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## Abstract

This paper tests the asymmetric long-run dynamics between oil price changes and Kuwait stock prices at the sectoral level. Our daily data on Brent and West Texas Intermediate (WTI) nominal spot crude oil prices spans from January 3, 2000 to December 9, 2015 for some sectors, and from May 14, 2012 to December 9, 2015 for others. We used a nonlinear cointegration methodology in which the nonlinear autoregressive distributed lags is utilized to allow for estimating asymmetric long- and short-run coefficients in a cointegration framework. The findings show asymmetric long-run effects between oil prices and some Kuwait sectoral stock prices. As for the short run, the findings show an asymmetric effect in case of WTI price measure, but symmetric effect in case of Brent price measure. The paper shows that using nonlinear models contributes to better understanding the long-run relationships, hence serving more in policy-making. Finally, the causality tests show that there is bidirectional causality between the Brent positive oil price shock and the stock prices of the following sectors: Banking, Consumer Goods, Consumer Services, Industrials and Real Estate. On the other hand, they show a unidirectional causality running from the Brent negative oil price shock to the stock prices of the Banking, Consumer Goods, Consumer Services, Industrials and Real Estate sectors. As for the WTI price measure, we find bidirectional causality between the WTI positive oil price shock and the stock prices of the Consumer Services and Industrials sectors, and unidirectional causality from the WTI negative oil price shock to the stock prices of the Consumer Services and Industrials sectors.



***JEL Classifications**:* G12, F3, Q43

***Keywords:*** Oil Price, Kuwait Stock Market, nonlinear cointegration, unit root



## ملخص

تهدف هذه الورقة إلى اختبار الديناميات غير المتناظرة طويلة المدى بين تغيرات أســـعار النفط وأســـعار الأســـهم في الكويت على المستوى القطاعي. بياناتنا اليومية على أسعار النفط الخام الاسمي من خام برنت وغرب تكساس (خام غرب تكساس الوسيط) تمتد من 3 يناير 2000 إلى 9 ديســـمبر 2015 لبعض القطاعات، ومن 14 مايو 2012 إلى 9 ديســـمبر 2015 للآخرين. اســـتخدمنا منهجية التكامل المشــترك غير الخطية التي يتم فيها اســتخدام التخلفات الموزعة خارج الانحدار الذاتي غير الخطية للسـماح بتقدير المعاملات غير المتناظرة والقصــيرة المدى في إطار التكامل المشــترك. وتظهر النتائج تأثيرات غير متناظرة على المدى البعيد بين أســعار النفط وبعض أسعار الأسهم القطاعية في الكويت. أما على المدى القصير، فإن النتائج تظهر تأثير غير متماثل في حالة قياس سعر خام غرب تكســاس الوســيط، ولكن تأثير متماثل في حالة قياس ســعر خام برنت. وتظهر الورقة أن اســتخدام النماذج غير الخطية يســهم في فهم أفضل للعلاقات على المدى الطويل، وبالتالي تقديم المزيد في صنع السياسات. وأخيرا، تظهر اختبارات السببية أن هناك علاقة سببية ثنائية الاتجاه بين صدمة برنت الإيجابية في أسعار النفط وأسعار الأسهم في القطاعات التالية: الخدمات المصرفية والسلع الاستهلاكية والخدمات الاســتهلاكية والصــناعات والعقارات. من ناحية أخرى، فإنها تظهر علاقة ســببية أحادية الاتجاه من صــدمة برنت الســلبية لأسـعار النفط إلى أسـعار الأسـهم في قطاعات البنوك والسـلع الاسـتهلاكية والخدمات الاسـتهلاكية والصـناعات والعقارات. أما بالنسـبة لأسـعار خام غرب تكسـاس الوسـيط، نجد السـببية ثنائية الاتجاه بين صـدمة أسـعار النفط الإيجابية لنفط غرب تكسـاس الوسـيط وأسـعار أسهم قطاعي الخدمات الاستهلاكية والصناعات، والسببية أحادية الاتجاه من صدمة أسعار خام غرب تكساس الوسيط السلبية لأسعار أسهم الخدمات الاستهلاكية والصناعات القطاعات.

## 1. Introduction

For the last few decades, mainly during the 1970s and 1980s, world oil prices have shown great volatility given the extensive use of oil, whether as a final consumption product or as a production input. This volatility shows tremendous impact on the global and national markets, reflecting the prominent role of oil prices in the economy. As such, given the seminal contribution of Hamilton (1983), the influence of oil price instability on most macro-economic indicators has been evidenced by a remarkable number of studies where the possibility of non-linearity between oil price changes and economic mobility is sanctioned, demonstrating that oil price increase (negative oil price impact) tends to have a wider influence on growth than oil price decrease (positive oil price impact) (See Lardic and Mignon, 2008; Arouri et al, 2011; Zhang, 2013).

More recently, the focus has shifted to the association between oil price changes and stock markets, where the association between the two variables has become a recognizable field of research in energy and financial economics, (for example, see Saorsky, 1999; Blanchard and Gali, 2007; Park and Ratti, 2008; Driesprong et al, 2008; Herrera and Pesavento, 2009). One rationale for using oil price changes as a factor affecting stock prices is that it is commonly acknowledged that crude oil price changes have a critical and a prominent impact on most economic activities, where the stock market acts as the barometer of the overall economy. Hence, oil price changes are likely to have a dominant influence on the behavior of stock prices (see Arouri and Nguyen, 2011). Likewise, oil price changes can influence the future expected cash flows of firms, since oil is counted as major input of production. Henceforth, an increase in oil prices would increase production costs, leading to lower profit levels, subsequently causing a depreciation in stock prices (see Apergis and Miller, 2009; Arouri and Nguyen, 2010; Moya-Martinez et al*,* 2014). Additionally, changes in oil prices also influence the discount rate that is usually used while valuing equity securities. An increase in oil prices would create higher inflationary pressures, leading to higher interest rates, in turn causing a negative impact on stock prices throughout the higher discount rates, according to the standard equity valuation model (see Miller and Ratti, 2009; Mohanty et al*,* 2011).[1]

By using a nonlinear cointegration methodology, this paper aims to test for the potential asymmetric dynamics between oil price changes and stock prices at the disaggregate sectoral level for Kuwait as an oil exporting economy, considering that oil price changes affect sectors differently depending on many factors. These factors include whether the sector is a net producer or net consumer of oil, the extent of the market competitiveness, the capability of transferring the increase in oil prices to consumers, and, finally, the capability and availability of the hedging instrument in the market place. We argue that the nonlinear cointegration test would lead to the identification of the heterogeneity of sector sensitivities to oil price changes, resulting in better understanding for energy policy decision makers. Furthermore, following Moya-Martinez et al (2014), we argue that the effect of oil price changes on the stock market has excessive impact on most economies, whether for oil-importing or oil-exporting markets. Regarding oil-importing markets, an increase in oil prices would mean more expensive energy costs, causing a negative impact on the stock market via its negative effect on the expected

[1] For example, higher oil prices would result in an increase in the cost of inputs, upsurge in imports, leading to a proliferation in the inflation rate. In the market place, this leads to an increase in the market interest rate, signaling a higher cost of capital for most corporations and leading to lower stock returns. Furthermore, since oil price upsurge increases production costs for non-oil industries, this is expected to trigger an increase in the cost of imported capital commodities, hence reversely affecting the possibilities of profits for the market-listed corporations. Inclusive, it is quite crucial for market-listed firms; given the stock valuation theory in which the fair value of a stock is simply equal to the sum of its discounted future cash flows at different time horizons where an appropriate discount rate is applied. So, ascertaining the persuasive influences impacting these cash flows and its related discount rate is pertinent; considering oil price is one of those foremost inducing factors that cause volatility in the estimated corporate cash flows, hence causing volatility in the stock prices of firms.

earnings of firms. However, the opposite is correct for the oil-exporting markets, where higher income and wealth can be attained.

