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Oil Price Asymmetry and Sectoral Stock Returns in Nigeria: An Application of Nardl Model

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Abstract: This study investigates the asymmetric impact of oil price dynamics on firms' stock returns at the sectoral level using daily data from 2006 – 2020 in Nigeria. However, most prior works in Nigeria that studied the nexus between oil price fluctuations and stock market returns focused on the aggregate level and employed aggregate indices. A Nonlinear Auto-Regressive Distributed lag econometric model that captures oil price fluctuations (positive and negative oil price change) was explored, in which short and long-run nonlinearities were estimated in both symmetric and asymmetric models. Eleven sectors constituting 100 firms from the Nigerian Stock Exchange were considered. Oil price dynamics impact sectoral stock returns in Nigeria differently. The result indicates that consumer goods, finance, and oil and gas sectorals' stocks positively respond to oil price asymmetry. Therefore, managers must design better strategies to protect respective sectoral's stock returns from oil price shocks.

Keywords: Oil price asymmetry, Sectoral analysis, Arbitrage Pricing Theory, Nonlinear Autoregressive Distributed Lag model

Jel Classification: G Financial Economics, F International Economics, O Economic Development, Innovation, Technological Change, and Growth

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1. Introduction

Petroleum product (gasoline, jet fuel, diesel. Heating oil, etc.) continues to attract interest in academic literature because of their economic importance in almost every sphere of human activities. Petroleum products are used in transportation, industrial production, and provision of heat to households among other usages. However, oil price is characterized by incessant price fluctuations mainly arising from global demand

and supply distortions. The effect of oil price fluctuations (especially crude oil price as the main driver of other energy prices) has become a prominent issue in most aspects of economic activities including stock markets due to its associated risks. This risk is usually transmitted to the stock prices through the exchange rate, affecting the firm's cash flow and stock returns. The risk seems to be pronounced in the Nigerian stock market because the market is still developing. More so, the use of financial derivatives[1] in the market is at the rudimentary stage. Hence, the seeming presence of oil price risk could lead to the mispricing of stocks; which affects portfolio investment decisions and inhibits economic growth.

A significant amount of empirical research has studied the financial and economic implications of incessant fluctuation of oil prices on the stock market, especially on the aggregate level (see: Jones and Kaul, 1996; Hashmi et al; 2022). However, one fundamental problem of using aggregate market indices to measure the extent of the risk exposure of stock returns to oil price risk is that most often, it masks the true response of stock returns to oil price risk (see: Hashmi *et al.*; 2022; Salisu and Isa, 2017). The rationale behind this is that firms and sectoral stocks respond differently to changes in oil prices. The differences in the firm's response stem from the firm's managerial ability, economics of scale, resource availability, productivity, and market capitalization amongst others. For example, the financial sector contributes more than 40% of the total market capitalization of the total firms used in this study and contains about 40 out of 171 firms listed in the Nigeria Stock Exchange (NSE) in 2020. Conglomerates, oil and gas, health, agriculture, and industrial sectors contribute about 1, 8.4, 1, 0.75, and 6 % respectively of the market capitalization from 2006 – 2020. These varied percentages/structures will extensively determine how oil price risk transmit to various sectors and should be different among sectors.

Consequently, Table 2 shows an upward movement of oil prices in 2017 from 2016, majorly alluding to the OPEC cartel production cut. Brent crude price rose from $43.5 per barrel (pb) to $54.1pb. Stocks from agriculture, conglomerates, consumer goods, banking, industrial, natural resources, and oil & gas sectors gained 0.74kobo (k), 0.6k, 0.7k, 0.23k, 0.12k, 0.20k and 0.11k, while construction, insurance, health, and service sectors lost 0.13k, 0.20k, 0.20k and 0.53k worth of value. But the average total stock returns show that stocks of the NSE gained value in the same period. Hence, aggregation does not show the respective sectors' specific behavior. Therefore, any policy arrived at using aggregation may be deceptive.

Most of the empirical works that studied oil price-stock returns dynamics on the sectoral level are done outside Nigeria (see: Alamgir and Amin, 2021; Ashiq and Shanmugasundaran, 2020; Bashir, 2022). Few empirical research studies in Nigeria

that focused on disaggregated analysis include Akachukwu (2022) and Babatunde *et al.* (2012). This paper departs from the prior studies in Nigeria by focusing on sectoral analysis. The study used 100 firms across eleven sectors and employed stock returns data. The study speaks directly to the stock returns that measure the viability of the investment, which informed investment decisions rather than market capitalization. The study employed the Nonlinear Autoregressive Distributed Lag model (NARDL) to account for the asymmetric associated with oil price-stock returns relations. Moreover, the study leveraged on the published sectoral stock price data in Nigeria that covers the period 2007 till date (14 years), which is good enough for the sectoral analysis conducted in this study.

This study is very important given Nigeria's peculiarity in crude oil production and consumption. Interestingly, Nigeria ranked the highest oil-producing country in Africa with an average of 2.4 million barrels per day (mbpd) and over 90% of the amount is exported. Conversely, due to the inept situation of domestic refineries, Nigeria imports more than 75% of its petroleum products for domestic use (NNPC, 2017). More so, the Nigeria Stock Exchange (NSE) is pivotal for the economic development of Nigeria as it provides listed companies and investors with a platform to raise long-term capital and investment opportunities, respectively. Going by this contest, this study aims to examine the effect of oil price fluctuation on the sectoral stock returns in the NSE.

1.2. Statement of the problem

The stock market is a major source of finance for investors and firms. However, oil price risk can affect this function, which makes stock returns uncertain. Oil price risk comes with liquidity challenges that either undervalue or overvalue the actual stock price due to the associated incessant fluctuations. This risk is pronounced in Nigeria because of the country's huge dependency on Petro-dollars: to this end, the federal government's annual budget is created based on projections of oil prices. Oil price risk is also presumed to be evident in Nigeria because the derivative markets are yet to be developed to hedge for firm's specific and common risks. Hence, there is a likelihood that oil price risk (premium) may be embedded in stock prices in Nigeria. Most of the existing studies have investigated the impact of oil price dynamics on stock returns at the aggregate level, especially in Nigeria, little attention has been devoted to sectoral analysis which is important due to sectoral differences (see: Alamgir and Amin, 2021). Sectoral analysis tends to show the exact relationship between each sectoral's stock return and oil price dynamics. Therefore, using aggregate stock prices to unravel the interaction between the variables may not show the true relationship

Further, the concepts of asymmetries and nonlinearity have become very important in conceptualizing and understanding the oil price-sectoral stock returns nexus. It has been argued that stock returns respond differently to positive oil price changes from negative oil price changes in magnitude. Given the fact that firms differ in their energy consumption, oil price increases or decreases may as well have different magnitude effects on the individual firms and their output. These differential responses stem from the fact that different sectors appear to have different market structures[12] and are heterogeneous. Therefore, identifying the level of sensitivity of various sectors to oil price risk will enable investors to minimize the risk associated with oil price volatility and provide valuable insight from several aspects. It is on this note that this study was designed to answer the research question: what is the relationship between oil price asymmetry and sectoral stock returns in Nigeria?

2. Literature Review

Most of the empirical studies that examined the nexus between oil price volatility and stock market returns focused more on the aggregate level. Cf: Hashmi *et al.* (2022); Managi *et al.* (2022); Bashir (2022); Diaz, *et al.* (2016); Dagher and El Hariri (2013); Jouini (2013). Some other researchers that investigated the two variables favored disaggregation of countries between oil-exporting and oil-importing nations, as they believe that such dichotomy will contribute to achieving robust results. Hani (2019) examined how oil price volatility affects the Gulf Cooperation Council (GCC) stock markets during and after the Arab Spring. The result showed that positive and negative oil price changes are significant on stock returns in some GCC countries (Saudi Arabia, Kuwait, and Bahrain). Other works that followed the framework are Sukcharoen, *et al.* (2014); Broadstock and Filis (2014); Ramos and Veiga (2013).

