OIL PRICES AND TECHNOLOGY STRATEGY OPTIONS IN THE NIGERIAN PETROLEUM INDUSTRY

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Abstract

For institutional investors in the oil and gas industry to enjoy sustainable synergistic returns, technology strategy must of necessity be right. As in most scenarios, the choice of technology development and/or improvement strategies may have to do with oil price dynamics. This study examined the extent of this functionality, with data from frontline oil firms in Nigeria, who account for over 97% of the sector's output in the economy. Using correlation and Chi-square (X^2) statistical analysis techniques, significant relationships were established. It is recommended that oil firms should consider technology development when the scenarios are bullish and technology improvement when it is bearish.

Introduction

The universal recognition of price as a key determinant of product supply and demand leaves the active players squarely on the receiving end, under perfect market conditions. As price takers, this strategic factor is crucial when the product is about to be supplied. This position holds sway, particularly within the horizon of conventionalism. The strategic approach requires more constructive and proactive analysis of pricing time series all through the phases of output creation and administration. The oil industry is not an exception, as it equally shares in these market-specific realities.

Purpose of the Study

The focus of this study is the petroleum industry in Nigeria, generally regarded as Africa's leading oil producing nation. The study was designed to examine and establish the relationship between oil prices and technology strategies of key players in the industry. The pertinent hypotheses (H), in null perspectives, were:

HOi: There is no significant relationship between prices and development of new technology. **HO_2:** There is no significant relationship between prices and technology development strategies of oil firms in Nigeria. HO_3: There is no significant relationship between prices and technology improvement strategies of oil firms in Nigeria.

Theoretical Framework

The development of nations depends to a large extent, on their ability to absorb and recreate technologies. Of all the differences between the developed and the underdeveloped countries, differences in the level of technological development, appear to be most pronounced. Technology is therefore, regarded as the most potent force causing underdeveloped countries to remain in a perpetual state of underdevelopment while further advancing the developed countries. It creates new industries and uses for existing products and alters industry structure (Kotler, Armstrong, Sanders, and Wong, 1996; Porter, 1985).

These merits notwithstanding, technology is not a self-perfecting phenomenon. It has to be managed. There is a marked difference; particularly with respect to making a new technology available and being able to profitably employ it in business. Unfortunately, there has been an age-long acute shortage of technology in the major sectors of the Nigerian economy. According to Fubara (1987), the acute shortage of technology and infrastructure in Nigeria has made many enterprises in developing countries to resort importing technologies at prohibitive costs. Also, there are divergent views on the categorization of technology strategies and their determinants (Kantrow, 1980).

Considering the fact that the petroleum industry is the foremost viable sector of the Nigerian economy, many people desire and actually need to know how technologies are selected and deployed in this

sectors. Basically, technology strategies relate to products, processes and competences in organizations, with two main dimensions, vis:

a) Development strategy for new technologies deployment, and
b) Improvement strategy for existing technologies enhancement.

Altogether, these translate to six technology strategies, designated as:

i. Product technology development strategy,
ii. Process technology development strategy,
iii. Competences technology development strategy,
iv. Product technology improvement strategy,
v. Process technology improvement strategy, and
vi. Competences technology improvement strategy.

Equally relevant is a consideration of the influences of the price of petroleum, production quota, R. & D. expenditures, sources of technologies, government, technology skills within the firm and unit cost of production. In this study, the influence of the price factor on the formulation of • technology strategies was considered. Furthermore, most top-flying businesses consider the linkages between business strategy and technology, in giving effect to overall corporate policy (Porter, 1985). i Chiesa.and Manzini (1998), in their work considered:

i. How strategic decisions are affected by changes in technology,
ii. How to embody technology in the strategy formulation process,
iii. How a technology programme can support a given strategy, and
iv. How to gain competitive advantage through changing processes.

In their opinion, competition is defined as positioning the firm in a given arena and technology acts as a support to a given competitive strategy.

Essentially, technology strategy prevails as the logic characterizing the allocation of resources for the selection and deployment of technology required for the production of goods, and competencies necessary for cooperate sustenance. Generally, a firm seeks to be a technology leader or a follower in a particular technology, and this is turn depends on the type of competitive advantage sought by the firm, the degree of sustainability of the technology lead and the advantages that is likely to occur for being a first mover. Many reputable firms, therefore, attempt to introduce new technology only when their existing markets place a demand for the products of the new technology, while new entrants channel their new technology to new market segments. Tzidony and Zeidman (1996).contended that besides enabling the firm to maximize the payoff of its technology options, technology strategy facilitates: i. Improvement of the chances of long-term growth of the product line, and ii. Finding new uses or customers for the product line.

Bower and Young (1995) in their study of the impact of technology strategies on UK oil and gas-related industry network, considered amongst other things the existence of a new technologically advanced network of organizations underpinning their technical needs, and placed the evolution of the network within a public policy framework aimed at:

i. Maximizing UK indigenous companies involvement in the industry, and
ii. Maximizing the extraction of North Sea oil and gas.

In another analysis of technology strategy in the US product market segment, it was established that product and process technologies strategies used by rival firms throughout the market growth and concentration phases of industry maturity, proved important to successful competition.