According to the literature so far, the empirical findings on the association between oil price changes and stock markets show ambiguous outcome, reflecting the volatile dynamics between the two variables over time. Having said this, from a sectoral perspective, there is some sort of consensus that both the Oil & Gas industries and the Mining industries tend to be positively impacted by positive changes in oil prices. Meanwhile, the opposite is true for the other industries, namely Transportation, Manufacturing, Food, Chemicals, Medical, Computer, Real Estate and General Services. Uncertain results are also acknowledged for industries such as Electricity, Engineering and Financial Services industries (for more details see Hammoudeh and Li, 2005; El-Sharif et al*,* 2005; Boyer and Filion, 2007; Nandha and Faff, 2008; Kilian and Park, 2009; Arouri and Nguyen, 2010; Arouri et al*,* 2011; Elyasiani et al*,* 2011; Broadstock et al, 2012; Degiannakis et al*,* 2013; Broadstock and Filis, 2014). As a whole, the aforementioned results on the association between oil price changes and stock markets can be categorized into three major groups: First, the positive impact of oil price changes on oil-related and oil-substitute industries, second, the negative impact on oil-using industries, and third, no significant impact on non-oil-related industries, such as the Financial Services industry.

On the regional framework basis, few local studies have looked at the effect of oil prices on entire stock markets in developing countries, such as the GCC countries in general and Kuwait in particular. Moreover, this influence from a sectoral perspective received even less attention.[2] On country-specific perception, we argue that for an oil producing economy, Kuwait as per our case, the nexus between oil prices and sectoral stock prices is very crucial; where a change in oil prices would have quite an equivocal impact on the country's economy, since oil industry companies are state-owned entities. The consequential upsurge in oil prices would build up the revenues of exports, hence fostering public expenditures and boosting growth. Such an upshot would count positively to the countries' long-term economic robustness and their volatility absorption capacity for the fluctuation of many structural factors influencing wealth and the economy. On the contrary, an increase in oil prices would have an adverse impact on private non-oil corporations since an increase in costs is foreseeable, causing an increase in the costs of production. Overall, although Kuwait has a stable economic outlook and is counted as one of the world's top exporters of oil and gas with relatively low production costs, the country's high economic outlook is affected by the latest volatile oil prices, as the country is significantly reliant on oil revenues, signaling a negative influence on economic concert since low oil prices exert a significant downward pressure on its economic front.

There are a number of motives that rationalize our interest in studying the relationship between oil prices and sectoral stock prices. First, less attention has been devoted to the association between oil price changes and the stock market prices, where ambiguous inferences signaling the need to conduct additional tests towards the association between the two variables were concluded (Li et al*,* 2012). As such, there have been relatively few studies that examined the association between oil price changes and stock markets, in which most of such studies were devoted to the industrial or developed economies, namely the United States, Canada, Japan and many European economies, while few studies looked at the developing or emerging economies. Second, examining the sectoral indices is a more relevant method for capturing the feedback relationship between oil price changes and stock market disturbances, since the market aggregation index may hide the characteristics of various sector reports (see Kilian, 2009; Kilian and Park, 2009; Arouri et al, 2012; Jouini, 2013; Degiannakis et al, 2013). Third, for

[2] Bearing in mind that the stock markets of the GCC countries (including Kuwait) experienced significant growth both in terms of market size and trading activity during much of the 2000s, stimulated by the flow of large amounts of petro-dollars into these economies, forming an environment that can be characterized by the phenomenon "too much money chasing too few stocks," (Balcilar et al*,* 2013; Demirer et al*,* 2015).

market participants, portfolio managers and investors in specific, a complete understanding of the reaction of sectoral indices to oil price fluctuations offers key evidence about which stock market sectors to choose during times of uncertainty in order to maximize returns or minimize risk, leading to a better understanding of the oil price transmission mechanism across sectors. The latter is important for traders when making optimal investment portfolio decisions.[3] Fourth, there is a need to broaden the understanding of the association between oil price changes and Kuwait stock market prices on a sector-by-sector basis as Kuwait is among the major oil-producers worldwide. Hence, the country's equity values may be affected by changes in oil prices. Finally, given the perspective of portfolio strategies, the stock market in Kuwait is largely segmented from the regional and international financial markets, reflecting its position as an alternative promising portfolio diversification for most equity investors, particularly in the regional aspect.

The contribution of this paper to the literature can be summarized in a threefold form. First, as per the context of Kuwait, the paper examines the asymmetric long-run effect of oil price changes on 10 sectoral stock prices, namely Banking, Consumer Goods, Consumer Services, Industries, Real Estate, Basic Material, Financial Services, Oil & Gas, Technology, and Telecommunications, testing whether oil price changes have similar influence on stock prices regardless of the discrepancies in the sectors. Second, our data spectrum is represented by a relatively recent sample of Kuwait sectoral stock market prices, besides using two measures of oil prices: the British oil price (Brent) and the West Texas Intermediate price (WTI). Third, the most notable contribution of this paper comes from testing for cointegration using the recently developed nonlinear autoregressive distributed lags (NARDL) model of Shin et al (2011), which extends the autoregressive distributed lags (ARDL) bounds testing approach of Pesaran et al (2001) to allow for estimating asymmetric long- and short-run coefficients in a cointegration framework.

The paper finds asymmetric long run effects between oil prices and Kuwait sectoral stock prices. As for the short run, our findings show an asymmetric effect in case of WTI price measure, but a symmetric effect in case of Brent price measure. On the whole, the findings give support for using nonlinear models as they contribute to better understanding the long run relationships, hence serving more effectively in policy-making.

The rest of this paper is structured as follows: Section two briefly reviews the related literature. Section three describes the data and methodology used. Section four outlines the empirical findings, while conclusions are postulated in section five.

