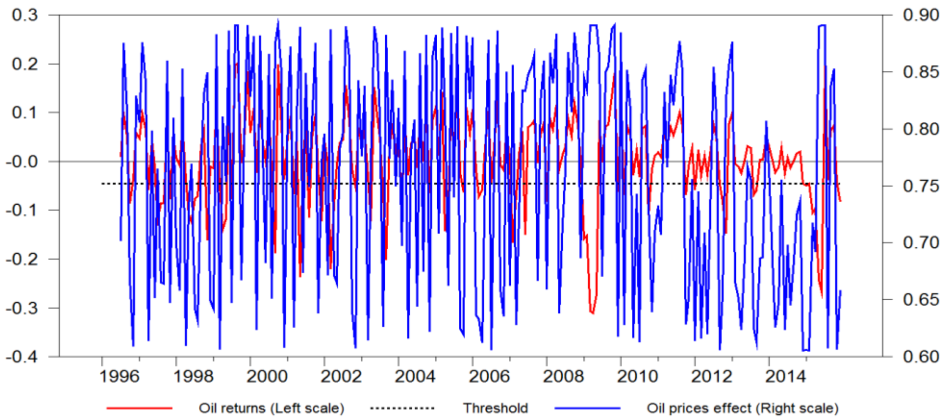
[17] Plots for Bahrain are not displayed because the long-run coefficients are not significant for large oil price changes.

All in all, our results indicate that the relationship between oil prices and stock markets can be considered asymmetrical, as well as regime switching, with respect to the*magnitude of oil price change in Oman and Qatar. This implies that large oil price changes exert greater impacts on stock returns than small oil price variations in these two countries.

Figure 7. Time-Varying Long-Run Impacts of Oil Prices on Stock Returns Using ESTR Specifications



Oman



Qatar

Note: Time-varying long-run oil price effects (right scale), oil returns (left scale), and threshold levels (right scale) are plotted on the y-axis. The x-axis includes/features the monthly time index from 2004–2015. Time-varying long-run oil impacts on GCC stock returns are obtained using the following formula: $\left[\sum_{j=0}^{N}\beta_j + \sum_{j=0}^{N}\phi_j\, G\left(or_{t-j};\hat{\gamma},\hat{c}\right)\right]/\left[1-\sum_{j=1}^{N}\lambda_j\right]$, with
$G\left(or_{t-j};\hat{\gamma},\hat{c}\right) = 1 - exp\left\{-\hat{\gamma}(or_{t-j}-\hat{c})^2\right\}$.

VI. Policy Discussion

Previous studies have shown the existence of generally robust relationships between oil prices and stock markets in GCC countries. These findings are expected, given that economic activity and growth in these countries are strongly influenced by their oil export earnings. Our study qualifies these results by showing that stock price sensitivity can be markedly higher for large oil price changes than for small ones, and that this sensitivity differs across GCC countries. This result has important implications for both investors and policymakers.

From an investment strategy perspective, our results underscore the importance for market participants to consider differences in the sensitivity of stock returns to oil prices across GCC countries when deciding on the composition of international stock portfolios. As highlighted in other studies, there can be substantial potential benefits to including stocks from GCC countries in portfolios that also include stocks from net oil importing countries, given that the latter group generally exhibits negative sensitivities to oil price changes. Our research emphasizes the importance for portfolio diversification decisions and oil-price-related hedging strategies to account for differences in stock return sensitivity across GCC countries, including the potential for substantial increases/spikes in sensitivity across threshold levels of oil price changes.

From an economic policy perspective, our results point to the need for measures to temper and smooth the impacts of oil price changes on stock returns over time. Such measures are especially beneficial from a macroeconomic stabilization viewpoint, given that a rise/fall in equity price increases/reduces the corporate sector's wealth, thereby reinforcing the adverse impact on aggregate demand.

