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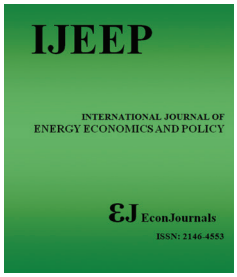

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Oil Price and Industrial Growth in Saudi Arabia: Sectoral and Asymmetry Analyses

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ABSTRACT

Oil price could have long-lasting effects on any oil-exporting economy due to its dependence on oil revenue. This present research probes the role of Oil Price (OP) on the 22 categories of manufacturing industries of Saudi Arabia and the growth of total industries during 1990-2018 in the nonlinear settings. To serve the purpose, we utilize the unit root test and nonlinear cointegration test of Shin et al. (2014) based on modified bound statistics of Kripfganz and Schneider (2019). The increasing or decreasing oil price could have different magnitude or direction of effects. Hence, the present research applies a nonlinear cointegration in the relationship between oil price and industrial growth. We found cointegration in the total industries' model and 19 industries' models. In the long run, increasing OP has a positive relationship with 8 out of 22 investigated industries and has a negative relationship with 2 out of 22 investigated industries. Decreasing OP has a positive relationship with 2 out of 22 industries and has a negative relationship with 4 out of 22 industries. In the short run, increasing OP has a positive relationship with one industry and has a negative relationship with 10 out of 22 investigated industries. Decreasing OP has a positive relationship with 3 out of 22 industries and has a negative relationship with one industry. Asymmetry is corroborated in all investigated models except the petroleum industry in the long run and is validated in all models in the short run.

Keywords: Oil Price, Manufacturing Industries, Asymmetry, Nonlinear Cointegration
JEL Classifications: Q41, Q43, L60, C22

1. INTRODUCTION

Oil Price (OP) and revenues are the major components of the Gulf Cooperation Council (GCC) region. OP and oil sector significantly contributes to supporting economic growth, fiscal revenues, and exports' earning of oil-exporting of the GCC region (Metwally and Perera, 1995; El Mahmah and Kandil, 2019; Nusair, 2016; Mahmood and Furqan, 2020). The effect of OP on the other macroeconomic indicators has also been investigated in the GCC region. For example, GCC literature corroborated that OP has a positive effect on the military spending (Erdogan et al., 2020), a positive effect on the energy depletion (Alkhateeb and Mahmood, 2020) a positive effect on the capital formation (Alkhateeb and Mahmood, 2021), a positive effect on the remittances outflows (De et al., 2019), a positive effect on trade performance (Metwally, 1993) and a positive effect on the exchange rate (Al Rasasi, 2017).

Saudi Arabia is the largest oil exporter in the GCC and world market. Also, the oil sector contributes more than 40% of Saudi income, more than 90% of exports, and more than 90% of government revenues (Government of Saudi Arabia, 2020). Hence, the oil sector and oil price would play a major role in the demand and supply sides of the Saudi economy. Saudi literature has investigated the role of OP in the performance of different macroeconomic indicators. In Saudi Arabia, OP has a positive effect on personal consumption (Mahmood and Zamil, 2019), a positive impact on employment (Alkhateeb et al., 2017), a positive effect on foreign investment inflows (Mahmood and Alkhateeb, 2018), a positive effect on economic growth (Mahmood and

Murshed (2021) a positive effect on fiscal variables (Mahmood, 2021), a positive effect on pollution (Mahmood et al., 2020), and a negative effect on imports (Algaeed, 2018). Some literature also investigated the energy and pollution issue in Saudi Arabia (Senan et al., 2018; Mahmood et al., 2019; Mahmood and Alanzi, 2020).

Increasing OP can be good news in the stock market of oil exporters' and can be bad news for an oil importers' stock market (Siddiqui et al., 2019). In the same line, decreasing OP could affect negatively to the exporter market and a positive effect on the importer market. A bulk GCC literature has investigated the OP and stock market nexus considering linear and nonlinear analyses (Fayyad and Daly, 2011; Mokni and Youssef, 2019; Arouri et al., 2010; Arouri and Rault, 2011; Arouri et al., 2011; Louis and Balli, 2014; Akoum et al., 2012; Ahmad, 2019; Nusair and Al-Khasawneh, 2018). In the linear analysis, Arouri et al. (2011) probed OP and Stock Market Returns (SMR) nexus and its volatility in GCC countries. They found that world OP has spillover and cause the volatility of SMR in the GCC. Using bootstrapping cointegration, Arouri and Rault (2011) reinvestigated OP and stock prices relationship in GCC and corroborated a positive impact of increasing OP on stock prices except for Saudi Arabia.