## 2. Literature Review

Understanding the dynamics that explain the volatility of stock prices is an important issue in the literature on financial economics, since it is crucial to all interested parties in the stock market, including investors, practitioners and policymakers, in making investment decisions. So far, although some studies have been devoted to the impact of oil price changes on stock prices at the sectoral or industry level, there is no consensus on the nature of the relationship between the two variables where the oil price exposure differs deeply among sectors. Until now, the positive association between stock prices of Oil & Gas companies and oil price

[3] More precisely, the feedback between crude oil price changes and sectoral stock market returns would provide an opportunity to explore speculators as well as regular investors' trading behavioral sentiments while buying and selling stocks on a daily basis. Those who are anticipating fast return will closely track movement in numerous stocks in order to capitalize on any relationship that might exist (see Louis and Balli, 2014). For instance, in case of inverse association between oil prices and industry sector returns, predictions of an increase in the price of oil may prompt investors to buy oil company stocks while selling industrial company stocks. Furthermore, from a portfolio management standpoint, identifying the heterogeneity of market sector sensitivities to oil price changes would validate the fact where there are sectors that still show diversification means during wide swings in oil prices (see Arouri, 2011). For an economy teetering into recession, Hammoudeh et al, (2009) identifies that investors may invest in defensive stocks, specifically those on the non-cyclical consumer goods sector, while they may invest in high tech sectors' stocks in terms of a booming economy.

increases has been evidenced by many studies, where this is not the case for non-Oil & Gas sectors that show a weak or negative connection to oil price changes. Indeed, sectors that generate a large share of their revenues from oil and oil-related products would usually exhibit a positive oil price exposure. Conversely, sectors where oil is a crucial input for their operations tend to display negative sensitivity to oil price changes (see Faff and Brailsford, 1999 for the Australian market; Sadorsky, 2001 and Boyer and Filion, 2007 as per the Canadian context; El-Sharif et al, 2005 for the United Kingdom).

Faff and Brailsford (1999) show that an increase in oil prices has a negative influence on industries like Paper and Packaging, Banking, and Transportation, while some other industries are better off in terms of their capability in passing a portion of the extra costs triggered by the increase in oil prices to their customers, thereby reducing the negative impact on their profitability. Nandha and Faff (2008) examine 35 global industry indices for the period 1983-2005, where they demonstrate that an increase in oil prices has a negative influence on most industries. However, this is not the case for non-Oil & Gas industries, the mining industry in particular. Arouri and Nguyen's (2010) findings suggest that the sensitivity of industries to changes in oil prices differ impressively from one sector to another in Europe, while Gogineni (2010) concludes that the stocks of heavily oil-reliant industries are significantly affected by oil price changes. Here, he reports that financial and insurance industries are negatively impacted by oil price changes.

Elyasiani et al (2011) documents significant evidence in which nine out of the 13 sectors analyzed show statistically significant association between their return and oil price changes. Based on the fact that industries differ in their consumption of oil, they therefore exhibit a different sensitivity to oil price changes. Mohanty et al (2011) used both country-level and industry-level stock market data and concludes a significant positive response of industry-specific prices to oil shocks, where evidence is shown to only 12 out of 20 industries as per the tested sample. By using the linear and asymmetric models, Arouri (2011) tests for short-term association in both mean and variance in the aggregate and sector-by-sector levels in Europe. The responses of European sector stock markets to oil price changes suggest that the strength of the association between the two variables fluctuates considerably across sectors. For comparison purposes, Arouri et al (2011) used the generalized VAR-GARCH approach on sector-level data to examine the extent of volatility transmission between oil prices and stock markets in Europe and the United States. Their results reveal the existence of a significant volatility spillover between the two variables, where the spillover is unidirectional from oil markets to stock markets in Europe, but bidirectional as per the case of the United States.

For the G7 countries, Lee et al (2012) shows that the Information Technology and Consumer Staples sectors are found to be the most impacted by oil price changes, followed by Financial Services, Utilities and Transportation sectors. Li et al (2012) investigates the relationship between oil prices and China's stock market at the sectoral level, where the panel cointegration relationship between the two variables is confirmed at the disaggregated sectoral level. Their estimates suggest that the real oil price changes have a positive impact on sectoral stocks in the long run. Based on data from 10 European sectors, Degiannakis et al (2013) suggests that the relationship between sector indices and oil price changes over time and is industry specific, concluding that both the origin of the oil price shock and the type of industry are important determinants of the correlation level between industrial sectors returns and oil prices. Over the weekly period from January 10, 2007 until September 28, 2011, Jouini (2013) examines the links between oil price changes and stock sector markets in Saudi Arabia. His findings show evidence of return and volatility transmission between the two factors. Cong et al (2013) investigates the interactive relationship between oil price changes and the Chinese stock market, concluding no statistical significant impact of the oil price changes on the real stock prices of most of China's stock market indices, except for the manufacturing index and some oil firms.

Broadstock and Filis (2014) examine the time-varying association between oil prices shocks and the stock market for China and the United States. While considering correlations from key selected industrial sectors, namely Metals & Mining, Oil & Gas, Retail, Technology, and Banking, they conclude that the effect differs widely across industrial sectors. Martinez et al (2014) investigates the sensitivity of the Spanish stock market at the industry level to changes in oil prices over the period 1993-2010, concluding that the degree of oil price exposure of Spanish industries is rather limited, although significant differences are shown across industries.

Hamma et al (2014) examines the transmission of volatility between oil and seven sector stock indices of Tunisia using a bivariate GARCH model. The results conclude significant shock and volatility spillovers across oil prices and the Tunisian sectoral stock market. However, the intensity of volatility interaction varies from one sector to another. By using weekly data on 10 sectoral indices over the period between January 1197 and February 2014, Caporale et al (2015) explores the time-varying impact of oil price changes on stock prices in China, concluding that oil price volatility affects stock returns positively during periods characterized by demand-side changes in all sectors, except for the Consumer Services, Financial Services, and Oil & Gas sectors, in which the later sectors exhibit a negative response to oil price changes during periods with supply-side changes. Huang et al (2015) investigates the multiscale dynamics association between oil price and the stock market in China at the sectoral level, concluding that the impact of oil price changes varies for different sectors over different time periods.

While the aforementioned studies examined the relationship between oil price changes and stock market prices at the sectoral level, most are related to developed economies, i.e. the United States, the United Kingdom, Europe, China and Australia. This paper extends the country-level analysis for an emerging market given the limited number of studies that have examined the relationship between oil price changes and the stock market in developing (emerging) economies, specifically in terms of a sector-by-sector basis. In addition, for the GCC countries in general, most of the empirical work focuses on the causal association between oil prices and the stock market (for example, see Hammoudeh and Choi, 2006; Zarour, 2006; Lescaroux and Mignon, 2008; Arouri et al, 2012; Jouini, 2013). However, though the findings on the relationship between oil prices and industrial sector indices are scarce, the paper sheds light on the sectoral analysis and offers a comprehensive sector-by-sector analysis as per the case of Kuwait.