In GCC countries' equity markets, most stocks are held in domestic nonoil companies.[18] Therefore, from a policymaker's viewpoint, stabilizing the impact of oil price change on nonoil growth is key. The main channel for such stabilization has been fiscal policy, given the GCC group's adherence to the exchange rate peg, in particular through public expenditure policy, and in view of the fledgling taxation system in GCC countries. Also, ongoing and expected structural reforms are important, insofar as they serve to diversify the economic base and raise nonoil sources of financing, thereby reducing the expected sensitivity of nonoil growth to oil-related influences over time. As an illustration, in the case of an oil price decline (the reverse channels operate for an oil price increase), oil revenue falls, leading to weaker fiscal and external positions. Equity returns fall to the extent that market participants expect an adverse impact on nonoil growth, of which the expected fiscal adjustment (especially government spending) is a key determinant. The sensitivity of stock return to price decline is likely to rise along with the decline in oil price, insofar as market participants expect a higher probability of an adverse impact on nonoil growth due to fiscal adjustment. That impact is tempered to the extent that the fiscal adjustment is complemented by reforms that diversify the economic base and raise nonoil growth resilience over time.

Given the above linkages, the sensitivity of equity return to oil price depends on economic conditions and policy-related considerations that can be grouped into three broad categories of factors.

The first category relates to the market expectations regarding/relating to the impacts of oil price changes on a country's fiscal balances under current policy trends, and the magnitude of

[18] Saudi Arabia's equity market is notable in the GCC, in that it also has significant direct exposure to the oil sector through stocks in the domestic petrochemical sector. Nevertheless, over three-quarters of Saudi market shares are in nonoil companies.

the fiscal adjustment that needs to be undertaken to achieve economically sound, or "desirable," fiscal balances that that are in line with the country's fiscal sustainability and intergenerational equity objectives. The fiscal gaps between the projected fiscal balances and desirable balances have been estimated by the IMF (2015, 2016, 2017)[19] in the aftermath of the oil price drop of 2014–15. These gaps are a function of the expected path of oil prices, and the degree of the country's dependence on oil, as well as the paths of expenditure and revenue-generating measures under current trends. Under the assumption that lower oil prices are expected to persist over the longer term, these fiscal gaps are estimated to be in the range of 15 to 25 percentage points of nonoil GDP for Bahrain, Oman, and Saudi Arabia; 10 percent for Kuwait; and 5 percent for Qatar and the UAE.

The second key category of factors is the pace at which fiscal adjustment measures are implemented to raise fiscal balances toward their desired levels and eliminate fiscal gaps. Fiscal adjustment that is smoothed over time would, ceteris paribus, contain the adverse impacts on nonoil growth, corporate profits, and equity markets. That pace, in turn, is determined by the fiscal space available, as measured by the size of a government's financial assets (fiscal buffers), and its capacity to borrow. A higher fiscal space enables a smoother fiscal adjustment, thereby reducing the impact of oil price change on the equity market. In addition, the greater space, by enabling easier access to international bond markets, tempers the impact of oil price change on domestic financing requirements and liquidity, further limiting the impacts on equity prices.

The IMF's (2015) assessment is that—measured in terms of financial assets—Kuwait, Qatar, and the UAE have relatively comfortable buffers, on the one hand, as current trends show that their assets are sufficient to finance their fiscal deficits for 20 more years. On the other hand, Bahrain's, Oman's, and Saudi Arabia's financial assets are sufficient to finance their deficits for less than five years, according to current trends/if current trends are any indication. As measured by their borrowing capacities, the assessments of debt-to-GDP projected paths for 2015 to 2020 suggests that Kuwait, Saudi Arabia, and the UAE have the widest fiscal spaces, and Oman and Qatar have intermediate positions, while Bahrain is in a relatively vulnerable position.

The third key category of factors relates to the extent to which the GCC economy is diversified, in particular as reflected in the share of oil fiscal revenue in total revenues (which ranges from about 70 percent for the UAE to 91 percent for Qatar, using the average for 2011–2014).Then, the GCC economy's diversification then hinges on the prospect of reducing that share over time through structural reforms.