Recently, some researchers suggest that the linear relationship between oil price and stock markets is not so evident in practice. Therefore, few studies have considered the existence of nonlinearity between the two variables. Salisu and Isa (2017) nonlinearly examined the connection between oil price and stock market of the eight (8) net oil-importing and five (5) net oil-exporting countries. The results revealed that stock returns respond nonlinearly and asymmetrically to oil price changes for both groups. (See: Alamgir and Amin (2021); Nader and Al Dohaiman (2013)).

Going forward, the firm's analysis was advocated to give a better understanding of the oil price-stock return relation.[2] They opined that the effects of oil price risks should vary considerably across different sectors (firms) even in the same economy and this depends on their production and consumption of oil (see: Alamgir and Amin, 2021; Phan, Sharma and Narayan, 2014). Ashiq and Shanmugasundaram (2020) used ARDL to investigate the implication of oil price and exchange rates variability

on major sectoral indices in India. The result revealed that exchange rate fluctuation influences sectorals' stock prices in India more than the crude oil price fluctuation impact. Hamdan and Hamdan (2019) examined the impact of oil price movement on stock market in Saudi Arabia in symmetric and asymmetric form. The result revealed that cement, petrochemical industries, building and construction, energy, and utilities sectors asymmetrically respond positively to oil prices movement. Other studies that employed firm's analysis include Bouri *et al.* (2016); Huang *et al.* (2015); Guglielmo *et al.* (2014); Hamma *et al.* (2014).

In Nigeria, few studies that examined oil price-stock return relation employed different methodological frameworks and on an aggregate level (see: Salisu and Isa, 2017[3]; Gil- Alana and Yaya, 2014; Fowowe, 2013; Babatunde at al. 2012). The present study differentiates itself from the aforementioned studies from Nigeria, methodologically, by adopting Nonlinear Autoregressive Distributed Lag (NARDL) model. The efficiency of the NARDL lies in its ability to use partial sum in decomposing positive and negative oil price fluctuation which is evident in the observed oil price data. It is also an improvement over GARCH and VAR models because of its ability to capture long-run and short-run asymmetries in the same model. The study also employed firms' or sectoral analysis. It is difficult to find a study that employed the NARDL in examining oil price-stock returns relation on the disaggregated level in Nigeria that covers 100 firms across 11 sectors using daily observations. This study is, therefore carried out to fill the identified gap.

Stylized Facts

2.1. Nigeria's Economy and Oil Dependency

The Oil industry has been the backbone of the Nigerian economy since the oil price surge of the 1970s. It is the major source of government revenue and creates employment opportunities for millions of Nigerians. Oil revenue accounted for about 71% of total government revenue on average from 1981-2020. It accounted for about 80% on average during 2003–2008. Nigeria's oil revenue declined in 2013 and recorded about 69% decrease. The decline was occasioned by the global crises in the international oil market. The decrease continued until 2020. This can be attributed to the tensions in oil-producing states like the Middle East, covid-19 pandemic, and the insecurity experienced in Nigeria.

As shown in Table 1, the share of oil export to total export averaged 94% over the entire period in Nigeria. The Share of oil export was above 95% until 2008 when it declined to 94% and further to its lowest ebb in 2019, amounting to about 83%. This coincided with the covid-19 pandemic period. In the same vein, the ratio of oil revenue

to capital formation was relatively high during 2000–2012 accounting for more than 100% of the total investment in Nigeria. By 2013, the proportion trended downwards to about 70%. In 2014, the contribution declined to 47% and the downward trend continued until 2020 as indicated in Table 1. This is attributed to drastic measures taken by the government to diversify the economy away from oil. This shows that investment in Nigeria hugely depends on the oil revenue trajectory. Nigeria's proven crude oil reserves have been growing consistently over time standing at 16 billion barrels (bbrl) in early 1980. It increased consistently to 20 bbrl in 1991. As crude oil prices continue to gain ground in the international oil market, Nigeria intensified its effort in search of oil in its territorial boundaries, by 2001 (a decade after), an additional 14,349 bbrl was discovered culminating in 34,349 bbrl. Currently, Nigeria has more than 37 bbrl of proven crude oil reserves, making her the second largest in Africa after Libya, and this figure account for 3.1% share of the Organization of the Petroleum Exporting Countries (OPEC) proven oil reserves.

Table 1: Indicators of oil dominance in Nigeria economy (2000-2020)

Years	*Total Rev. (N' Billion)*	*Oil Rev. (N' Billion)*	*Oil Rev./ Total Rev. (%)*	*Total Export (N' Billion)*	*Oil Export (N 'Billion)*	*Oil Export/ Total Exp.(%)*	*Capital Formation (N' Billion)*	*Oil Rev./ Capital Formation (%)*	*Nig. Proved oil reserve*(- Millions barrels)*
2000	1906.16	1591.68	83.5	1945.7	1920.9	98.73	331.06	480.79	31506
2001	2231.6	1707.56	76.52	1868.9	1839.9	98.45	372.14	458.85	34349
2002	1731.84	1230.85	71.07	1744.2	1649.4	94.56	499.68	246.33	35255
2003	2570.1	2074.28	80.71	3087.9	2993.1	96.93	865.88	239.56	31506
2004	3920.5	3354.8	85.57	4602.8	4489.5	97.54	863.07	388.7	34348
2005	5547.5	4762.4	85.85	7246.5	7140.6	98.54	804.4	592.04	35255
2006	5965.5	5287.57	88.64	7324.7	7191.1	98.18	1546.53	341.9	35873
2007	5727.5	4462.91	77.92	8309.8	8110.5	97.6	1936.96	230.41	37200
2008	7866.59	6530.6	83.02	10387.7	9861.8	94.94	2053.01	318.1	37200
2009	4844.59	3191.94	65.89	8606.3	8105.5	94.18	3050.58	104.63	37200
2010	7303.67	5396.09	73.88	12011.6	11300.5	94.08	4012.92	134.47	37200
2011	11116.85	8878.97	79.87	15236	14323.5	94.01	3908.28	227.18	37200
2012	10654.75	8025.97	75.33	15139.3	14260	94.19	3357.4	239.05	37139
2013	9759.79	6809.23	69.77	15262	14131.8	92.59	9666	70.45	37071
2014	10068.85	6793.72	67.47	12960.5	12007	92.64	1424.07	47.7	37448
2015	6912.5	3830.1	55.41	8845.2	8184.5	92.53	1743.13	25.97	37062
2016	5679.03	3082.41	54.28	8835.6	8178.8	92.57	14493.6	21.27	37450
2017	7444.8	4109.72	55.2	13988.4	12913.2	92.31	23047.5	17.813	37453
2018	9551.7	5545.88	58.06	18707.3	17281.9	92.38	25291.7	21.92	36972
2019	10262.3	5536.73	53.95	19910.5	16703.4	83.89	19622.2	28.21	36890
2020	9276.28	4732.54	51.01	12613.6	11058.2	87.66	19871.7	23.81	36972

Source: CBN Statistical Bulletin, 2021; * OPEC Annual Statistical Bulletin, 2021 and Author's Computation

2.2. Sectoral Stock Returns Dynamics in the NSE and Oil Price Changes, 2007-2020

The analysis used 11 sectors though the financial sector was split into Banking and non-Banking (Insurance) industries. The division of the financial sector into two stems from the fact that the sector contributes more than 40% of the NSE market capitalization (MCAP) in the study. A positive value means that the sector's stock return has grown in value while a negative value implies a loss in the value of the sector's stock. After the year, 2000, incidences like soaring demand from China, geopolitical tension in the Middle East and the North Korean Missile test of 2003 pushed international oil prices up. Brent oil price rose to an average of $70.9 pb in 2007 from $65.2 per barrel in 2006. This culminates in about 10.7% increase. In 2008, the surge in oil price rose by 34% from 2007 and all the sectoral stocks recorded positive returns except the financial sector. For instance, Agriculture, Conglomerates, Consumer goods, Health, ICT, Oil and Gas, and Industrial sectors gained 2.2%, 32.9%, 0.35%, 18.2%, 34.4%, 19.4, and 5.1% respectively while Banking and insurance lost 1.3% and 3.4% respectively in 2008. The loss in the value of financial sector stocks in 2008 might be attributed to the sudden withdrawal of investment from banks as financial crises ensued.