## 3. Data and Methodology

To investigate the link between Kuwait sectoral stock prices and oil prices, daily data on Brent and WTI nominal spot crude oil prices are taken from the website of Energy Information Administration (EIA) (www.eia.doe.gov). Data on daily Kuwait sectoral stock market prices is extracted from the Kuwait Stock Exchange (KSE) historical database profile. The stock prices were converted to US dollars using the daily exchange rate reported by the Kuwait Central Bank. Our daily data spans from January 3, 2000 to December 9, 2015 for some sectors, and from May 14, 2012 to December 9, 2015 for others.[4] We utilize ten sectors, namely Banking, Consumer Goods, Consumer Services, Industries, Real Estate, Basic Material, Financial Services, Oil & Gas, Technology, and Telecommunications.

The bulk of research on modeling sectoral stock market prices has been performed in a linear structure. Nonetheless, many macroeconomic variables postulate nonlinear characteristics.

[4] Daily data was adjusted to match the sequence of the differences between the working days between Kuwait Stock Market and oil markets.

Moreover, stock market prices are driven by economic activities, implying that its behavior could also demonstrate nonlinearity. Thus, using linear models would not be an appropriate approach in studying the relationships between sectoral stock market prices and other economic variables; it could provide misleading evidence on such associations. Additionally, under the nonlinearity structure, the reaction of stock market prices to the economy's positive shocks may be different from the reaction to negative ones. Likewise, the presence of nonlinearities in the behavior of oil prices, the key variable in this paper, has been documented by significant empirical literature (see Kisswani and Nusair, 2013). As such, oil prices can cause asymmetric influences on sectoral stock market prices. For this reason, we investigate the potential asymmetric relationship between oil prices and the Kuwait sectoral stock market prices for various sectors by employing the recently developed nonlinear autoregressive distributed lags (NARDL) model of Shin et al (2011). This approach extends the autoregressive distributed lags (ARDL) bounds testing approach of Pesaran et al (2001) to allow for estimating asymmetric long- and short-run coefficients in a cointegration framework.

To start, we hypothesize the following asymmetric long run equation of sectoral stock market prices:

$$S_t = \alpha_0 + \alpha_1 O_t^+ + \alpha_2 O_t^- + e_t \qquad (1)$$

where ($S_t$) is sectoral stock market price, ($O_t$) is nominal spot oil price (hereafter oil price),[5] $\alpha = (\alpha_0, \alpha_1, \alpha_2)$ is a cointegration vector or a vector of long run parameters to be estimated, and the disturbance ($e_t$) follows the *iid* process with zero mean and finite variance, and it is independently distributed. All variables are measured in logarithms. In equation (1), $O_t^+$ and $O_t^-$ are partial sums of positive and negative changes in ($O_t$):

$$O_t^+ = \sum_{i=1}^{t} \Delta O_i^+ = \sum_{i=1}^{t} \max(\Delta O_i, 0) \qquad (2)$$

and

$$O_t^- = \sum_{i=1}^{t} \Delta O_i^- = \sum_{i=1}^{t} \min(\Delta O_i, 0) \qquad (3)$$

The NARDL setting is a cointegration test that employs positive and negative partial sum decompositions, enabling the detection of asymmetric effects in both the long and the short run. Indeed, the description of the NARDL allows for the joint investigation of the issues of nonstationarity and nonlinearity in the setting of an unrestricted error correction model. From equation (1), the long run relation between sectoral stock market prices and oil price increases is captured by $\alpha_1$, which is anticipated to be negative. Meanwhile, $\alpha_2$ captures the long-run relation between sectoral stock market prices and oil price decreases, and is also expected to be negative, as they are believed to move in the opposite direction. We further expect that the decreases in oil prices will cause different long-run variations in the sectoral stock market prices as compared to oil price increases of the same magnitude, i.e. $\alpha_2 \neq \alpha_1$. Hence, the long-run association as characterized by equation (1) indicates an asymmetric long-run oil price pass through to the sectoral stock market prices.

Following Shin et al (2011), equation (1) can be outlined in an ARDL context along the line of Pesaran et al (2001) as:

$$\Delta S_t = \alpha + \beta_0 S_{t-1} + \beta_1 O_t^+ + \beta_2 O_t^- + \sum_{i=1}^{p} \gamma_i \Delta S_{t-i} + \sum_{i=0}^{q} (\theta_i^+ \Delta O_{t-i}^+ + \theta_i^- \Delta O_{t-i}^-) + u_t \quad (4)$$

where all the variables are as described in equation (1), beside $p$ and $q$ are lag orders. The long run coefficients ($\alpha_1 = -\frac{\beta_1}{\beta_0}$ and $\alpha_2 = -\frac{\beta_2}{\beta_0}$) will represent the long-run effects of oil price increases and decreases on the sectoral stock market prices respectively. $\sum_{i=0}^{q} \theta_i^+$ captures the

[5] In this paper, we use nominal oil prices, as consumer price index at daily basis is not available. Narayan et al (2007) illustrates that using daily data does not require identifying real values. This approach was also adopted by Ghosh and Kanjilal (2014).

short-run effect of oil price increases on sectoral stock market prices, while $\sum_{i=0}^{q} \theta_i^-$ shows the short-run effect of oil price decreases. The specification of equation (4) shows that the model captures the asymmetric short-run impact of oil price variations on the sectoral stock market prices, as well as the asymmetric long-run effect.

To carry out the nonlinear ARDL methodology, we need to apply the following steps: first, run a unit root test to check the order of integration of the variables involved to verify that none is I(2). If this is the case then this makes the computed F-statistics for testing cointegration invalid, although the ARDL methodology for cointegration is valid irrespective of whether the variables are I(0) or I(1). To this end, we apply the commonly employed ADF and PP unit root tests for determining the order of integration for the sectoral stock market prices and oil prices. In the second step, we estimate equation (4) using the standard OLS method incorporating the significant number of lags to capture the most reliable representation of the NARDL model. In the the third step, by using the estimated NARDL model, we test for the existence of a long-run relationship among the variables (cointegration) by conducting an F-test for the joint significance of the coefficients of the lagged level variables. The null hypothesis of no cointegration ($H_0$: $\beta_0 = \beta_1 = \beta_2 = 0$) is tested against the alternative of cointegration ($H_1$: $\beta_0 \neq \beta_1 \neq \beta_2 \neq 0$). Two sets of critical value bounds for the F-statistic are generated by Pesaran et al (2001). If the computed F-statistic falls below the lower bound critical value, the null hypothesis of no-cointegration cannot be rejected. On the other hand, if the computed F-statistic exceeds the upper bound critical value, the null hypothesis is rejected, implying a long-run cointegration relationship among the variables in the model. However, if the computed F-statistic value falls within the bounds, the test is inconclusive. In the final step, once cointegration is established, we test the long- and short-run asymmetries between oil prices and sectoral stock market prices to draw conclusions and inferences. Within this step, we can also develop the asymmetric cumulative dynamic multiplier effects of a one percent change in $O_{t-1}^+$ and $O_{t-1}^-$ respectively as:

$$m_k^+ = \sum_{j=0}^{k} \frac{\partial S_{t+j}}{\partial O_{t-1}^+}, m_k^- = \sum_{j=0}^{k} \frac{\partial S_{t+j}}{\partial O_{t-1}^-}, h = 0, 1, 2, .... \quad (5)$$