Fayyad and Daly (2011) argued that increasing OP accelerate the surplus in oil-exporters while the deficit in the oil-importer advance economies. In the empirical exercise, they found that the OP effect on SMR increases in four GCC countries, the UK and the USA after increasing OP and financial crisis. This relationship was more prominent in Qatar, UAE, and UK. Louis and Balli (2014) investigated OP and SMR volatility in GCC countries. In their empirical analysis, they found the low to medium level of relationship between OP and SMR volatility. Moreover, they found that shock to volatility relationship was found more prominent than that of a shock to OP returns in dynamic analyses in the GCC region. Akoum et al. (2012) investigated the OP return and SMR relationship in Egypt, Jordon, and six GCC countries. They could not validate a short-run relationship. However, the strong long-run co-movements are found between OP returns and SMR in these countries. In the non-oil producing countries' analysis, they found the co-movements between OP return and SMR in Jordon were stronger than that of the Egyptian market. Ahmad (2019) explored the OP and SMR nexus in the GCC region and found a strong relationship in the analysis of the 2014 OP crisis period.

After a discussion of linear analysis, some literature also cared about the asymmetry or possible nonlinear relationship between OP and the stock market. For example, Arouri et al. (2010) examined the nonlinear impact of OP on SMR. They corroborated the OP and SMR relationships in the 4 GCC countries but this relationship was nonlinear and switching as well. However, they could not establish this relationship in Kuwait and Bahrain. Nusair and Al-Khasawneh (2018) investigated an asymmetrical effect of OP on SMR. They corroborated the asymmetry in the relationship and also found that both OP and SMR are booming or crashing together in the GCC region. Mokni and Youssef (2019) explored the extent of the association of OP and SMR of the GCC region and found a high degree of relationship. They found that this relationship was most prominent in Saudi Arabia. Moreover, the strength of the relationship was found stronger after the 2014 OP crisis and the spillovers of OP on other countries' markets were also observed. But, OP could not affect the markets in asymmetry analyses.

El-Chaarani (2019) explored the asymmetrical relationship among OP, SMR, and political stability in GCC countries. OP showed an asymmetrical effect on SMR and the effects of the declining OP were found greater than the rising OP. The role of political instability was found prominent to accelerate the effects of decreasing OP on SMR. Siddiqui et al. (2019) investigated the OP and sectoral stock indices nexus in six GCC and 4 largest Asian oil importers. In the analysis of the Saudi market, they investigated 7 sectoral indices including industries' index and aggregate index as well. Before the OP slump 2014, they found an insignificant relationship in most sectors. During the slump 2014, OP harms the energy index and shows a positive effect on the financial, industry, telecommunication, transport, and utility sectors. Further, they found a negative impact of increasing OP and a positive impact of decreasing OP on the aggregate index. Hence, they corroborated the asymmetrical relationship in OP and stock indices in most sectors.

Bulk literature signifies the importance of OP and the macroeconomic performance of GCC countries. Particularly, the OP and GCC stock market relationship is well explored in the established literature but sectoral analyses are scant in GCC literature. Siddiqui et al. (2019) investigated the OP and sectoral stock market relationship in GCC countries and analyzed 7 sectors including industrial and non-industrial sectors. So, the focus on the industries' categories was not limited. Moreover, the stock market carries only listed firms, and non-listed firms were ignored in the OP and stock market literature of GCC countries. Louis and Balli (2014) argued that the non-oil sector was growing in the GCC region because of the oil sector's contribution. Hence, the oil sector could play a significant role in developing the industrial sector in the GCC region. Saudi Arabia is the largest oil exporter of the GCC region and world as well. Hence, the Saudi economy is greatly influenced by any change in OP and industrial growth also depends on OP due to demand and supply linkages. But, the literature is missing the important relationship between OP and industrial growth in Saudi Arabia. To fill this literature gap, this present study probes an asymmetrical relationship between OP and industrial growth in the aggregate industrial units' growth and a case of 22 categories of industrial units, using a maximum available period of 1990-2018.

2. METHODOLOGY

The oil sector contributes significantly to the income of the oil-exporter and increasing OP has a greater impact on the income of Saudi Arabia (Alkhathlan, 2013; Alkhathlan et al., 2020). Hence, increasing income may raise the overall saving and investment level in the country. So, increasing OP can have a positive impact on industrial growth. Moreover, Bodenstein et al. (2011) argued that increasing OP transferred the wealth of oil-importers to exporters which may support the investment and industrial sector growth in exporters' countries. Contrarily, increasing OP may

attract more portfolio investment in oil and related industries in the oil-exporting country, then the non-oil sector may be lesser attractive in the rising OP. Therefore, increasing OP may hurt the growth of the non-oil sector industry in the oil-exporting country. Le and Chang (2013) elaborated another explanation of this negative impact. Rising OP would increase the inflation in the oil-exporting countries due to increasing income and aggregate demand. It would put pressure on the central bank to increase the interest rate and use other tight monetary policy tools to combat inflation. Consequently, it would create a negative effect on investment and industrial growth. Above all discussed effects of increasing OP can be discussed in the opposite direction for a decreasing OP. But, the direction and magnitude of the relationship of increasing OP may not necessarily have the same effects as of decreasing OP (Siddiqui et al., 2019). Hence, asymmetry can be expected in a relationship between OP and industrial growth. Considering this argument, we assume the asymmetry in their relationship. So, we assume the following model:

$$IND_{it} = f(POP_t, NOP_t) \quad (1)$$

Here, IND_{it} is a natural logarithm of the number of industrial units in industrial classification i and t is a period 1990-2018. For estimations, we regress equation 1 on each industry's growth model, and then it may pronounce as time series analysis. POP_t and NOP_t are the positive and negative variables of the oil price which are derived suggested by Shin et al. (2014), in the following way:

$$NOP_t = \sum_{i=1}^{t} \Delta OP_i^{+} = \sum_{i=1}^{t} \max(\Delta OP_i, 0) \quad (2)$$

$$NOP_t = \sum_{i=1}^{t} \Delta OP_i^{-} = \sum_{i=1}^{t} \min(\Delta OP_i, 0) \quad (3)$$