From 2010 to 2012, oil prices exhibited upward movement. Agriculture, Construction, and Consumer goods sector stock gained while Conglomerates, Banking, Non-Banking, Health, Natural Resources, and Services lost value over the three-year period. The Industrial and Oil & Gas sector only gained in 2010 and lost value in the other two successive years. There was an upward movement in oil prices in 2017 and 2018 majorly alluded to the OPEC cartel production cut. Brent crude price rose from $43.5pb to $54.1pb amounting to 19.1% in 2017. Stocks from Agriculture, Conglomerates, Consumer Goods, Banking, Industrial, Natural Resources, and Oil & Gas sectors gained 0.74%, 0.6%, 0.7%, 0.23%, 0.12%, 0.20%, and 0.11%, respectively. When oil price fell in 2019 by about 34% from 2018, Agriculture, banking, and oil and gas stocks gained but the aggregate stock indices shaded about 1.2%. Generally, from Table 2, it is evident that various sectoral stocks responded differently to the oil price swings. The striking feature of Table 2 is that the behavior of the average aggregate stock returns (last column) is different from some sectoral stock returns' response to oil price fluctuation in most of the years. Hence, using aggregate market index may oftentimes mask the sectoral's characteristics due to sectoral differences.

2.3. Nigeria and OPEC Oil Export Composition

The OPEC members contributed more than 80% of world crude oil export in the 1960s and 1970s. Nigeria's share of export to OPEC was quite low accounting for less than 2%

Table 2: Sectoral stock returns dynamics in the NSE and oil price changes, 2007-2020

years	*Oil price*	*Agric.*	*Con-glomer-ates*	*Con-struction*	*Con-sumer goods*	*Banking*	*Insur-ance*	*Health*	*ICT*	*Indus-trial*	*Nat-ural Res.*	*Oil & Gas*	*Ser-vices*	*Avg. Stock Retur*	*% Avg. Return*
2007	90.94	.	.	.	.	.	.	.	.	.	.	.	.	.	.
2008	95.82	0.022	0.330	0.029	0.004	-0.012	-0.03	0.182	0.34	0.051	0.515	0.194	0.067	1.693	14.112
2009	61.76	-0.231	-0.142	-0.420	-0.152	-0.422	-0.52	-0.181	-0.1	-0.23	-0.037	-0.264	-0.372	-3.105	-25.871
2010	79.69	-0.146	-0.015	0.149	0.217	0.0002	0.054	-0.003	-0.1	0.042	-0.099	0.041	-0.043	0.068	0.563
2011	111.8	0.051	-0.106	0.009	0.072	-0.069	-0.21	-0.074	-0.1	-0.03	-0.076	-0.027	-0.157	-0.704	-5.869
2012	111.8	0.252	-0.044	-0.216	0.047	-0.036	-0.09	-0.046	0.22	-0.02	-0.059	-0.155	-0.17	-0.313	-2.604
2013	108.6	0.288	0.013	0.288	0.208	0.187	0.197	0.1755	0.08	0.193	0.011	0.024	0.015	1.801	15.008
2014	97.7	-0.062	-0.012	0.030	0.011	0.002	-0.02	0.029	-0.1	0.086	-0.026	0.075	-0.02	0.030	0.247
2015	52.2	-0.093	-0.196	-0.160	-0.823	-0.113	0.016	-0.163	-0.1	0.003	-0.034	-0.02	-0.078	-1.026	-8.554
2016	43.57	0.084	-0.182	0.062	-0.066	-0.137	-0.06	-0.258	-0.1	-0.09	-0.046	0.052	-0.102	0.934	-7.802
2017	54.18	0.746	0.069	-0.131	0.080	0.231	-0.03	-0.011	-0.2	0.129	0.015	0.111	-0.053	0.995	8.290
2018	71.34	0.077	0.196	0.003	0.142	0.292	0.006	-0.091	0	0.002	-0.009	0.201	0.009	0.805	3.371
2019	64.3	-0.075	0.009	-0.061	-0.381	-0.838	-0.08	-0.041	-0.1	-0.08	-0.027	0.055	-0.073	-0.138	-1.253
2020	41.96	0.037	-0.391	-0.073	-0.188	-0.631	-0	-0.006	0.01	0.092	0.007	0.024	-0.035	-0.096	-9.618

Sources: *Energy Information Administration, 2020; Central Securities Clearing System Limited (CSCS) 2020

in the 1960s and 7% in the 1970s but it improved thereafter. Available statistics showed a negative relationship between the share of OPEC crude oil export to the world and the share of Nigeria's crude oil export to OPEC during the entire period. The inverse relationship is attributed to the incessant political and regional crises associated with the Middle East countries, and the region accounts for about 65% of total OPEC export. During such crises, Nigeria's share of crude oil production and export to OPEC tends to increase because non-Middle East OPEC members increase their quota in order to augment the production loss in the Middle East. When relative peace is restored, OPEC's total production rises while the proportion of Nigeria's export to OPEC diminishes.

Nigeria's percentage share of crude oil export to OPEC has been higher than her percentage share of crude oil production to OPEC. This gave credence to the fact that Nigeria, exports a higher percentage of her crude abroad (as can be seen in column 5 of Table 3). The rise in % share of Nigeria's crude export signifies that other OPEC member states export less proportionate of their crude oil production relative to Nigeria. Most of these countries refine a significant amount of their crude oil domestically while Nigeria refines a negligible amount of hers locally. As such, Nigeria is always susceptible to world oil price fluctuations.

However, 15-year domestic capacity utilization of refineries in Nigeria from 2006-2020 showed that the four refineries in Nigeria were underutilized (see: figure 1). The refineries were meant to produce 445,000 b/d but produced 20% of the capacity in 2006. It is alarming that by 2020, the refineries produce less than 5% of their capacity. This statistic implies that more than 90% of refined oil products and consumption in Nigeria are imported. This cumulates the fact why Nigeria's stock market and the economy generally is prone to world oil crises. They export a significant percentage of her crude and at the same time, import almost all her refined oil consumption needs.

2.4. Institutional Policy and Stock Market in Nigeria

The Nature of institutional framework and reforms in Nigeria possesses an interesting revelation in understanding the performance of the stock market. Nigeria has had several economic reform initiatives since the 1986-1993 Structural Adjustment Programme (SAP). The program aimed at restructuring, diversification of the production base of the economy, and deregulation especially the foreign exchange and financial market. However, the fundamental challenges in the economy remained relatively unabated after SAP. The economy still experienced massive unemployment, increased inflation, and other macroeconomic imbalances.

Afterward, National Economic Empowerment and Development Strategy (NEEDS) policy was launched in 1999–2003 as Nigeria embraced a civilian regime

Table 3: Nigeria and OPEC's average contribution to world crude oil production and exports, 1961 -2020, ('000 b/d)

					PRODUCTION			*EXPORT*		
Years	**Oil Price Changes (US $)*	*Nig. Oil Prodn.('000 barrels)*	*Nig. Oil Export('000 barrels)*	*Oil Export/ Prodn. (%)*	*Nigeria % to OPEC*	*Nigeria % to World*	*OPEC % to World*	*Nigeria % to OPEC*	*Nigeria % to World*	*OPEC % toWorld*
1961-1965	1.80	116.48	114.64	98.42	0.92	0.42	44.68	1.12	1.01	89.97
1966-1970	1.80	500.70	483.00	96.46	2.50	1.25	49.52	2.80	2.43	87.08
1971-1975	6.22	1889.12	1830.02	96.87	6.66	3.58	53.76	7.30	6.31	86.39
1976-1980	21.84	2085.32	2008.16	96.30	6.98	3.47	49.82	7.79	6.26	80.51
1981-1985	30.96	1370.34	1118.76	81.64	7.73	2.56	33.64	10.30	5.04	51.67
1986-1990	17.95	1514.52	1294.56	85.43	7.67	2.65	34.50	9.43	5.23	55.33
1991-1995	17.83	1883.76	1601.40	85.01	7.89	3.15	40.02	9.06	5.31	58.54
1996-2000	19.79	2064.14	1909.52	92.51	7.76	2.97	38.28	9.70	5.37	55.30
2001-2005	34.22	2327.80	2168.10	93.14	8.33	3.34	37.76	10.21	5.44	53.31
2006-2010	75.19	2302.40	2174.36	94.44	6.54	3.13	47.87	9.18	5.29	57.67
2011-2015	96.58	2344.80	2193.33	93.54	6.35	3.04	47.94	9.15	5.37	58.70
2016-2020	56.14	1559.86	1883.42	120.78	5.18	2.10	40.65	8.16	4.23	59.92

Sources: OPEC Statistical Bulletin (various issues) *BP Statistical World Energy Review (2021) and Author's Computation.