Note that as $h \to \infty$, $m_k^+ \longrightarrow \alpha_1$ and $m_k^- \longrightarrow \alpha_2$

To further investigate the nexus between oil prices ($O_t^+$ and $O_t^-$: partial sums of positive and negative changes in $O_t$) and the sectoral stock market prices, the paper tests the direction of causality between the series using the Granger causality test (1988). This test infers that if two series are cointegrated, then there must be Granger-causation in at least one direction. A variable X Granger causes Y, if Y can be predicted with better accuracy by using past values of X with other factors held constant. The Granger causality test involves estimating the following model:

$$y_t = \mu_t + \sum_{i=1}^{p} \alpha_i y_{t-i} + \sum_{i=1}^{p} \beta_i X_{t-i} + \varepsilon_t \quad (6)$$

where $\mu_t$ denotes the deterministic component and $\varepsilon_t$ is white noise. The null hypothesis of non-causality from X to Y in equation (6) can be stated as: $H_0$: $\beta_i = 0$, for $\forall_i$. Rejecting the null suggests there is Granger causality. The null hypothesis can be tested by using the F-test. If the *p*-value is significant, then this implies that the first series Granger causes the second series (null is rejected).

**4. Empirical Findings**

Given that the linear and non-linear ARDL tests can be applied regardless of the series order of integration, the bounds testing procedure requires that no I(2) variables are involved because they invalidate the computed F-statistics. For this reason, it is compulsory to first test the integration properties of the participating variables to confirm that none of the used series are I(2). Therefore, we apply the Augmented Dickey-Fuller (1979) and Phillips-Perron (1988) unit root tests. The findings, displayed in table 1, suggest that the two oil price measures and all sectoral stock prices are nonstationary in levels, while they are stationary in first differences. Thus, we can proceed with the bounds testing procedure (testing for cointegration in the non-linear ARDL framework) since the tests indicate none of the variables is I(2).

In testing for cointegration, we estimate equation (4) using the appropriate lag order. The bounds F-statistics of the non-linear ARDL models are reported in table 2. The findings document a long-run relationship (cointegration) between Brent oil price and the following stock prices: Banking (at the 10 percent level), Consumer Goods (at the 10 percent level), Consumer Services (at the one percent level), Industrials (at the five percent level) and Real Estate (at the five percent level). Meanwhile, WTI oil price is cointegrated with the following stock prices: Consumer Services (at the one percent level) and Industrials (at the 10 percent level).[6] As for the rest of the sectors, no cointegration evidence was found. Continuing with this analysis and for the sectoral stock prices that were found cointegrated with oil price measures, we go one further step by estimating the cointegration results: the short- and long-run coefficients. Tables 3 and 4 report these estimates. Additionally, some diagnostic tests such as Jarque-Bera statistics for error normality (J-B) and the LM statistics for autocorrelation up to order two are presented in tables 3 and 4. Additionally, we also examine the structural stability of the cointegrated relations by the CUSUM and CUSUMSQ statistics, where Figures 1.a and 1.b show the graphs for these statistics.

The results of the diagnostic tests of both models (in tables 3 and 4) suggest adequate specifications as the models pass normality tests and show free autocorrelation errors. All error correction coefficients (ECM) are negative, as required, and are highly significant. However, the ECMs show a low rate of convergence to equilibrium; any deviation from the long-run equilibrium between variables is adjusted and corrected in less than one percent for each period and takes at least more than 33 periods to return to the long-run equilibrium level. Additionally, the CUSUM statistics show that the long-run equilibrium is stable, but that is not the case using the CUSUMSQ statistics. Turning now to the short-run estimates, the results reported in table 3 show that Brent oil price has a symmetric effect on the stock prices of the Banking, Consumer Services, Industrials and Real Estate sectors, where the coefficients on the partial sums of positive and negative changes in ($O_t$), $O_t^+$ and $O_t^-$ are not significant. However, the effect is asymmetric regarding the Consumer Goods sector; where the oil price increase is significant at the 10 percent level, while the oil price decrease has no effect. As for the WTI measure, the short-run coefficients reported in table 4 show asymmetric effect for both the Industrials and Real Estate sectors. Turning to the long-run coefficients calculated using the estimated outcomes in tables 3 and 4 and summarized in table 5, it appears that all the long-run coefficients are negative as expected, but both variables, the partial sums of positive and negative changes in $O_t$ ($O_t^+$ and $O_t^-$), carry coefficients that are different in size. This outcome provides evidence of asymmetric effects in the long run.

Finally, we look at the Granger causality test between oil prices ($O_t^+$ and $O_t^-$; partial sums of positive and negative changes in $O_t$) and the sectoral stock market prices that demonstrated long-run relation. The causality results, reported in table 6, show that there is bidirectional causality between Brent positive oil price shock and the stock prices of the Banking, Consumer Goods, Consumer Services, Industrials and Real Estate sectors. On the other hand, a unidirectional causality running from Brent negative oil price shock to the stock prices of the Banking, Consumer Goods, Consumer Services, Industrials and Real Estate sectors is reported in table 6. As for the WTI price measure, we find bidirectional causality between the WTI positive oil price shock and the stock prices of Consumer Services and Industrials, and

[6] The noticeable result was not finding cointegration between oil price measures and Oil & Gas stock prices. At this point we don't have any clear explanation for why this could be the case.

unidirectional causality from the WTI negative oil price shock to the stock prices of Consumer Services and Industrials.

## 5. Conclusions

In this paper, we investigated the dynamics between sectoral stock prices and selected oil prices, namely Brent and WTI measures, using Kuwait daily data. The paper contributes to the literature by using a nonlinear cointegration methodology: the nonlinear Autoregressive Distributed Lag cointegration technique. This technique allows for testing the asymmetric effects in both the long- and short-run time periods. We employed daily data from January 3, 2000 to December 9, 2015 for some sectors, and from May 14, 2012 to December 9, 2015 for others.

The cointegration results show that we can reject the null hypothesis of no cointegration for some sectors, revealing the presence of an asymmetric long-run effect between the two variables. As for the short run, we found an asymmetric effect in case of the WTI price measure, but a symmetric effect in case of the Brent price measure. On the whole, we conclude that using nonlinear models contribute to better understanding the long-run relationships, thus helping more in policy-making. Our conclusion on non-linearity between oil price changes and the stock market go in line with Lardic and Mignon (2008), Arouri et al (2011) and Zhang (2013). The results on the long-run cointegration relationship between the two variables and varying impact of oil price changes on stock prices is supported by Park and Ratti (2008) for Norway, Arouri (2011) for Europe, Li et al (2012) for the Chinese stock market at the sector level, Degiannakis et al (2013) for the European sectors, Hamma et al (2014) for Tunisia, and Caporale et al (2015) and Huang et al (2015) for China.