Here, OP_t is a natural logarithm of OPEC OP in the US dollar during 1990-2018. POP_t and NOP_t are restricted summation of positive and negative deviations in OP_t, respectively. Hence, the POP_t series carries only positive movements of OP_t, and the NOP_t series carries only negative movements of OP_t. In this way, we can distinguish the impact of POP_t (rising OP_t) and NOP_t (falling OP_t) on industrial growth. Further, we can apply the cointegration on the hypothesized relationships. OP_t and IND_{it} data are sourced from the Government of Saudi Arabia (2020). Before starting cointegration, the unit root testing is a pre-condition. Hence, we apply the Augmented Dickey and Fuller (ADF) test in the following way:

$$\Delta y_t = C + \delta_1 y_{t-1} + \sum_{i=1}^{k} \upsilon_{1i} \Delta y_{t-i} + e_t \quad (4)$$

$$\Delta y_t = C + \lambda T + \delta_2 y_{t-1} + \sum_{i=1}^{k} \upsilon_{2i} \Delta y_{t-i} + e_t \quad (5)$$

Equations 4 and 5 are test equations, proposed by Dickey and Fuller (1981), with intercept (C) and C and T (Trend), respectively. Both equations can be tested with H_0: unit root and stationarity can be claimed if H_0 is rejected. Afterward, Autoregressive Distributive Lag (ARDL) can be applied to equation 1 to test the hypothesized relationship following Pesaran et al. (2001) procedure. It may be called nonlinear ARDL of Shin et al. (2014) because of POP_t and NOP_t variables in the equation and can be expressed as follows:

$$\Delta IND_t = \alpha_0 + \alpha_1 IND_{t-1} + \alpha_2 POP_{t-1} + \alpha_3 NOP_{t-1} + \sum_{j=1}^{n1} \beta_{1j} \Delta IND_{t-j} + \sum_{j=0}^{n2} \beta_{2j} \Delta POP_{t-j} + \sum_{j=0}^{n3} \beta_{3j} \Delta NOP_{t-j} + \xi_t \quad (6)$$

ARDL in equation 6 is the dynamic model and cares about the endogeneity in the relationship. Equation 6 would be tested for cointegration with H_0: $\alpha_1 = \alpha_2 = \alpha_3 = 0$ of no-cointegration with the bound test, which utilizes the critical statistics of Kripfganz and Schneider (2019). After that, we extract impacts from the normalizing procedure, and then short-run effects are retrieved from the following equation:

$$\Delta IND_t = \gamma \ ECT_{t-1} + \sum_{j=1}^{n1} \beta_{1j} \Delta IND_{t-j} + \sum_{j=0}^{n2} \beta_{2j} \Delta POP_{t-j} + \sum_{j=0}^{n3} \beta_{3j} \Delta NOP_{t-j} + \xi_t \quad (7)$$

Equation 7 would announce the presence of a short-run relationship if gamma is negative and statistically significant. Afterward, we may interpret the betas for the short-run effects of OP.

3. DATA ANALYSES

Table 1 shows the ADF results. Our independent variables POP_t and NOP_t are non-stationary at levels and stationary at first differences. Additionally, industries are also non-stationary at the level and stationary at first difference except Computer and Printing, which are not proved as stationary at their first difference. Some industries series are showing stationary behavior at a level including intercept (C) in analyses i.e. Cloth and Printing. Some industries' series is also showing stationary behavior at a level including C and T in analyses i.e. Beverage, electrical and reformed metals. But, these mentioned industries' series are non-stationary either with only C or both C and T. Hence, all the industries' series are comfortable for cointegration analyses except Computer and Printing.

Table 2 shows the bound test but the computer and printing industries are skipped from bound test analysis as these industries could not meet the stationarity condition. Bound test corroborates cointegration at least at 10% in the models of Beverage, Cloth, Engine, Leather, Paper, Pharmaceutical, Textile, and others. While, the bound test could not validate cointegration in the rest of the models but a negative parameter of ECT_{t1} validates cointegration alternatively (Pesaran et al., 2001) in the rest models except the model of Furniture. Moreover, P-values of diagnostics are at least more than 0.1, hence there are no econometric issues in the estimated models. Hence, we may discuss the long and short-run estimations for all models except the model of Furniture.