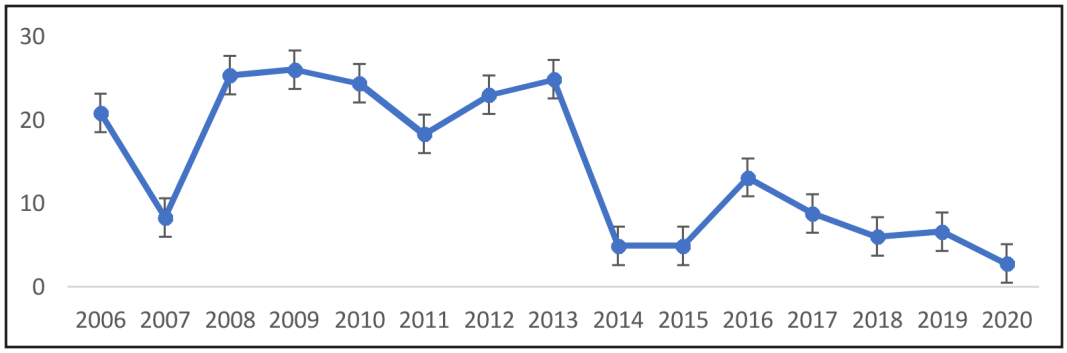

Figure 1: Domestic refinery capacity utilization in Nigeria (%) 2006-2020

Source: NNPC Annual Statistical Bulletin, 2021

in 1999. The goals of the NEEDS include deregulation, infrastructural development, economic diversification, and foreign exchange liberalization. In spite of the increase in inflation witnessed in that period, market capitalization (MCAP) rose tremendously from N294.5 billion to N1.26 trillion, accounting for about a 328.7% increase. While All Share Index (ASI) also moved up by 282.3% in the NSE. This period marked a turnaround in the activities and indices of the stock exchange market. The turnover ratio, number of deals and volume of trade received a significant boost in The Exchange. Arising from the NEEDS policy was the financial system reform in 2004-2005, which was majorly anchored on banking reform (recapitalization exercise). According to CBN (2007), the reform boosted investment in the NSE through pension fund custodian. The MCAP, ASI, volume of trade, number of deals, value traded, turnover ratio, number of listed companies increased by 406.9%, 143.2%, 417.3%,168.6%, 828%, 83%, 11.9% respectively from 2004–2007 before the global financial crises began in 2008.

Corporate Governance and Financial Reporting reforms have been undertaken in the NSE by various government regimes over the decades which aimed at improving stock market efficiency. These rules and regulations were majorly bent towards enhancing corporate governance in order to boost investment. The NSE adopted International Financial Reporting Standards and as well passed the Financial Reporting Act into law in 2010. There are other specific reforms carried out by the NSE such as the introduction of an Automated Trading System (ATS), online trading, Electronic Initial Public Offer (E-IPO), Remote Trading, E-bonus, etc. These reforms deepened stock market development in Nigeria which is evidenced as the NSE was ranked one of the best stock markets in Africa in 2015.

3. Methodology

Theoretical Framework

The Arbitrage Pricing Theory (APT) as developed by Ross (1976) forms the theoretical framework for the study. The APT best describes the Nigeria context where unprecedented fluctuations in crude oil price resulting from the country's huge dependency on oil revenue possess risk factor which affects investment in the financial market. Algebraically, consider an investor who places all his funds in a portfolio reflecting the composition of the stock market, the rate of return on the security is broken into its expected and unexpected components:

$$R_i(p) = E(R_i) + e_i \tag{1}$$

Where $R_i(p)$ is the actual stochastic rate of returns on security *i*. $E(R_i)$ is the expected rate of return on security *i*, e_i denotes unexpected rate of return; with $E(e_i)$ = 0 and var(e_i) = δ^2_i (finite).

Eqn. 1 follows the capital asset pricing model (CAPM) foundation where returns on investment is a function of only one factor generating risk.

However, the sources of uncertainty (e_i) from equation (1) is decomposed into Uncertainty (risk) that affects all firms, which is captured by φ_i and uncertainty that is firm's specific, which is captured by e_i in equation 2. Let β be the factor sensitivity of each factor generating uncertainty (risk) for each security *i*. It is important to note that φ_i and e_i are uncorrelated in Eqn. 2

$$R_i(p) = E(R_i) + \beta_i\varphi_i + e_i \tag{2}$$

The CAPM framework above is transformed into APT. To represent APT and show the n-factor of systematic risk is given as;

$$R_{it}(p) = E(R_{it}) + \sum_{n=1}^{k} \beta_{in}\varphi_{nt} + \varepsilon_{it} \tag{3}$$

Where $R_{it}(p)$ is the actual rate of return on security i in any given time t; $E(R_{it})$ is the expected rate of return on security; β_{in} measures the sensitivity of security *i* response to nth-common risk factors φ_{nt}; is the nth- factor generating risk common to the returns of all asset under consideration between t-1 and t. $\sum_{n=1}^{k}$ is the summation symbol for all nth factors. (ε_{it}) is the error term.

In vector notation, the APT framework from equation (3) can be expressed as:

$$R_{it}(p) = \beta_i\varphi_{it} + \varepsilon_{it} \tag{4}$$

Where φ_{it} is the vector of common risk factors that affect assets' return in *i* sectors; β_i is a vector that shows the sensitivity of the common risk factors in *i* sectors while the other variables remain as defined in equation 3.

Model Specification

To capture the variability of oil price on stock returns, we decompose the common factor in Eqn. (4) into oil price risk and other systematic risks in a linear form and show the n-number of sectors in Nigeria, we obtain eqn. (5)

$$r_{it} = B_{1i}Q_{it} + \beta_{2i}P_{it} + e_{it} \tag{5}$$

where $r_{it} = R_{it}(p)$ which is the actual rate of return on security in *i* sectors at any given time *t*; φ_i and $\beta_{i's}$ variables remain as defined in eqn.4 above. p_{it} denotes oil price fluctuation risk. while e_{it} is the error term.

Instructively, oil price responds to positive news (shock) differently from negative news (shock). This is where asymmetric comes in. Hence, the study partitioned oil price into positive and negative oil price changes to account for such behavior as shown in eqn. (6)

$$P_t = Po + P_t^+ + P_t^- \tag{6}$$

Where p_o is the initial value of oil price, $p_t^+ \; and \; p_{t^-}$ denote the partial sum process of positive and negative oil price changes. P_t is the price of oil at time t. Therefore, infusing eqn. (6) into eqn. (5), stock returns-oil price risk relation yields Eqn. (7)

$$r_{it} = B_{1i}\varphi_{it} + \beta_{2i}^{+}P_t^+ + \beta_{2i}^{+}P_t^- + e_{it} \tag{7}$$

Eqn. 7 states that return on security (r_{it}) is determined by vector of common risk factors (φ_{it}); plus positive and negative oil price risk (oil price asymmetry) which is ($p_t^+ and \; p_{t^-}$); plus unobserved and specific risk factors that impact on securities under consideration across the sectors at a given time denoted as e_{it}.