In most cases, financial assets are traded based on sector stock price. However, our findings indicate that it is crucial for market traders to understand the oil price transmission mechanism across sectors in order to form their optimal portfolio decisions. Having said this, by using sectoral stock prices of an exporting economy, this paper provides useful information for market participants to build their speculation and arbitrage strategies and diversify their optimal portfolio across sectors. The findings also indicate the possibility to predict the movement of sectoral stock prices as it is cointegrated with oil prices, which can be anticipated based on the expectation of oil demand and supply dynamics.

This paper proposes the following policy implications. First, the cointegration tendency between the two variables implies that investors need to be aware of the different behavior of sectoral stock prices towards oil price changes. Second, discrepancies in the response of sectoral stock prices to Brent and WIT oil price changes implies that investors and policymakers should consider altered benchmark information to maintain their decisions in different sectors over dissimilar time horizons. Third, the asymmetric effects imply that market participants should take up diverse strategies to hedge the risk of oil price changes, hence shrinking financial market disturbances caused by significant oil price shocks. Fourth, the bidirectional causality between the two variables implies that, by utilizing the information of one market, an investor can speculate in the other market in the long run. This result may highlight the possibility of considering the Kuwait stock exchange as an attractive destination for portfolio hedging and diversification strategies to hedge against oil price changes.

The findings of this paper may be of great interest to different economic parties. For portfolio managers, heterogeneity of the impact of oil price changes on sectoral stock prices may be applied to recognize possible sector-based investment and/or hedging opportunities. In addition, the chance of developing an optimal portfolio asset allocation decisions will enable investors to develop hedging strategies that can reduce portfolio risk considerably. As for investors, the cointegration between the two variables provides some degree of future predictability of stock prices, where portfolio diversification, speculation, arbitrage and hedging strategies have to be developed when one expects a change in oil prices. Likewise, for risk management purposes, the managers of firms would have the chance to recognize that oil price changes constitute a crucial portion of the overall market or a systematic risk factor of their sectoral stock price. Finally, for policymakers, identifying the relationship between oil price changes and the sectoral stock price is very helpful in enhancing the development of superior energy investment and consumption polices.

To this end, an extension of this paper can examine the effect of oil price shocks on sectoral stock prices by considering the presence of structural breaks that have directly affected oil prices. The structural breaks could be a reason for not finding a long-run relationship, or could be a reason causing the long-run relationship to change. Considering that the structural breaks in the model could add value to the analysis, this will be the objective of our future work.

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## Figure 1a: Brent Oil Price

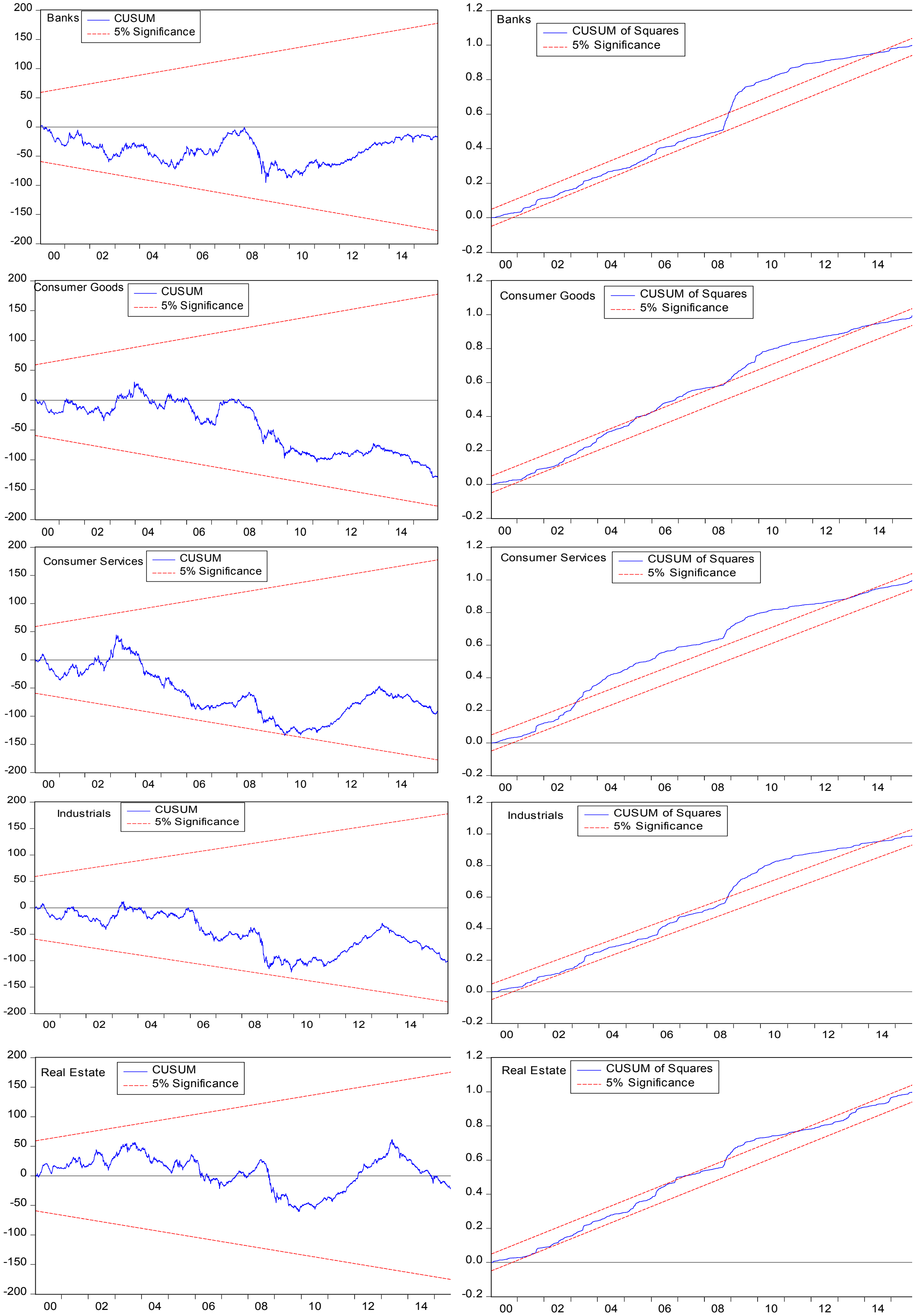
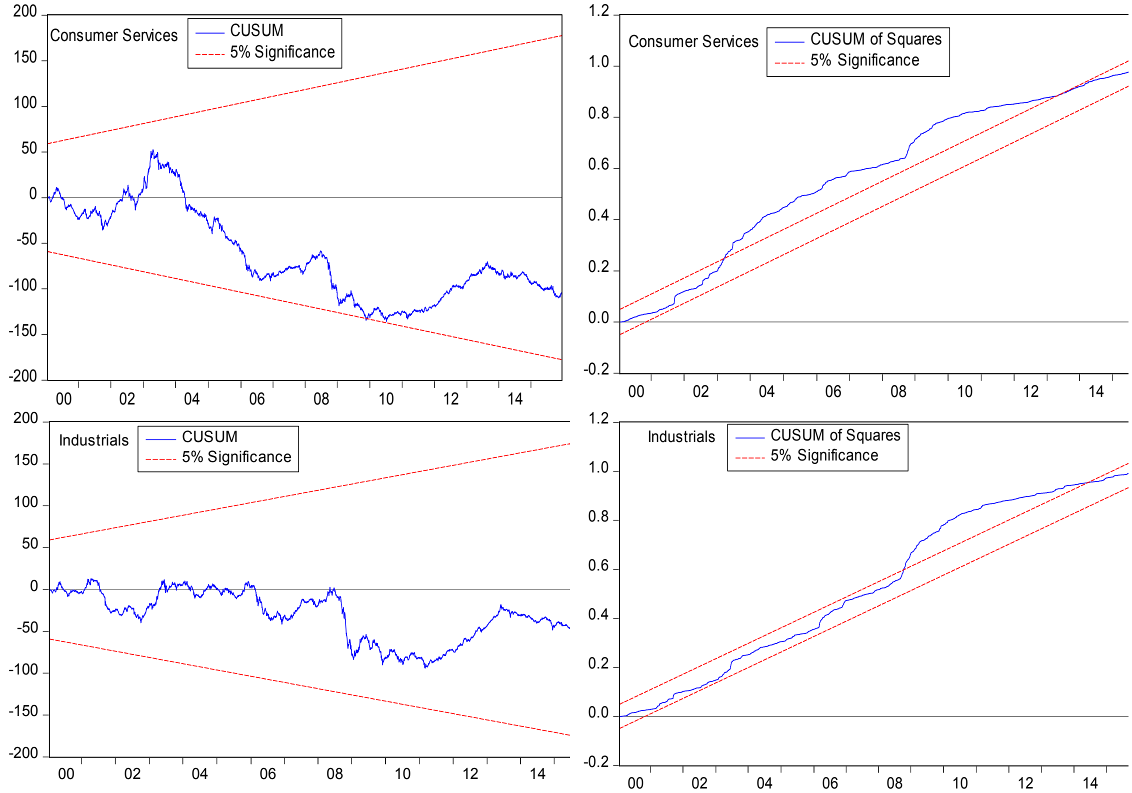