The increasing OP (POP_t) has a positive impact on the growth of total industrial units and in the case of Chemical, Cloth, Electrical, Engine, Machine, Metal, Reformed Metals, and Petroleum industries in Table 3. It means that increasing OP has transferred wealth from oil importing to the Saudi economy as per

Table 1: ADF test

Variable	Level		First difference	
	C	C and T	C	C and T
POP	0.4631 (0.9821)	−2.3862 (0.3781)	−3.9532 (0.0057)	−3.8932 (0.0272)
NOP	−0.0295 (0.9479)	−1.9036 (0.6260)	−4.7926 (0.0007)	−4.8032 (0.0035)
Beverage	0.0883 (0.9572)	−5.6749 (0.0007)	−3.9078 (0.0074)	−3.4727 (0.0675)
Chemical materials and products	−0.8336 (0.7938)	−2.7277 (0.2339)	−5.5268 (0.0001)	−5.4855 (0.0007)
Cloth	−3.6000 (0.0123)	−2.1463 (0.4992)	−3.0780 (0.0404)	−4.0731 (0.0180)
Computers, electronic and optical products	1.1589 (0.9969)	2.9185 (1.0000)	0.7205 (0.9901)	−0.5714 (0.9720)
Electrical equipment	−0.2958 (0.9136)	−3.6003 (0.0532)	−4.7412 (0.0008)	−4.6258 (0.0052)
Engine, trailer and semitrailer vehicles	−0.7649 (0.8130)	−2.4553 (0.3457)	−7.4719 (0.0000)	−7.3872 (0.0000)
Food Products	−2.2214 (0.2036)	−1.1367 (0.9042)	−4.0418 (0.0044)	−4.5905 (0.0057)
Furniture	−2.0002 (0.2851)	−1.9161 (0.6196)	−4.9457 (0.0005)	−5.2188 (0.0013)
Leather and related products	−1.1513 (0.6800)	−1.2286 (0.8846)	−2.0017 (0.2844)	−4.0304 (0.0198)
Machines and equipment	0.5720 (0.9862)	−2.3040 (0.4183)	−5.7223 (0.0001)	−5.6547 (0.0005)
Base metal products	0.2689 (0.9722)	−1.3571 (0.8514)	−5.3445 (0.0002)	−5.3878 (0.0009)
Non-metal products	0.7804 (0.9918)	−1.1398 (0.9036)	−4.0031 (0.0049)	−4.1207 (0.0162)
Paper and products	−2.6223 (0.1005)	−2.7583 (0.2230)	−4.5675 (0.0012)	−4.9013 (0.0028)
Coke, coal and refined petroleum products	−1.1211 (0.6552)	−1.6118 (0.7624)	−3.3847 (0.0206)	−3.2918 (0.0890)
Basic pharmaceutical products and pharmaceuticals	−0.9985 (0.7397)	−1.6387 (0.7511)	−5.1513 (0.0003)	−5.1819 (0.0014)
Rubber and plastic products	−2.0048 (0.2832)	−2.0285 (0.5611)	−3.3943 (0.0202)	−3.6865 (0.0409)
Printing	−2.0107 (0.5675)	−2.5050 (0.3233)	−2.5423 (0.1172)	−2.2719 (0.4340)
Reformed Metal	−1.1596 (0.6772)	−4.6530 (0.0061)	−4.2724 (0.0025)	−4.1949 (0.0138)
Textile	−2.5874 (0.1074)	−0.6928 (0.9638)	−0.6554 (0.8397)	−5.1887 (0.0014)
Transportation equipment	−2.2272 (0.2017)	−1.9219 (0.6164)	−6.6892 (0.0000)	−4.3279 (0.0111)
Wood products	−1.0547 (0.7190)	−2.2653 (0.4378)	−5.5395 (0.0001)	−5.3338 (0.0010)
Other manufacturing industries	−2.2451 (0.1965)	−1.9114 (0.6187)	−2.6453 (0.0967)	−3.1113 (0.0381)
Total	−0.7413 (0.8200)	−1.8746 (0.6407)	−4.7836 (0.0007)	−4.6940 (0.0045)