However, to deal with the existence of asymmetries in oil price-stock returns relation using NARDL, it is essential to commence the specification with the ARDL framework. Therefore, Eqn. (5) is transformed into symmetric panel ARDL of Pesaran *et al.* (2011) as shown in (8).

$$r_{it} = \alpha_{0i} + \sum_{j=1}^{K1} w_{ij}\varphi_{it-j} + \sum_{j=0}^{k_2} \psi_{ij}p_{t-j} + \varepsilon_{it} \tag{8}$$

Equation 8 states that sector i's stock returns depend on the summation of nth comon factors that affect the sectoral's (market) stock returns including lag of stock returns and risks associated to oil price distortions.

r_{it} denotes sector i's stock returns index over a period of time. p_{t-j} represents Brent oil price and its lag. φ_{it-j} is a vector of the control variables which include the lag of the stock returns. w_{ij} *and* ψ_{ij} are short-run coefficients for common risk factors and oil price risk respectively, same as betas in eqn. 5.

Expanding eqn. (8) and factor out lag of stock returns in both the short and long-run yields eqn. (9):

$$r_{it} = \alpha_{0i} + \alpha_{1i}\varphi_{it-1} + \beta_{1i}r_{it-1} + \alpha_{2i}p_{t-1} + \sum_{j=1}^{k1} w_{ij}\varphi_{it-j} + \sum_{j=1}^{k3} \delta_{ij}r_{it-j} + \sum_{j=0}^{k2} \psi_{ij}p_{t-j} + \mu_i + \varepsilon_{it} \tag{9}$$

Where $\beta_{1i}\ r_{it-1}$ denotes lag of stock returns with its coefficient across the sectors in the long-run. $\sum_{j=1}^{k3} \delta_{ij}r_{it-j}$ implies lag of stock returns with its coefficient across the sectors in the short-run. denotes group specific effect. But for convenience, lag of stock returns (r_{it-j}) will henceforth infuse into the vector-variable (φ_{it-j}). Other variables definition remains the same.

It is instructive to note that the analysis so far is a linear ARDL. However, to pursue nonlinear form of the analysis, consider eqn. (7) and following eqn. (9), the nonlinear version of the model is expressed as:

$$r_{it} = \alpha_{1i}\varphi_{it-1} + \alpha_{2i}^{+}p_{t-1}^{+} + \alpha_{2i}^{-}p_{t-1}^{-} + \sum_{j=1}^{m} w_{ij}\varphi_{it-j} + \sum_{j=0}^{n} (\psi_{ij}^{+}p_{t-j}^{+} + \psi_{ij}^{-}p_{t-j}^{-}) + \mu_i + \varepsilon_{it} \tag{10}$$

The NARDL model for estimation is presented in eqn. 11,

$$r_{it} = \alpha_{0i} + \alpha_{1i}\varphi_{it-1} + \alpha_{2i}^{+}p_{t-1}^{+} + \alpha_{2i}^{-}p_{t-1}^{-} + \sum_{j=1}^{11} \delta_{ij}\varphi_{it-j} + \sum_{j=1}^{11} (\gamma_{ij}^{+}p_{t-1}^{+} + \gamma_{ij}^{-}p_{t-1}^{-}) + \mu_i + \nu_{it} \tag{11}$$

Equation 11 states that setoral stock returns in the Nigeria Stock Exchange (r_{it}) are determined by (a) unconditional expected return across sectors (α_{0t}), long-run vector of the control variables[4] ($\alpha_1\ \varphi_{it-1}$), long-run positive oil price risk and its coefficient ($\alpha_{2i}^{+}p_{t-1}^{+}$) long-run negative oil price risk and its coefficient ($\alpha_{2i}^{-}p_{t-1}^{-}$), short-run vector of the control variable used and their coefficients ($\sum_{j=1}^{11} \delta_{ij}\varphi_{it-j}$), short-run positive oil price risk and its coefficient ($\sum_{j=1}^{11} \gamma_{ij}^{+}p_{t-1}^{+}$), short-run negative oil price risk and its coefficient ($\sum_{j=1}^{11} \gamma_{ij}^{-}p_{t-1}^{-}$) plus error term ($v_{it}$). It is interesting to note that all the regressors used involve their lag form and lag of the endogenous variable since we are dealing with Autoregressive Distributed Lag (ARDL) model.

Estimation technique and data sources

The study employed Arbitrage Pricing Theory. A Nonlinear Auto-Regressive Distributed Lag econometric model that captures positive and negative oil price change was explored. Eleven sectors comprises of 100 firms from the NSE were considered: Agriculture, Consumer Goods, Construction, Finance, Oil & Gas, Information and Communication Technologies (ICT), Conglomerates, Health, Services, Industrial and Natural Resources. The oil price risk and other determinants (World Market Risk-gbr, Exchange Rate-exr, Lag of Stock Return- and Domestic Market Liquidity-mktl) were utilized. The empirical models were analysed using daily observation from 3rd January, 2007 to 31st December 2020. The stock return was calculated by the logarithm difference of two successive closing periods of stock price. The study applied mean group and pool mean group estimators on symmetric and asymmetric model for each sector. Hauseman specific test was also applied to select the relatively efficient estimator between the MG and PMG estimator in each sector. Data were obtained from the Central Bank of Nigeria statistical bulletin, NSE annual report, STOXX Europe 50 and Energy Information Administration annual energy outlook. All estimates were validated at $\alpha \leq 0.05$.

4. Results and Discussions

The aggregate and sectorals' estimates obtained are presented for the four variants of the model; models (1A), (1B), (2A), and (2B). Models (1A) and (1B) report mean group (MG) and pool mean group (PMG) estimates of the symmetric regression. Models (2A) and (2B) show asymmetric estimates of MG and PMG regressions. Instructively, to choose the efficient estimator between the MG and the PMG in each symmetric and asymmetric regression for each sector, the study applied the Hausman Specific Test Decision rule. The decision rule for the Hausman Test is: if the Hausman Test Chi-square is significant, you reject the PMG estimator, otherwise accept PMG. All estimates were validated at $\alpha \leq 0.05$.

Results Presentation

Financial sector oil price-stock returns relation

The PMG estimates are efficient estimators in both linear (symmetric) and nonlinear (asymmetric) models. Table 5 showed that financial sector stock returns do not react to oil price fluctuations in the short-run from model 1B. However, when oil price risk persists (long-run), the sectoral's stock returns respond to the oil price risk negatively. One percent change in oil price results in about 0.20% drop in the stock returns. Other variables of interest are significant in both the short-run and long-run except

market liquidity in the long-run. Exchange rate is inversely related to financial stock returns. This could be attributed to the high taste for foreign products by Nigerians.

However, the symmetric model is silent on if it is actually an increase or decrease in oil price that is exerting negative influence on the stock returns. To answer this puzzle, the asymmetric model becomes handy to solve the problem (specifically model 2B). It is obvious that financial stocks respond to oil price changes asymmetrically. In the short-run, one percent increase in oil price results in about 0.18% rise in financial stock returns daily. While a % drop in the price of oil leads to about 0.1 reductions in stock returns. Consequently, when the oil price moves up by 1%, stock returns of the sector gain about 3.83% in the long-run while a % drop in the oil price necessitated about 18.80% drop in financial sector stocks. From the foregoing, it can be inferred that the financial sector stock responds more to negative oil price change than positive oil price variation. Other variables of interest are significant. Market liquidity is significant in the short-run but with the wrong sign. This shows that as market liquidity deepens, investors pay less attention and it becomes less determinant.