In terms of the signals of structural reform, all six GCC countries have set out broadly similar reform plans in the aftermath of the 2014 oil price decline. They have also made progress in setting out and clearly communicating credible, well-defined medium-term fiscal frameworks. Within each framework, an important objective has been to implement adjustment policies that are supported by structural reforms to diversify their economies away from the

[19] See the IMF *Regional Economic Outlook* for the Middle East and Central Asia issues for the years 2015 to 2017.

hydrocarbon sector, and expand the contribution of the private sector. In that regard, the UAE has made a head start in diversifying its export base, including in tourism, business, and transport services. Bahrain has also made important strides in expanding financial services and food processing. Saudi Arabia, in line with its strategic development plan (Vision 2030), has initiated significant reforms in the equity and bond markets to encourage greater foreign investment, and made progress in privatization.

However, GCC countries have been uniformly slow in expanding their nonoil revenue bases, with delays in the implementation of regional VAT frameworks.

The interplay between the three aforementioned factors, and the impact on nonoil growth, are key determinants of the sensitivity of stock-return-to-oil-price change and, in particular, the prevalence of a “threshold effect” (i.e., stock return sensitivities are significantly higher for large oil price changes than for smaller ones). However, it is difficult to predict a priori the weight that market participants for a particular country would give each of the three factors in forming expectations about the impact of a given oil price change. In particular, the econometric results of our paper indicate that the threshold effect applies to Oman and Qatar, but not to the other GCC countries.

What is special about these two countries with respect to the considerations set out above? In Oman’s the case, its fiscal gap is estimated at 25 percent of nonoil GDP, the highest among all GCC countries. In terms of its fiscal space, its financial assets are not sufficient to finance its deficits for more than five years, and it has an intermediate position in terms of the path of public debt-to-GDP ratio. It also does not fare well on the diversification front, with a relatively high ratio of fiscal oil revenue to total fiscal revenue (89 percent).

For Qatar, the fiscal gap is among the lowest in the GCC group, at 5 percent of nonoil GDP. It fares relatively well in terms of its fiscal space, with ample financial assets and an intermediate position regarding its public debt-to-GDP ratio. However, it has the least diversified economy among the GCC countries, with the highest ratio of hydrocarbon fiscal revenue to total revenue (91 percent).

In sum, Oman and Qatar each has features that, as a result of a large oil price change, could potentially signal a high likelihood of substantial fiscal adjustment to market participants. However, the combination of relevant factors is different in the two cases. While Oman has challenges on account of all three factors, in the case of Qatar, the main operative factor appears to be its high degree of reliance on hydrocarbon revenue.

VII. Conclusion

This paper investigates the presence of asymmetric mechanisms in the response of stock markets to oil prices. The recent spectacular swings in the oil crude market, as well as the dramatic change in the financial environment since the eruption of the subprime crisis, have revived interest in the asymmetric and nonlinear relationship between oil price and the stock market. While the bulk of the existing empirical literature has paid more attention to the asymmetry arising from the direction of oil price change, our study proposes to implement a relevant econometric method that enables us to explore the two possible sources of asymmetry in stock price reactions: the direction and magnitude of oil price change. We use the class of nonlinear STR models, where different regimes can be identified with respect to estimated thresholds. To capture the asymmetry arising from the direction of oil price shock, we use the LSTR, which is appropriate for separating oil price into positive and negative changes. However, for capturing asymmetric behavior with respect to the size of oil price movement, the ESTR is more suitable for distinguishing between large and small oil price changes. Our study is conducted for the six GCC countries (Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the UAE) using monthly data from January 2004–December 2015. When investigating the presence of asymmetry with respect to the direction of oil price change, our results reveal little evidence that negative oil price changes exert larger impacts on stock returns than positive oil price changes do. Our LSTR models were not able to distinguish between positive and negative oil price deviations properly. To some extent, only Kuwait's stock market responses to oil price changes are significantly unequal across the two regimes. We found that large negative price changes (over 10 percent decreases) have more pronounced effects than positive (and small negative) oil price changes. However, when using the ESTR specification to examine the asymmetry with respect to oil price change's magnitude, we found that stock return sensitivity is significantly higher for large oil variations than for small ones. This result is valid for two GCC countries in particular, namely, Oman and Qatar.