Table 2: Bound and diagnostic tests

Dependent Variables	Bound Test	Hetero	Serial Correlation	Normality	Functional Form
Beverage	5.1452	2.0628 (0.1036)	0.4160 (0.6648)	2.0306 (0.3623)	0.0093 (0.9243)
Chemical materials and products	1.8663	2.0286 (0.1238)	0.4821 (0.6241)	0.8562 (0.6497)	1.5540 (0.2257)
Cloth	7.3706	1.1344 (0.3787)	1.0123 (0.3832)	0.7120 (0.6811)	0.0135 (0.9088)
Electrical equipment	1.2663	1.1255 (0.3689)	0.4090 (0.6695)	0.8752 (0.6158)	0.2255 (0.6395)
Engine, trailer and semitrailer vehicles	3.6426	0.6819 (0.6422)	0.1520 (0.8600)	0.9371 (0.5678)	0.5000 (0.4876)
Food Products	1.7676	1.4355 (0.2541)	0.0348 (0.9658)	2.8306 (0.2428)	0.3747 (0.5467)
Furniture	2.0334	1.1205 (0.3564)	0.1290 (0.8796)	3.2346 (0.1384)	1.1585 (0.2585)
Leather and related products	15.3281	1.1851 (0.3436)	0.3129 (0.7346)	0.8548 (0.6522)	0.0850 (0.7733)
Machines and equipment	1.9752	1.8422 (0.1665)	2.1502 (0.1403)	2.2552 (0.2678)	0.5806 (0.4538)
Base metal products	2.2552	1.7487 (0.1737)	0.3321 (0.7211)	0.5543 (0.7694)	0.5475 (0.4672)
Non-metal products	2.9317	1.7337 (0.1791)	0.2853 (0.7547)	1.1724 (0.4968)	0.0683 (0.7962)
Paper and products	3.9411	1.1757 (0.3582)	0.3774 (0.6910)	0.5615 (0.7552)	0.3240 (0.5759)
Coke, coal and refined petroleum products	2.5660	0.7330 (0.5788)	0.0153 (0.9848)	1.7394 (0.4265)	1.4029 (0.2489)
Basic pharmaceutical products and pharmaceuticals	5.2264	1.7194 (0.1897)	1.4973 (0.2699)	1.0029 (0.6056)	0.0025 (0.9607)
Rubber and plastic products	1.2890	1.1854 (0.3436)	1.0379 (0.3717)	1.9280 (0.3951)	0.6463 (0.4300)
Reformed metal	1.6708	1.6484 (0.1963)	0.6526 (0.5309)	1.7170 (0.4367)	0.7658 (0.3910)
Textile	3.3762	0.8428 (0.5663)	0.2598 (0.7742)	0.8349 (0.6587)	0.3362 (0.5688)
Transportation equipment	2.8761	1.4543 (0.2499)	0.1964 (0.8233)	0.2231 (0.8944)	2.5110 (0.1064)
Wood products	2.6530	0.5621 (0.6925)	0.6842 (0.5154)	0.8104 (0.6668)	1.7549 (0.1989)
Other manufacturing industries	3.4204	2.0671 (0.1023)	2.3426 (0.1207)	1.6720 (0.4426)	0.4878 (0.4875)
Total	1.3031	1.2870 (0.3041)	0.1789 (0.8375)	3.0466 (0.1469)	0.4526 (0.5081)
Critical Bound F-values			At 1% 4.0934-4.9199 At 5% 3.0836-3.8155 At 10% 2.6175-3.2969		

the arguments of Bodenstein et al. (2011). Hence, increasing OP helps to improve income, savings, and investment of the country (Alkhathlan, 2013) which promotes the growth of Chemical, Cloth, Electrical, Engine, Machine, Metal, and Petroleum industries. Contrarily, POP_t hurts the growth of Pharmaceutical and other industries. It means that increasing OP could not support the growth of Pharmaceutical and other industries. Overall, increasing OP has a pleasant effect on the growth of most of the industries' categories. The decreasing OP (NOP_t) has a positive relationship with the growth of the petroleum and transport industries. It means that decreasing OP reduces the revenues to support the petroleum and transport industries. Moreover, NOP_t has a negative relationship with the growth of Beverage, Pharmaceutical, Wood, and other industries. It shows that the slump in OP shifts

the focus of the government from the oil sector to support the Beverage, Pharmaceutical, Wood, and other industries. NOP_t has a statistically insignificant relationship with the growth of most industries. It may be claimed due to a reason that the Saudi government has a lot of reserves that may utilize to support the economy in the OP slump period. So, decreasing OP shows negative effects on lesser industries' categories.

Table 4 shows the short-run results and short-run relation is corroborated in all industries except Leather, Furniture, Paper, and Textile. Lagged industrial growth has a positive impact on the present industrial growth of Beverage. The lagged industrial growth has negative effects on the present industrial growth of Engine, Pharmaceutical, Paper, and Transport. The increasing OP (POP_t) has a positive impact on the Machine industry. Moreover,