**Figure 1b: WTI Oil Price**



## Table 1: ADF and PP Unit Root Tests

| | Level | | First Difference | |
|---|---|---|---|---|
| **Variable** | **ADF** | **PP** | **ADF** | **PP** |
| Brent | -1.67, [0] | -1.76, [8] | -61.75***, [0] | -61.76***, [6] |
| | (0.76) | (0.72) | (0.00) | (0.00) |
| WTI | -1.4, [0] | -1.28, [31] | -64.76***, [0] | -64.80***, [32] |
| | (0.86) | (0.89) | (0.00) | (0.00) |
| Banking | -0.64, [1] | -0.61, [5] | -57.39***, [0] | -57.4***, [1] |
| | (0.98) | (0.98) | (0.00) | (0.00) |
| Basic Materials | -1.01, [1] | -1.1, [5] | -33.87***, [0] | -33.84***, [2] |
| | (0.94) | (0.93) | (0.00) | (0.00) |
| Consumer Goods | -1.37, [1] | -1.37, [4] | -58.37***, [0] | -58.44***, [3] |
| | (0.87) | (0.87) | (0.00) | (0.00) |
| Consumer Services | -1.43, [1] | -1.24, [25] | -52.26***, [0] | -55.16***, [23] |
| | (0.85) | (0.90) | (0.00) | (0.00) |
| Financial Services | -0.44, [1] | -0.58, [12] | -25.23***, [0] | -25.74***, [10] |
| | (0.99) | (0.98) | (0.00) | (0.00) |
| Industrials | -1.52, [1] | -1.46, [23] | -51.13***, [0] | -53.27***, [20] |
| | (0.82) | (0.84) | (0.00) | (0.00) |
| Oil and Gas | -0.67, [0] | -0.6, [2] | -31.08***, [0] | -31.07***, [0] |
| | (0.97) | (0.98) | (0.00) | (0.00) |
| Real Estate | -1.4, [1] | -1.39, [23] | -51.26***, [0] | -53.32***, [18] |
| | (0.86) | (0.86) | (0.00) | (0.00) |
| Technology | -2.31, [2] | -2.62, [5] | -24.62***, [1] | -33.18***, [1] |
| | (0.43) | (0.27) | (0.00) | (0.00) |
| Telecommunications | -2.32, [0] | -2.5, [6] | -19.35***, [1] | -29.94***, [4] |
| | (0.42) | (0.33) | (0.00) | (0.00) |

Notes: The constant and trend terms are included in the test equations and the AIC is used to select the optimal lag order in the ADF test equation. Numbers in parentheses are MacKinnon (1996) p-value of the test. Numbers in [ ] denote optimal lags. ***denote significance at the 1% level.

## Table 2: Bounds Test for Non-Linear Cointegration

| | F-statistic | Conclusion | F-statistic | Conclusion |
|---|---|---|---|---|
| **Dependent Variable** | **Brent** | | **WTI** | |
| Banking | 4.42* | Cointegration | 3.44 | No Cointegration |
| Basic Materials | 1.75 | No Cointegration | 0.73 | No Cointegration |
| Consumer Goods | 4.3* | Cointegration | 2.74 | No Cointegration |
| Consumer Services | 6.69*** | Cointegration | 6.28*** | Cointegration |
| Financial Services | 1.25 | No Cointegration | 0.66 | No Cointegration |
| Industrials | 5.48** | Cointegration | 4.02* | Cointegration |
| Oil & Gas | 1.78 | No Cointegration | 0.88 | No Cointegration |
| Real Estate | 5.57** | Cointegration | 2.23 | No Cointegration |
| Technology | 1.49 | No Cointegration | 1.4 | No Cointegration |
| Telecommunications | 2.53 | No Cointegration | 2.53 | No Cointegration |

| | Critical Values | |
|---|---|---|
| **Significance** | **I0 Bound** | **I1 Bound** |
| 10% | 3.38 | 4.02 |
| 5% | 3.88 | 4.61 |
| 1% | 4.99 | 5.85 |

Notes: The bounds test includes a linear trend. The bounds test critical values are from Pesaran *et al* (2001). ***, **, * denote significance at the 1%, 5% and 10% levels, respectively.