Table 5: Financial sector oil price-stock returns relation

VARIABLES	*SYMMETRIC MODELS*		*ASYMMETRIC MODEL*	
	Model(1A) mg_symmetric	*Model(1B) pmg_ symmetric*	*Model(2A) pmg_symmetric*	*Model(2B) pmg_ asymmetric*
Short-run estimates				
Ec	-0.0575**(0.0434)	-0.0118**(0.00522)	-0.0143***(0.00547)	-0.0117***(0.00393)
D.lop	-0.0352(0.0297)	0.00966(0.0333)		
D.lexr	-0.0295***(0.0070)	-0.0329***(0.00706)	-0.0256***(0.00667)	-0.0282***(0.00650)
D.lgbr	0.0190***(0.0111)	-0.0202**(0.0110)	0.0199**(0.0110)	0.0211**(0.0109)
D.mktl	-5.97e-07***(1.62e-07)	5.91e-07***(2.09e-07)	-5.83e-07***(1.70e-07)	-3.98e-07**(1.67e-07)
$D.r_{it-1}$	0.6733*(0.0036)	0.0983(2.0280)	6.6072(0.00291)	1.0114(0.02291)
D.lop_p			-0.176***(0.0332)	0.186***(0.0233)
D.lop_n			-0.111***(0.0325)	-0.140***(0.0468)
Long-run estimates				
Lop	0.0658(0.183)	-0.200**(0.102)		
Lexr	-0.707*(0.408)	-1.173***(0.144)	-0.503(0.394)	-0.901***(0.102)
Lgbr	-0.104(0.666)	-1.125***(0.173)	-0.505(0.758)	-0.944***(0.158)
Mktl	9.29e-05***(1.79e-05)	6.34e-05**(6.55e-05)	0.000139***(2.57e-05)	5.45e-05(5.75e-05)
r_{it-1}	-1.046(0.0751)	0.0316*(0.0177)	4.1188*(0.0072)	0.429***(0.0136)
lop_p			-5.017(6.851)	3.837***(2.125)
lop_n			56.13***(12.57)	-18.81***(2.451)
Constant	-0.00140***(0.0184)	-0.0227**(0.0133)	-0.0371***(0.0381)	-0.0254**(0.0127)
Hausman test $\ddot{X}_n^2$	symmetric 4.64		Asymmetric 17.28	
p-value	(0.3268)		(0.1700)	
Observations	89,880	89,880	89,868	89,868

Standard errors are in parentheses while ***, **, and * represent p<0.01, ** p<0.05, * p<0.1 respectively

Consumer Goods sector stock returns-oil price relation

According to the Hausman test results in this sector, the PMG are the true estimators in both the symmetric (linear) and asymmetric (nonlinear) models (i.e. model 1B and 2B). In model 1B from Table 6, it is only exchange rate that was significant but wrongly signed. Depreciation of the exchange rate denotes that the value of the currency has

Table 6: Consumer goods sector stock return-oil price change relation

Variables	*SYMMETRIC MODELS*		*ASYMMETRIC MODEL*	
	Model(1A) mg_symmetric	*Model(1B) pmg_symmetric*	*Model(2A) pmg_symmetric*	*Model(2B) pmg_asymmetric*
Short-run estimates				
Ec	-0.00999*** (0.00183)	-0.00650***(0.00137)	-0.00869***(0.00163)	-0.00556*** (0.000961)
D.lop	0.00992(0.0169)	0.0115(0.0165)		
D.lexr	-0.0176***(0.00949)	-0.0181***(0.00949)	-0.0134(0.00944)	-0.0152(0.00944)
D.lgbr	-0.00625(0.0140)	-0.00477(0.0142)	-0.0105(0.0137)	-0.00894(0.0132)
D.mktl	1.01e-08(1.43e-07)	1.05e-07 (1.31e-07)	3.19e-08(1.35e-07)	-5.23e-08(1.23e-07)
$D.r_{it-1}$	2.7002(0.08722)	0.08755 (0.1265)	0.0950(1.0069)	1.0082(0.13091)
D.lop_p			-0.0370(0.0226)	-0.0383**(0.0177)
D.lop_n			-0.0863***(0.0223)	-0.0837**(0.0220)
Long-run estimates				
Lop	-3.861(4.195)	0.926***(0.0156)		
Lexr	0.582(1.033)	0.206(0.212)	-8.756(8.563)	-0.0998(0.213)
Lgbr	-1.196(1.170)	-0.101(0.253)	11.36(11.01)	-0.0399(0.321)
Mktl	0.000293(0.000246)	5.68e-05(9.45e-05)	-0.00180(0.00182)	6.80e-05**(0.000117)
r_{it-1}	0.7902(1.00549)	-0.6520(0.12197)	-0.42980(0.2021)	-3.33002(0.16007)
lop_p			28.56(2.001)	1.309***(0.0119)
lop_n			-142.3(169.1)	-39.59**(0.0338)
Constant	-0.0203*(0.0306)	-0.00967*** (0.00357)	0.0324*(0.0243)	0.0231***(0.00418)
Hausman test $\ddot{X}_n^2$	symmetric 2.81		Asymmetric 4.01	
p-value	0.3268		0.1936	
Observations	46,206	46,206	46,200	46,200

P-values are in parentheses; *** p<0.01, ** p<0.05, * p<0.1

fallen, which worsen inflation rate. During inflationary period, households prefer investing in stocks and other durables to prevent eroding the value of their wealth. This leads to increase in productivity, rise in profit and stock returns. This implies that households do not invest in consumer sector stocks during exchange rate risk. However, in the long run, exchange rate has no impact on the sectoral's stock returns. Oil price risk shows no relationship with the sector's stock returns in the short run in model 1B. When oil price risk persists, a percentage change in the oil risk affected consumer good stock returns by about 0.93% in the long run. Closer inspection of column 3 of Table 6 indicated that other control variables like global market risk (gbr) and domestic market liquidity (mktl), though rightly signed, do not exert significant impact on stock returns of this sector.

From model 2B, it is seen that the sector was asymmetrically impacted by oil price changes both in the short and long run. This gives credence to the significance of oil price to the sector in model 1B in the long run. Negative oil price change affected the stock of the sector in magnitude than positive oil price change. In the short run, despite that positive oil price change has a wrong sign; a % change in negative oil price reduced consumer goods stocks by 0.08%. Then, in the long run, the magnitude of negative oil price variation lowered the sectoral's return with about 39.59%. While positive oil price shock increased consumer goods sector stock returns by about 1.31%. It is conspicuous that the other control variables were not significant in model

4.3.2. Agricultural sector stock return-oil price change relation

The Hausman test for the symmetric regression on Agricultural sector indicated that PMG is the efficient model as contained in Table 7. Hence, the focus was on interpreting the coefficients of PMG, which is model (1B). Oil price fluctuation and Agricultural stock returns showed negative relationship but insignificant in the short run in model 1B. The opposite is true in the long run but still insignificant. Consequently, among the other variables of interest, it is only exchange rate that is significant (0.66%) but wrongly signed in the long run.

As regards to the asymmetric models (model 2A and 2B), Hausman test revealed that the PMG estimator (model 2B) is the preferred model. Estimates from model (2B) reported no relationship between oil price fluctuation and Agricultural stock returns in both the short and long run. In terms of sign, it is wrongly signed in both the short and long run for negative oil price risk. For the positive oil price risk, the short run coefficient (0.03) is positive but not significant. Although, it is expected that increase in oil price would cause stock returns of oil exporting countries like Nigeria to rise and vice versa, (see: Salisu and Isa, 2017). However, this conclusion is not obtainable in Agricultural

stock returns in Nigeria both in the symmetric and asymmetric models. This may not be unconnected to lack of linkage between Agriculture and stock market in Nigeria. Moreover, returns from Agricultural sectoral stocks did not exhibit asymmetries to oil price changes given the results obtained.

Table 7: Agricultural sector stock return-oil price change relation

VARIABLES	*SYMMETRIC MODELS*		*ASYMMETRIC MODEL*	
	Model(1A) mg_symmetric	*Model(1B) pmg_ symmetric*	*Model(2A) pmg_symmetric*	*Model(2B) pmg_ asymmetric*
Short-run estimates				
Ec	-0.0303***(0.0213)	-0.0272***(0.0225)	-0.0303***(0.0212)	-0.0272***(0.0225)
D.lop	-0.00504(0.0300)	-0.00183(0.0297)		
D.lexr	-0.0140(0.0146)	-0.0141(0.0104)	-0.0102(0.0178)	-0.0125(0.0116)
D.lgbr	-0.00694***(0.00198)	-0.00341(0.00273)	-0.00696***(0.00129)	-0.00360(0.00315)
D.mktl	-1.04e-07(3.63e-07)	1.29e-05(1.34e-05)	1.05e-06(7.83e-07)	1.32e-05(1.35e-05)
$D.r_{it-1}$	-0.058(0.113)	0.0057(0.00081)	-3.219(0.0005)	-1.0044(0.0041)
D.lop_p			0.0505(0.0442)	0.0258(0.0604)
D.lop_n			-0.0142(0.0695)	0.00476(0.0893)
Long run estimates				
Lop	0.390***(0.0156)	0.154(0.131)		
Lexr	0.552(1.041)	0.669***(0.0194)	0.265(0.987)	0.550***(0.0151)
Lgbr	1.219**(0.569)	0.215(0.221)	0.0399**(0.0547)	0.0231(0.221)
Mktl	0.000280(0.000416)	4.50e-06(0.000653)	0.000245(0.000380)	-3.58e-05(0.000646)
r_{it-1}	0.0073(0.184)	0.9311(0.28620)	2.0833(0.06202)	0.5088(0.00990)
lop_p			-8.254**(0.0199)	-1.849(2.307)
lop_n			6.257** (0.06837)	1.614(2.323)
Constant	-0.125***(0.0123)	-0.0711*(0.0505)	-0.0745***(0.0221)	-0.0384**(0.0236)
Hausman test $\ddot{X}_n^2$	**symmetric** 1.02		**Asymmetric** 1.26	
p-value	0.9063		0.9391	
Observations	7,704	7,704	7,701	7,701

values are in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Oil and Gas sector stock return-oil price relation