Table 3: Long run results

	POP	NOP	Intercept
Beverage	0.0629 (0.1203)	−0.2306 (0.0142)	4.4777 (0.0000)
Chemical materials and products	0.3488 (0.0048)	−0.0363 (0.8706)	5.5122 (0.0000)
Cloth	0.3004 (0.0377)	0.3026 (0.3793)	4.2778 (0.0000)
Electrical equipment	0.2438 (0.0557)	−0.0818 (0.7280)	4.6540 (0.0000)
Engine, trailer and semitrailer vehicles	0.3446 (0.0000)	0.1305 (0.2400)	4.1838 (0.0000)
Food Products	0.1388 (0.4757)	−0.4665 (0.3618)	4.3736 (0.0205)
Furniture	0.2109 (0.2128)	0.1406 (0.6335)	5.2766 (0.0000)
Leather and related products	−0.4146 (0.4271)	0.5826 (0.3294)	5.2930 (0.0003)
Machines and equipment	0.1893 (0.0127)	−0.1945 (0.1228)	4.4482 (0.0000)
Base metal products	0.6477 (0.0464)	0.1418 (0.7620)	4.3240 (0.0000)
Non-metal products	1.1586 (0.3940)	1.0417 (0.5891)	6.8402 (0.0000)
Paper and products	−0.1406 (0.6737)	−0.4765 (0.2162)	6.3537 (0.0050)
Coke, coal and refined petroleum products	1.0736 (0.0005)	1.1491 (0.0743)	3.8815 (0.0000)
Basic pharmaceutical products and pharmaceuticals	−0.2676 (0.0361)	−1.4069 (0.0005)	1.8063 (0.0000)
Rubber and plastic products	0.3272 (0.2622)	0.0884 (0.8855)	6.6741 (0.0000)
Reformed Metal	0.2257 (0.0628)	−0.0886 (0.7398)	6.0861 (0.0000)
Textile	−0.6442 (0.8707)	1.6752 (0.8444)	10.0847 (0.7230)
Transportation equipment	−0.0196 (0.8538)	0.2606 (0.0510)	2.7423 (0.0000)
Wood products	0.0363 (0.6927)	−0.6183 (0.0006)	3.2775 (0.0000)
Other manufacturing industries	−0.3184 (0.0511)	−0.5939 (0.0522)	4.6060 (0.0000)
Total	0.3486 (0.0520)	0.1012 (0.7853)	8.3104 (0.0000)

Table 4: Short run results

	ΔIND_t	ΔPOP_t	ΔPOP_{t-1}	ΔNOP_t	ΔNOP_{t-1}	ECT_{t-1}
Beverage	0.7068 (0.0441)	−0.2389 (0.0654)		0.0407 (0.7507)		−0.8413 (0.0143)
Chemical materials and products		−0.0393 (0.5273)	−0.0067 (0.8797)			−0.1849 (0.0824)
Cloth		−0.1183 (0.2381)		0.1195 (0.1656)	−0.1257 (0.1385)	−0.2067 (0.0112)
Electrical equipment		−0.0629 (0.2876)		−0.0123 (0.7505)		−0.1507 (0.0888)
Engine, trailer and semitrailer vehicles	−0.3841 (0.0000)	−0.0121 (0.8538)		0.0469 (0.1041)		−0.3592 (0.0959)
Food Products		−0.0577 (0.0131)		0.0189 (0.3714)		−0.3405 (0.0914)
Furniture		0.0390 (0.4694)		0.0260 (0.6236)		−0.1851 (0.2693)
Leather and related products		−0.0270 (0.2114)		0.0379 (0.3063)		−0.0651 (0.1511)
Machines and equipment		0.0530 (0.0737)		−0.0544 (0.2954)		−0.2798 (0.0917)
Base metal products		−0.1822 (0.2777)		0.0232 (0.7286)		−0.1640 (0.0732)
Non-metal products		−0.1349 (0.0949)		0.0579 (0.1170)		−0.3556 (0.0252)
Paper and products	−0.4872 (0.0044)	−0.1169 (0.0039)	−0.0838 (0.0445)	−0.0281 (0.2350)		−0.0590 (0.3550)
Coke, coal and refined petroleum products		−0.3362 (0.0063)		0.1693 (0.0000)		−0.1474 (0.0226)
Basic pharmaceutical products and pharmaceuticals	−0.4767 (0.0472)	−0.2512 (0.0102)	−0.1345 (0.4579)	0.3251 (0.0049)	0.1001 (0.3149)	0.5005 (0.0476)
Rubber and plastic products		−0.1474 (0.0130)		0.0069 (0.8770)		−0.0778 (0.0869)
Reformed Metal		−0.1482 (0.0584)		−0.0205 (0.7612)		−0.2310 (0.0923)
Textile		−0.2388 (0.0263)	0.1729 (0.0892)	0.2135 (0.0341)	−0.2528 (0.0410)	−0.0200 (0.8176)
Transportation equipment	−0.4523 (0.0000)	−0.0027 (0.8474)		0.0363 (0.1444)		−0.1394 (0.0011)
Wood products		−0.1428 (0.1421)		−0.1640 (0.0044)		−0.2653 (0.0060)
Other manufacturing industries		−0.0628 (0.0416)		0.1540 (0.2757)		−0.1971 (0.0871)
Total		−0.1007 (0.0427)		0.0113 (0.7456)		−0.3431 (0.0413)

POP_t hurts the growth of the total industrial unit and industries of Beverage, Food, Non-metal, Paper, Petroleum, Pharmaceutical, Plastic, Reformed-Metal, Textile, and others. The decreasing OP (NOP_t) has a positive relationship with the growth of Petroleum, Pharmaceutical, and Textiles. Moreover, NOP_t has a negative relationship with the growth of the Wood industry. NOP_t has a statistically insignificant relationship with the growth of the rest of the industries.