## Table 3: Nonlinear ARDL Estimation Results (Brent Oil Price)

| Independent Variable | Banking | | Consumer Goods | | Consumer Services | |
|---|---|---|---|---|---|---|
| | Coefficient | p-value | Coefficient | p-value | Coefficient | p-value |
| Constant | 0.001084** | 0.0172 | 0.000763 | 0.1529 | 0.001204*** | 0.0029 |
| S(-1) | -0.000328 | 0.1735 | -0.000520 | 0.1609 | -0.000147 | 0.3724 |
| $O^{+}$(-1) | -0.000679 | 0.2916 | -0.001636** | 0.0232 | -0.001841** | 0.0014 |
| $O^{-}$(-1) | -0.001329** | 0.0387 | -0.002275*** | 0.0021 | -0.002300*** | 0.0001 |
| ΔS(-1) | 0.087346*** | 0.0000 | 0.064437*** | 0.0001 | 0.167916*** | 0.0000 |
| ΔS(-2) | -0.035765** | 0.0253 | 0.018199 | 0.2561 | 0.020891 | 0.1976 |
| ΔS(-3) | | | 0.033593** | 0.0357 | 0.027331* | 0.0875 |
| $\Delta O^{+}$ | | | 0.000669 | 0.9622 | | |
| $\Delta O^{+}$(-1) | | | 0.024682* | 0.0785 | | |
| $\Delta O^{+}$(-2) | | | -0.024426* | 0.0821 | | |
| | | | | | | **Diagnostic tests:** |
| $ECM_{t-1}$ | -0.000334*** | | -0.000543*** | | -0.000153*** | |
| Adjusted $R^2$ | 0.011805 | | 0.010554 | | 0.043663 | |
| LM(2) | 1.626718 | | 4.575769 | | 0.392729 | |
| JB | 2636.45*** | | 1186.49*** | | 1447.81*** | |

| Independent Variable | Industrials | | Real Estate | |
|---|---|---|---|---|
| | Coefficient | p-value | Coefficient | p-value |
| Constant | 0.000807** | 0.0457 | 0.000537 | 0.2841 |
| S(-1) | -0.000174 | 0.4862 | -0.000156 | 0.6183 |
| $O^{+}$(-1) | -0.001708*** | 0.0024 | -0.002059*** | 0.0018 |
| $O^{-}$(-1) | -0.002030*** | 0.0004 | -0.002564*** | 0.0002 |
| ΔS(-1) | 0.194531*** | 0.0000 | 0.191117*** | 0.0000 |
| $\Delta O^{-}$ | | | 0.014534 | 0.2276 |
| | | | | **Diagnostic tests:** |
| $ECM_{t-1}$ | -0.000182*** | | - 0.00011*** | |
| Adjusted $R^2$ | 0.044515 | | 0.043347 | |
| LM(2) | 2.317746 | | 4.660380 | |
| JB | 1408.27*** | | 1640.86*** | |

Note: ***, **, * significant at the 1%, 5% and 10% levels, respectively.

## Table 4: Nonlinear ARDL Estimation Results (WTI oil price)

| Independent Variable | Consumer Services | | Industrials | |
|---|---|---|---|---|
| | Coefficient | p-value | Coefficient | p-value |
| Constant | 0.001905*** | 0.0000 | 0.001425*** | 0.0015 |
| S(-1) | 0.00 | 0.9743 | 0.00 | 0.8101 |
| $O^{+}$(-1) | -0.001556** | 0.0140 | -0.001271** | 0.0432 |
| $O^{-}$(-1) | -0.001753*** | 0.0037 | -0.001458** | 0.0170 |
| ΔS(-1) | 0.168873*** | 0.0000 | 0.196715*** | 0.0000 |
| ΔS(-2) | 0.022584 | 0.1637 | | |
| ΔS(-3) | 0.029544* | 0.0647 | | |
| $\Delta O^{+}$ | | | -0.021036* | 0.0531 |
| $\Delta O^{-}$ | 0.012957 | 0.1731 | 0.006914 | 0.4946 |
| $\Delta O^{+}$(-1) | | | -0.012177 | 0.2589 |
| $\Delta O^{+}$(-2) | | | 0.017932* | 0.0734 |
| $\Delta O^{-}$(-1) | 0.018250* | 0.0576 | 0.022330** | 0.0290 |
| $\Delta O^{-}$(-2) | 0.020447** | 0.0334 | | |
| | | **Diagnostic tests:** | | |
| $ECM_{t-1}$ | -0.000008*** | | -0.000062*** | |
| Adjusted $R^2$ | 0.041265 | | 0.044091 | |
| LM(2) | 0.185249 | | 2.738665 | |
| JB | 1478.47*** | | 1387.05*** | |

Note: ***, **, * significant at the 1%, 5% and 10% levels, respectively.

## Table 5: Long-run Relations

| Sector | Brent Oil Price | | WTI Oil Price | |
|---|---|---|---|---|
| | $O^+$ | $O^-$ | $O^+$ | $O^-$ |
| Banking | -2.072 | -4.05 | | |
| | (0.49) | (0.302) | | |
| Consumer Goods | -3.15 | -4.38 | | |
| | (0.308) | (0.23) | | |
| Consumer Services | -12.52 | -15.64 | -289.22 | -325.83 |
| | (0.44) | (0.40) | (0.97) | (0.97) |
| Industrials | -9.8 | -11.65 | -20.38 | -23.37 |
| | (0.54) | (0.51) | (0.82) | (0.82) |
| Real Estate | -13.35 | -16.63 | | |
| | (0.65) | (0.64) | | |

Notes: numbers in ( ) are p-values.

## Table 6: Pairwise Granger Causality Tests

| ***1. Brent Oil Price*** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **$O_t^+$ does not Granger Cause $S_t$** | | **$S_t$ does not Granger Cause $O_t^+$** | | **$O_t^-$ does not Granger Cause $S_t$** | | **$S_t$ does not Granger Cause $O_t^-$** | |
| | F-Statistic | Prob. | F-Statistic | Prob. | F-Statistic | Prob. | F-Statistic | Prob. |
| Banking | 3.64** | 0.03 | 5.72*** | 0.00 | 3.53** | 0.03 | 1.59 | 0.20 |
| Consumer Goods | 3.93** | 0.02 | 4.97*** | 0.01 | 4.53** | 0.03 | 0.02 | 0.89 |
| Consumer Services | 6.81*** | 0.00 | 7.03*** | 0.00 | 6.29*** | 0.00 | 1.64 | 0.19 |
| Industrials | 3.45** | 0.03 | 6.04*** | 0.00 | 3.26** | 0.04 | 0.21 | 0.81 |
| Real Estate | 2.58* | 0.08 | 2.39* | 0.09 | 2.57* | 0.08 | 1.37 | 0.25 |

| ***2. WTI Oil Price*** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **$O_t^+$ does not Granger Cause $S_t$** | | **$S_t$ does not Granger Cause $O_t^+$** | | **$O_t^-$ does not Granger Cause $S_t$** | | **$S_t$ does not Granger Cause $O_t^-$** | |
| | F-Statistic | Prob. | F-Statistic | Prob. | F-Statistic | Prob. | F-Statistic | Prob. |
| Consumer Services | 7.27*** | 0.00 | 5.92*** | 0.00 | 7.93*** | 0.00 | 0.63 | 0.53 |
| Industrials | 3.58** | 0.03 | 3.87** | 0.02 | 4.75*** | 0.01 | 0.37 | 0.69 |

Notes: $S_t$ is sectoral stock market price. $O_t^+$ and $O_t^-$ are the partial sums of positive and negative changes in oil price. Lags included in the test are 2. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.