The Hausman test results for the estimates of this sector indicated the PMG estimators as the efficient one in both the symmetric and asymmetric regressions as shown in

Table 8. Starting with the symmetric model, from model 1B, oil price fluctuation was significant (0.0681) and positively related to oil and gas stock returns in the short-run. The co-movement persisted in the long-run but not significant (0.0625). Obviously, other variables of interest show insignificant relation with the sector in the short-run.

Moving to the model with asymmetry (model 2B), in the short-run, negative oil price change was significant with an inverse relationship while positive oil price change showed no connection with oil sector stocks. In the long-run, a percentage change in positive oil price resulted in about 2.40% appreciation in oil and gas stocks. While 1% change in negative oil price movement yielded about 1.72% decline in oil and gas stocks in the long-run. Evidently, oil and gas sector's stocks responded to oil price fluctuations asymmetrically. In particular, the magnitude of the positive oil price changes is greater (2.377) than the magnitude of negative oil price change (-1.726) in absolute terms. What this portends is that investors invest more on oil and gas stocks during positive oil price changes than the rate at which they withdraw their investment during negative oil price movements. The rationale for the higher magnitude of positive oil price changes than negative oil price shock could be attributed to higher welfare associated with oil boom in oil exporting countries like Nigeria that encourages investment; which is contrary to the rate of investment experience during oil glut period. In summary, oil and gas sector stock prices respond to oil price changes asymmetrically. Surprisingly, exchange rate affects stock price in this sector as expected while gbr and mktl do not matter in explaining oil and gas stock returns. The study covered similar results for the seven other sectors in the larger work but cannot present them here because of world count limitation.

Table 8: Oil and Gas sector stock return-oil price change relation

Variables	*Symmetric Model*	*Asymmetric Model*
	Model(1A) *mg_symmetric*	*Model(2A)* *mg_asymmetric*
Short-run estimates		
Ec	-0.00965**(0.00392)	-0.00978**(0.00398)
D.lop	0.0681**(0.0342)	
D.exr	-0.0190***(0.00984)	-0.0171**(0.0102)
D.gbr	-0.00445(0.00331)	-0.00452(0.00330)
D.mktl	-6.18e-07(4.13e-07)	5.77e-07*(4.15e-07)
D.rit_1	0.06371(0.00636)	0.8524**(0.03904)
D. P_{t-1}^{+}		0.0188(0.0408)
D. P_{t-1}^{-}		0.0612***(0.0227)
Long-run estimates		
Op	0.0625(0.119)	

Variables	*Symmetric Model*	*Asymmetric Model*
	Model(1A) *mg_symmetric*	*Model(2A)* *mg_asymmetric*
Exr	0.232(0.162)	0.177**(0.132)
Gbr	0.257(0.195)	0.293(0.195)
Mktl	3.51e-05(0.000113)	3.34e-05(0.000113)
r_{it-1}	2.49003(0.00758)	7.9531(0.00698)
P_{r-1}^{+}		2.377**(2.085)
P_{r-1}^{-}		-1.726**(2.137)
Constant	0.0109**(0.00837)	0.0135*(0.00945)
Hausman **test**	Symmetric	Asymmetric
$\ddot{X}_{n}^{2}$	3.99(0.4070)	4.45(0.3481)
Observations	12,840	12,835

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Aggregate market oil price-stock returns in Nigeria

Table 9 revealed that MG (model 1A) is the true model for the symmetric regression as shown by the Hausman Test statistic. In model 1A, oil price changes do not significantly influence the stock returns in Nigeria in the short-run. In the long-run, oil price change is negatively related to stock market returns with an estimated coefficient of about -0.73 percent. The estimates of the other variables of interest are significant in the long-run except the exchange rate as depicted in model 1A. As regards to the asymmetric regressions, model 2B is the efficient model. All the variables under consideration are significant in both the short-run and long-run except market liquidity and short-run lag of stock returns. In the short-run, positive oil price change is inversely related to stock return, which is contrary to the a priori expectation and empirical findings of Masil *et al.*, (2011). This is plausible given the fact that during initial upward price movement, investors may not be in a hurry to invest in stocks.

They would want to monitor the movement to determine if the changes are transitory or permanent. Then, when the oil price risk persists, investors would have adjusted and determined the policy dynamics of the upward movement, and are likely to invest more in stock as the income keeps rising. Hence, the Long-run estimates indicated positive relation between the hike in oil price and stock returns. However, for the negative oil price change, there is a positive relationship between the two variables in the short-run and long-run as indicated in model 2B. A percentage decrease in oil price leads to about 0.10% drop in stock prices in short-run. This is supported by empirical literature that stock price responds to negative news more quickly than positive news

(Narayan and Gupta, 2015). A hike in oil price indicated positive relation with stock returns also which showed that a 1% increase in oil price gives rise to about 5.13% increase in stock market return in the long run in model 2B. Generally, the results indicated that stock returns in Nigeria exhibited oil price asymmetry in both the short-run and long-run. The stock market responded more to negative oil price variation (25.46%) than positive oil price change in the long-run (5.13%).

Table 9: Aggregate market oil price-stock returns relation

Variables	*Symmetric Models*		*Asymmetric Model*	
	Model(1A) mg_symmetric	*Model(1B) pmg_symmetric*	*Model(2A) pmg_symmetric*	*Model(2B) pmg_asymmetric*
Short-run estimates				
Ec	-0.0286***(0.0157)	-0.00904***(0.00201)	-0.0125***(0.00231)	-0.00835***(0.00136)
D.lop	-0.00217(0.0163)	0.0142(0.0171)		
D.lexr	-0.0189***(0.0041)	-0.0222***(0.00409)	-0.0157***(0.00401)	-0.0194***(0.00396)
D.lgbr	0.0116**(0.00666)	0.0118*(0.00657)	0.0112*(0.00654)	0.0115**(0.00643)
D.mktl	3.49e-07***(9.07e-08)	-2.45e-07***(9.20e-08)	-3.16e-07***(9.06e-08)	-7.81e-08(7.58e-08)
D.r_{it-1}	0.1335(0.2568)	0.6662(-0.2229)	0.9582*(0.3906)	0.0381(0.2243)
D.lop_p			-0.0999***(0.0169)	-0.114***(0.0134)
D.lop_n			-0.0707***(0.0159)	-0.104***(0.0212)
Long-run estimates				
Lop	-0.733**(0.783)	0.0213(0.0638)		
Lexr	-0.911***(0.309)	-1.004***(0.0898)	-2.540(1.593)	-0.828***(0.0671)
Lgbr	-0.105(0.357)	0.799***(0.106)	2.044(2.070)	-0.457***(0.102)
Mktl	0.000134***(4.74e-05)	5.46e-05(3.99e-05)	-0.000233(0.000339)	4.15e-05(3.78e-05)
r_{it-1}	0.774**(0.0129)	0.864(0.1390)	0.9823**(0.3651)	0.397***(0.0511)
lop_p			4.769(5.610)	5.131***(1.451)
lop_n			4.186(31.99)	-25.46***(1.791)
Constant	0.0414**(0.0163)	-0.00142(0.00359)	0.0352**(0.0193)	0.0197***(0.00295)
Hausman test $\ddot{X}_n^2$	symmetric 11.44		Asymmetric 13.48	
p-value	0.0096		0.191	
Observations	254,467	254,467	254,370	254,370

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.10. Where MG=Mean group and PMG=Pool mean group estimators

Discussion and synthesis of the sectoral stock market results

The discussion revealed the similarity and dissimilarity among the sectorals' results in row 4, column 4 and 5 of Table 10 and equally compared them to aggregate stock market result in Table 10. The result reveals that oil price asymmetry does not have significant impact on Agricultural, ICT, industrial, natural resources, and service sector

stock returns in both the short-run and long-run. Although, industrial and ICT sector stocks record positive and negative significant responses respectively to negative oil price variation in the short-run. The study concludes that oil price asymmetries do not determine the stock price of these sectors in the long-run. This suggests that there could be evidence of some big firms or sectors masking the effect of oil price changes to stock returns in Nigeria when the aggregate market index is used. Cong *et al.* (2008) found a similar result for the Chinese sectoral stock market.