In summary, asymmetry is corroborated with different directions or magnitude of effects in all industries' results except petroleum and total industries' model in the long run. The asymmetry is also proved in all industries' cases and total industries' models in the short-run as well. An increasing OP shows a positive relationship with 8 out of 22 investigated industries and has a negative relationship in 2 out of 22 investigated industries. In contrast, decreasing OP has a positive relation with 2 out of 22 investigated industries and has a negative relationship in 4 out of 22 investigated industries. An increasing OP has a positive relationship with one industry in the short-run and has a negative relationship in 10 out of 22 investigated industries. Moreover, decreasing OP has a positive relationship with 3 out of 22 investigated industries and has a negative relationship in one industry.

4. CONCLUSIONS

We explored the role of OP in the industrial units' growth in Saudi Arabia, using nonlinear ARDL and a period of 1990-2018. We start on 22 types of industries and total industrial growth as well. First, we do unit root analyses which validate the total industries' model and 20 industries' models to be carried out for cointegration analyses. Bound test and error correction term validate cointegration in the total industries' model and 19 industries' models and could not validate the cointegration in the Furniture model. The short-run relation is validated in the growth of all industries except Leather, Furniture, Paper, and Textile. During long-run, increasing OP has a positive relationship with 8 out of 22 investigated industries i.e. Chemical, Cloth, Electrical, Engine, Machine, Metal, Reformed Metals, and Petroleum industries, and also has a positive relationship in total industries' model. Further, it has a negative relationship with 2 out of 22 investigated industries i.e. Pharmaceutical and other industries. Decreasing OP has a positive relationship with 2 out of 22 industries i.e. Petroleum and transport industries and has a negative relationship with 4 out of 22 industries i.e. Beverage, Pharmaceutical, Wood, and other industries. During short-run, increasing OP shows a positive relationship with the Machine industry. Moreover, it has a negative relationship with 10 out of 22 investigated industries i.e. Beverage, Food, Non-metal, Paper, Petroleum, Pharmaceutical, Plastic, Reformed-Metal, Textile, and others and also with the growth of total industrial units. Decreasing OP has a positive relationship with 3 out of 22 industries i.e. Petroleum, Pharmaceutical, and Textiles industries, and has a negative relationship with the Wood industry. In the asymmetry analyses, all industries' results except petroleum and total industries' result show the asymmetry in the long-run relationship. Like that, asymmetry is also corroborated in all the short-run results. Moreover, lagged industrial growth has positive effects on the present industrial growth of Beverage and has negative effects on the present industrial growth of Engine, Pharmaceutical, Paper, and Transport.

REFERENCES

Ahmad, S. (2019), The impact of oil price uncertainty on stock returns in Gulf countries. International Journal of Energy Economics and Policy, 9(6), 447-452.

Akoum, I., Graham, M., Kivihaho, J., Nikkinen, J., Omran, M. (2012), Co-movement of oil and stock prices in the GCC region: A wavelet analysis. The Quarterly Review of Economics and Finance, 52(4), 385-394.

Al Rasasi, M. (2017), Oil prices and GCC exchange rates. Energy Sources, Part B: Economics, Planning, and Policy, 12(4), 344-350.

Algaeed, A.H. (2018), The oil price volatility and a revisited Saudi import demand function: An empirical analysis. International Journal of Energy Economics and Policy, 8(6), 59-69.

Alkhateeb, T.T.Y., Mahmood, H. (2020), Oil price and energy depletion nexus in GCC countries: Asymmetry analyses. Energies, 13(2), 3058.

Alkhateeb, T.T.Y., Mahmood, H. (2021), Oil price and capital formation nexus in GCC countries: Asymmetry analyses. International Journal of Energy Economics and Policy, 10(6), 146-151.

Alkhathlan, K.A. (2013), Contribution of oil in the economic growth of Saudi Arabia. Applied Economics Letters, 20(4), 343-348.

Alkhathlan, K.A., Alkhateeb, T.T.Y., Mahmood, H., Bindabel, W.A. (2020), Determinants of diversification from oil sector in Saudi Arabia. International Journal of Energy Economics and Policy, 10(5), 384-391.

Arouri, M.E.H., Lahiani, A., Bellalah, M. (2010), Oil price shocks and stock market returns in oil-exporting countries: The case of GCC countries. International Journal of Economics and Finance, 2(5), 132-139.

Arouri, M.E.H., Lahiani, A., Nguyen, D.K. (2011), Return and volatility transmission between world oil prices and stock markets of the GCC countries. Economic Modelling, 28(4), 1815-1825.

Arouri, M.E.H., Rault, C. (2011), Oil prices and stock markets in GCC countries: Empirical evidence from panel analysis. International Journal of Finance and Economics, 17(3), 242-253.

Bodenstein, M., Erceg, C.J., Guerrieri, L. (2011), Oil shocks and external adjustment. Journal of International Economics, 83(2), 168-184.

De, S., Quayyum, S., Schuettler, K., Yousefi, S.R. (2019), Oil prices, growth, and remittance outflows from the Gulf Cooperation Council. Economic Notes, 48(3), e12144.

Dickey, D.A., Fuller, W.A. (1981), Likelihood ratio statistics for autoregressive time series with unit root. Econometrica, 49, 1057-1072.