Our results should be useful to researchers, regulators, and market actors. More specifically, GCC countries, being OPEC members and part of the Organization's decision-making process, should look carefully at the impacts of oil price variations on their own economies and stock markets. For investors, the significant (and asymmetric) relationship between oil prices and stock markets implies a certain degree of predictability within GCC stock markets.

Our results also underline the role of economic policy in reducing the sensitivity of stock return to oil price change, particularly the existence of a threshold effect in higher oil price change. From a policy perspective, our framework could serve to point to each country in which the threshold effect is operative, and thus, where policy action can be especially beneficial from the economic stabilization and reform perspectives. These include policies to: ensure consistency with fiscal sustainability and intergenerational equity goals, as well as structural reforms to diversify their economic and revenue bases.

Further research is desirable to extend our analysis. First, the asymmetric mechanisms in stock markets' responses to oil price variations in GCC countries are likely to be different across various economic sectors. Therefore, a sectoral analysis of this link could provide additional and disaggregated results, and complement our analysis. Second, the class of nonlinear smooth transition regression implemented in this paper could be used to examine the effects of other energy products, such as natural gas, on GCC stock markets. Third, it would be beneficial to test for nonlinear causal relationships between oil and stock markets in GCC countries, as well as other oil-exporting countries.

VIII. Appendix. Full results from LSTR and ESTR models

Table A1. Full Estimation Results from LSTR Specifications?

	Bahrain	**Kuwait**	**Oman**	**Qatar**	**Saudi Arabia**
Transition variable (s_t)	or_{t-4}	or_{t-4}	or_{t-6}	or_{t-6}	or_{t-3}
Threshold ($\boldsymbol{c}$)	-0.095***	-0.100***	0.099***	0.091***	0.040
	(0.019)	(0.012)	(0.019)	(0.012)	(0.034)
Speed of transition ($\boldsymbol{\gamma}$)	6.766	8.654	7.341	14.052	4.032
	(7.401)	(13.941)	(5.747)	(16.131)	(4.492)
Linear part: $\boldsymbol{G(s_t;\gamma,c)=0}$					
Constant	0.002	0.022	0.027	0.057	0.008
	(0.019)	(0.017)	(0.012)	(0.025)	(0.022)
sr_{t-1}	0.184*		0.169**	0.168*	0.097
	(0.099)		(0.087)	(0.100)	(0.086)
sr_{t-2}			0.133	-0.267***	
			(0.0902)	(0.097)	
sr_{t-3}		-0.153*			
		(0.088)			
sr_{t-4}		-0.160*			0.133*
		(0.090)			(0.083)
sr_{t-5}					0.104
					(0.088)
sr_{t-6}					
or_t		0.371**	0.082	0.284***	0.201*
		(0.190)	(0.055)	(0.099)	(0.114)
or_{t-1}			0.059		
			(0.0534)		
or_{t-2}	0.505***	0.493***	0.098**		0.261***
	(0.139)	(0.123)	(0.0506)		(0.104)
or_{t-3}				0.176*	
				(0.098)	
or_{t-4}			0.087*		-0.184*
			(0.052)		(0.111)
or_{t-5}	0.903***				
	(0.324)				
or_{t-6}	-1.314***		0.081		
	(0.364)		(0.057)		
wr_t	0.315***	0.337***	0.097*	-0.003	0.428***
	(0.091)	(0.084)	(0.061)	(0.126)	(0.106)
i_t^{us}	-0.010	0.024	-0.039*	-0.028	0.009
	(0.0351)	(0.031)	(0.023)	(0.047)	(0.041)
Nonlinear part: $\boldsymbol{G(s_t;\gamma,c)=1}$					
or_t			0.718**	0.566*	-0.499**
			(0.391)	(0.344)	(0.240)
or_{t-1}				0.493*	0.603**