The next category of results obtained suggested that conglomerates, construction, and health sector stock indices react differently to oil price shocks in different horizons. In the long-run, conglomerate sector is directly and inversely related to positive and negative oil price variation respectively. Oil price asymmetry has an inverse relationship with construction sector stock returns in the long-run. The result equally suggests that positive oil price fluctuation does not account for health sector stock return in Nigeria both in the short and long-run. While negative oil price change affects health sector equity returns positively in the short and long-run. This result implies that asymmetries in oil price fluctuation affect different sectors differently depending on their market structure[5] to oil price risks. Huang *et al.* (2015) study has a similar finding that Brent crude oil has various temporary and persistent effects on the Chinese stock market.

Table 10: Summary of the Results of Asymmetric Oil Price-Stock Returns Nexus

Oil Price-Stock Returns Relation in Sectoral Level in Nigeria				
Sectors	*Asymmetric Short-run Model*		*Asymmetric Long-run Model*	
	Positive Relation	*Negative Relation*	*Positive Relation*	***Negative Relation***
Agregate Stocks	-0.114***	-0.104***	5.131***	-25.46***
Agriculture	0.0258	0.00476	-1.849	1.614
Conglomerates	0.0969**	-0.0781	55.97**	91.39***
Construction	0.0108	-0.0226	-2.939**	2.464*
Consumer Goods	-0.0383**	-0.0383**	1.309*	-39.59***
Financial	0.186***	-0.140***	3.837**	-18.81***
Health	0.0019	-0.0581**	2.812	-0.294**
ICT	0.0146	0.164*	-3.303	-0.83
Industrial	-0.0258	-0.0458***	0.658	3.334
Natural Resources	0.0027	0.0531	1.772	-2.254
Oil & Gas	0.0188	0.0612***	2.377**	-1.726**
Services	0.004	-0.0322	-2.239	0.0583

The results of consumer goods, financial, and oil & gas sectors responded positively to upward and downward oil price fluctuation in the long-run. Li *et al.* (2012) finding in China is similar to this study's result. Huang *et al.* (2015) found the same result

for financial and consumer goods sector but a contrasting result for oil and gas sector in China. Sonenshine and Cauvel (2017) found opposite result for consumer goods in the US. A striking common characteristic of the three sectoral's stocks is that their asymmetric responses to oil price movement are similar to the result of the aggregate stock market. This remarkable observation may be connected to the fact that the three sectors constituted more than 70% and 65% of the total MCAP and the study's sample respectively. The result suggested that firm's or sectoral's characteristics could actually influence the result obtained when considering aggregate studies; thereby giving credence to the sectoral analysis being undertaken in this study.

Discussion and synthesis of the aggregate stock market result

The study discussed the relationship between aggregate stock market returns and oil price variation in Nigeria. There was an inverse relationship between oil price change and stock returns in Nigeria in the symmetric form in the long-run (Table 9, model 1A). Empirical evidence of similar findings is documented by Adeleke (2011) for Nigeria, Ghosh and Kanjillal (2014) for India. However, there is evidence that oil price changes is significantly and positively related to stock returns in the long-run for the asymmetric regression in model 2B of Table 9. The result showed that Nigeria's stock returns exhibit oil price asymmetries. Moreover, negative oil price asymmetries had more influence (25.46%) than positive oil price asymmetries (5.13%). Phan *et al.* (2014) reported corresponding results for oil-producing countries. Although, the finding is in contrast with much of the available information from the prior literature (see: Alamgir and Amin, 2021; Sim and Zhou, 2015; Narayan and Gupta, 2014; Salisu and Isa, 2017). The difference in the result may have alluded to the high volume of oil importation in Nigeria.

Stock returns in the Nigeria stock market signaled exposure to bilateral exchange rate risk as evidenced in the study results. The result seems plausible given the fact that over-dependence of Nigerians on importation of inputs and consumables worsened the exchange rate and this negatively affects stock returns. Further, it is likely that government policy on the exchange rate in Nigeria to different transactions and sectors also contributed to the inverse relationship. The result of the study conforms to the findings of Afolabi (2012) and Hashmi *et al.* (2022). The study recorded insignificant effect of market liquidity in the long-run although with the right sign from model 2B of Table 9. This simply means that the turnover ratio in the Nigerian stock market may be unable to explain return on stocks. Shiller (2000) identified subtle reactions by investors who invest on stocks simply because few other agents (investors) are buying stocks which he calls herding investors. These (herding) investors ignore market

fundamentals but followed market-crowd-behavior. This may be the characteristics of most Nigerian investors and why the liquidity ratio was not significant in the true model of this study.

5. Conclusion and Recommendations

Conclusion

The study covered eleven sectors. Three of the eleven sectors examined do not respond to oil price in both symmetric and asymmetric forms in Nigeria. These sectors are agriculture, natural resources, and services sectors. Among the sectors that asymmetrically reacted to oil price risk - industrial and ICT sectors only react to oil price change in the short-run. The study also found that positive and negative oil price risk has a positive and inverse relationship with conglomerates' stock returns respectively in the long-run. Construction sector stock return is inversely correlated to positive and negative oil price variation in the long-run. Negative oil price risk affects health sector stocks positively in the long-run while the upward movement of oil price risk has no impact in the sector. Results from consumer goods, financial, and oil & gas sectors indicated that positive and negative oil price risks have a positive relationship with the sectorals' stocks in the long-run. In the aggregate, there is evidence of Nigeria's stock market returns responding to oil price fluctuations asymmetrically.

Policy Recommendations

The study shows that the influence of positive and negative oil price fluctuation varies in magnitude and across sectors, confirming the evidence of oil price asymmetry in the NSE. Therefore, the government should create a special purpose fund as a corporate governance strategy to manage risk associated with oil price volatility in the NSE. The result brings to the fore the need for requisite hedging strategy for each sector according to the asymmetric impact of the oil price risk by financial managers in Nigeria. Therefore, monetary authorities are encouraged to put adequate measures in mitigating instability against exchange rate. Moreover, the policy of different exchange rates for different transactions and sectors in Nigeria should be reconsidered as this occasioned more instability and hampers stock market viability.

Contribution to knowledge

Empirically, the study added to the body of knowledge by using NARDL to examine oil price-stock return link on sectoral level while considering the asymmetric feature of oil price which is lacking in the literature in Nigeria. Theoretically, the study infused oil

price risk into the APT model nonlinearly by splitting oil price risk into positive and negative oil price risk (asymmetric) and showing oil price risk-stock returns relation in Nigeria

Notes

1. Derivatives are financial instruments for hedging against market risk and unfavorable business environment whose value depends on the values of other, more basic, underlying variables. Nigeria Stock Exchange (NSE) announced the use of derivative in 2017 in its history.
2. Most of these studies focused on few developed countries (see, Arouri *et al.*, 2011).
3. Though Salisu and Isa (2017) employed nonlinear specification but on cross country analysis.
4. Exchange rate risk, Global market risk, lag of stock market returns, and domestic market liquidity.
5. Such as firm's or sectoral's utilization of energy, nature of the firm's product, managerial ability of the sector etc.

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