El Mahmah, A., Kandil, M. (2019), Fiscal sustainability challenges in the new normal of low oil prices: Empirical evidence from GCC countries. International Journal of Development Issues, 18(1), 109-134.

El-Chaarani, H. (2019), The impact of oil prices on stock markets: New evidence during and after the Arab spring in Gulf Cooperation Council economies. International Journal of Energy Economics and Policy, 9(4), 214-223.

Fayyad, A., Daly, K. (2011), The impact of oil price shocks on stock market returns: Comparing GCC countries with the UK and USA. Emerging Markets Review, 12(1), 61-78.

Government of Saudi Arabia. (2020), Saudi Arabian Monetary Agency, Annual Statistics 2020. Riyadh: Saudi Arabian Monetary Agency.

Kripfganz, S., Schneider, D.C. (2019), Response Surface Regressions for Critical Value Bounds and Approximate p-Values in Equilibrium Correction Models, Economics Department Discussion Papers Series, Paper Number 19/01. Exeter, UK: University of Exeter.

Available from: http://www.people.exeter.ac.uk/repec/dpapers/dp1901.pdf.
Le, T.H., Chang, Y. (2013), Oil price shocks and trade imbalances. Energy Economics, 36, 78-96.
Louis, R.J., Balli, F. (2014), Oil price and stock market synchronization in gulf cooperation council countries. Emerging Markets Finance and Trade, 50(1), 22-51.
Mahmood, H. (2021), Role of oil price in fiscal cyclicality in Saudi Arabia. International Journal of Energy Economics and Policy, 11(2), 194-198.
Mahmood, H., Alanzi, A.A. (2020), Rule of law and environment nexus in Saudi Arabia. International Journal of Energy Economics and Policy, 10(5), 7-12.
Mahmood, H., Alkhateeb, T.T.Y. (2018), Foreign direct investment, domestic investment and oil price nexus in Saudi Arabia. International Journal of Energy Economics and Policy, 8(4), 147-151.
Mahmood, H., Alkhateeb, T.T.Y., Al-Qahtani, M.M.Z., Allam, Z., Ahmad, N., Furqan, M. (2020), Urbanization, oil price and pollution in Saudi Arabia. International Journal of Energy Economics and Policy, 10(2), 477-482.
Mahmood, H., Furqan, M. (2020), Oil rents and greenhouse gas emissions: Spatial analysis of gulf cooperation council countries. Environment, Development, and Sustainability, 1, 24.
Mahmood, H., Furqan, M., Alkhateeb, T.T.Y., Fawaz, M.M. (2019), Testing the environmental Kuznets Curve in Egypt: Role of foreign investment and trade. International Journal of Energy Economics and Policy, 9(2), 225-228.
Mahmood, H., Murshed, M. (2021), Oil price and economic growth nexus in Saudi Arabia: Asymmetry analysis. International Journal of Energy Economics and Policy, 11(1), 29-33.
Mahmood, H., Zamil, A.M.A. (2019), Oil price and slumps effects on personal consumption in Saudi Arabia. International Journal of Energy Economics and Policy, 9(4), 12-15.
Metwally, M.M. (1993), The effect of the downturn in oil prices on the external surpluses of the GCC countries. International Journal of Energy Research, 17(3), 173-182.
Metwally, M.M., Perera, N. (1995), The effect of the downturn in oil prices on the relative efficiency of government expenditure in the GCC countries. International Journal of Energy Research, 19(7), 639-643.
Mokni, K., Youssef, M. (2019), Measuring persistence of dependence between crude oil prices and GCC stock markets: A copula approach. The Quarterly Review of Economics and Finance, 72, 14-33.
Nusair, S.A. (2016), The effects of oil price shocks on the economies of the Gulf Co-operation Council countries: Nonlinear analysis. Energy Policy, 91, 256-267.
Nusair, S.A., Al-Khasawneh, J.A. (2018), Oil price shocks and stock market returns of the GCC countries: Empirical evidence from quantile regression analysis. Economic Change and Restructuring, 51, 339-372.
Pesaran, M.H., Shin, Y., Smith, R.J. (2001), Structural analysis of vector error correction models with exogenous I(1) variables. Journal of Econometrics, 97(2), 293-343.
Senan, M.A.M., Mahmood, H., Liaquat, S. (2018), Financial markets and electricity consumption nexus in Saudi Arabia. International Journal of Energy Economics and Policy, 8(1), 12-16.
Shin, Y., Yu, B., Greenwood-Nimmo, M. (2014), Modelling asymmetric cointegration and dynamic multiplier in an ARDL framework. In: Horrace, W.C., Sickles, R.C., editors. Festschrift in Honor of Peter Schmidt. New York: Springer Science and Business Media.
Siddiqui, A., Mahmood, H., Margaritis, D. (2019), Oil prices and stock markets during the 2014-16 oil price slump: Asymmetries and speed of adjustment in GCC and oil importing countries. Emerging Markets Finance and Trade, 56(1), 1-31.