	Bahrain	Kuwait	Oman	Qatar	Saudi Arabia
				(0.285)	(0.276)
or_{t-2}	-0.471***	-0.435***			-0.264
	(0.171)	(0.147)			(0.220)
or_{t-3}				-0.493	
				(0.323)	
or_{t-4}					
or_{t-5}	-0.893***		-1.035***	-1.201***	
	(0.339)		(0.385)	(0.480)	
or_{t-6}	1.181***			0.415	
	(0.368)			(0.266)	

Note: Table reports estimates of STR equation (4) using the LSTR over 2004–2015. Numbers in parentheses are the standard errors. *, ** and, *** denote significance at the 10%, 5%, and 1% levels, respectively.

Table A2. Full Estimation Results from ESTR Specifications

	Bahrain	**Kuwait**	**Oman**	**Qatar**	**Saudi Arabia**
Transition variable (s_t)	or_{t-4}	or_{t-4}	or_{t-6}	or_{t-5}	or_{t-6}
Threshold ($\boldsymbol{c}$)	0.052*	-0.003	0.020*	-0.045***	-0.032
	(0.032)	(0.012)	(0.013)	(0.010)	(0.025)
Speed of transition ($\boldsymbol{\gamma}$)	0.185	0.318	1.347	1.181*	1.545
	(0.242)	(0.317)	(1.221)	(0.686)	(2.043)
Linear part: $\boldsymbol{G(s_t;\gamma,c)=0}$					
Constant	-0.006	0.0168	0.029	0.072	-0.003
	(0.019)	(0.017)	(0.015)	(0.026)	(0.022)
sr_{t-1}	0.153		0.138	0.286***	
	(0.100)		(0.101)	(0.097)	
sr_{t-2}			0.137	-0.106	
			(0.098)	(0.093	
sr_{t-3}		-0.146*		0.127	
		(0.092)		(0.095)	
sr_{t-4}		-0.189**			0.131
		(0.092)			(0.087)
sr_{t-5}	0.130				0.104
	(0.092)				(0.094)
sr_{t-6}			-0.096		0.117
			(0.095)		(0.088)
or_t	0.159*	0.148*		0.291**	
	(0.099	(0.093)		(0.141)	
or_{t-1}			0.206**	0.437***	
			(0.107)	(0.177)	
or_{t-2}			0.096	-0.613***	0.264*
			(0.088)	(0.213)	(0.155
or_{t-3}			-0.129		
			(0.108)		
or_{t-4}	0.169			-0.318*	-0.280*
	(0.142			(0.202)	(0.172)

or_{t-5}					0.223
					(0.201)
or_{t-6}		-0.163*		0.623***	
		(0.090)		(0.194)	
wr_t	0.323***	0.319***	0.058	-0.127	0.476***
	(0.095)	(0.084)	(0.068)	(0.122)	(0.111)
i_t^{us}	-0.016	0.005	-0.013	0.038	0.000
	(0.036)	(0.032)	(0.025)	(0.043)	(0.042)
Nonlinear part: $G(s_t; \gamma, c) = 1$					
or_t			0.344**		
			(0.180)		
or_{t-1}			-0.252	-0.489***	0.354*
			(0.197)	(0.267)	(0.220)
or_{t-2}	0.735**	0.739**		0.922	
	(0.394)	(0.322)		(0.256)	
or_{t-3}			0.255*		
			(0.147)		
or_{t-4}				0.480***	
				(0.248)	
or_{t-5}	0.720			-0.502	
	(0.657)			(0.364)	
or_{t-6}	-1.204*			-0.715***	
	(0.756)			(0.247)	

Note: Table reports estimates of STR equation (4) using ESTR over 2004–2015. Numbers in parentheses are the standard errors. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

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