With respect to corporate strategy efficiency, pricing system is crucial. The prices of products constitute the source of revenue for investment in the technologies. For the oil industry, the price of crude oil is crucial. In the international market, oil pricing is a political issue, significantly influenced by the state of World peace, drive for alternative energy sources, intensity of industrial activities and the level of supply of oil relative to demand (Lukrnan, 1989). Prior to the formation of Organization of Petroleum Exporting Countries

(OPEC), seven big oil companies controlled the oil industry, including fixing the price of crude oil. Their strength eroded in the 1960s and ended by series of events during the 1970s. In 1973, the war and the Arab oil embargo on America, forced OPEC to transfer power completely from the seven firms and Compagine Francaise des Petrole (CCFP) to the cartel. From then on, the prices of oil began to be set by World politics, principally Middle East politics instead of market forces.

The reduction of supply of Arab oil in the 1970s could also be traced to the closure of the *tapeline,* which carried about 480,000 bpd of crude from Saudi Arabia to the terminal near Sidon, Lebanon. The reduction in supply and difficulty in navigating through Cape Town to the rest of the Arab World, following the closure of the Suez Canal in 1967, informed the decision of Libya to increase the price of their oil. The country cashed in on its proximity to Europe, to influence the price, so the rest of OPEC had to tow the same line. Today, OPEC member states are at liberty to increase or reduce production as the case may be, to influence changes in price. In 1989, OPEC member .states were joined by non-OPEC members to deliberate on the strategies for ensuring that price of oil did not fall to the 1986 levels.

While the nations are interested in raising the price of crude oil, the multinational oil companies want reduction in the price of crude oil without a reduction in the price of the refined products and by-products. From 1973 to 1980, the price of oil rose and peaked. Accordingly, Lukman (1989) observed that these price levels alarmed countries into adopting measures to counter such high reliance on OPEC. Obviously, drops in oil companies' revenue adversely affect their budgets for technology development. For the Nigerian oil industry, the trend in the prices of oil relate to three eras which were characterized by:

i. Rising prices (1972-74, 1978-1980, 1988-1990),
ii. Stable prices (1974-1978), and
iii. Falling prices (1980-1988, 1990-1994, 1997-1998).

'" Analysts contend that these price trends affect policy decisions in the oil industry (Fubara, 1986). The influence extends to the technology strategies of the firms, since their revenue accrues from oil sales. The revenue accruing to government is also determined using a formula that functionally relates to the price of oil. These are the issues underlying the targets of this study.

Methodology

Combination of homothetic and ideographic methodologies was adopted since the study was retrospective in the consideration of strategic decisions in the oil industry. More specifically an ex-post facto research design and trend analysis were involved. Relevant primary data were sought from the selected firms for the period, 1970 to 1998. There were difficulties in obtaining accurate responses, but secondary data sources such as annual reports, periodicals, published articles, and books on the subject, were handy. Copies of questionnaire were sent to all the seventeen companies listed in the Central Bank of Nigeria dairy in 1999, as the oil companies operating in Nigeria. Within a reasonable time frame, ten of these companies returned their completed questionnaire. This sample is 58% of the study population. In terms of production, the ten companies account for over 97% of production in the Nigerian oil industry. They were therefore considered very representative of the companies in the oil industry bloc. The in-house magazine of the Nigerian National Petroleum Corporation (NNPC), was a veritable source of secondary data.

In addition, some executives of the oil companies and officials of the Department of Petroleum Resources (DPR), was interviewed. The main statistical methods of data analyses include chi-square (X) and correlation. The formulae are as follows:

Pxy = $NEXY-E(X)(Y)/[(NSX^2-\{X\}^2(Ni:Y^2-\{Y\}^2)]^{a5}$ ..... (Equation 1)

Pxy = Correlation coefficient

X = Independent Variable

Y - Dependent Variable

N = Number of observation, and

X^2 £(Of-Ef)2/Ef .....Equation 2)

Where: X^2 = Chi-square statistic

Of = Observed frequency

Ef= Expected frequency

These were applied relative to the various hypotheses outlined in the conceptual foundations.

Data Analysis

In new technologies development with oil prices, the number of wells drilled in the oil industry, employing such new technologies, and the overall oil prices for the periods covered by this study were analysed to test H,: The test is exemplified by the Tables and computations below:

Table 1: Number of Wells Drilled and Prices of Oil (1972-1998)

Period	Average No. of Wells Drilled	Average Price of Oil (S/b)
72-73	371	4.23
74-78	196	14.25
79-80	174	28.30
81-88	113	25.95
89-90	105	21.28
91-94	111	18.41
95-96	125	19.24
97-98	150	18.64

Research Data, 2002 (Drawn from NNPC, 1 998: Discovering a New Nigeria).

Table 2: Correlation Database (Hypothesis 1)

Period	X	Y	X2	Y2	XY	Y/X
72-73	4.23	271	17.9	73441	1146.3	64.1
74-78	14.25	96	203.1	9216	1083	5.3
79-80	28.30	74	800.0	5476	2094.2	3.1
81-88	25.95	13	673.4	169	337.4	0.5
89-90	21.28	5	452.8	25	106.2	0.2
91-94	18.14	11	338.9	121	202.5	0.6
95-96	19.24	25	370.2	625	481	1.3
97-98	18.64	50	347.4	2500	932	2.7
Totals	150.3	545	3204.6	91.573	6382.6	77.8

Source: Research Data, 2002 (Drawn/Computed from Table 2).

Substituting the above data in equation 1;

$$Pxy = [(8)(6382.6) - (150.3)(545)]/[8)(3204.6) \quad (150.3)^2)(8(91573) - 545^2)]0.5 - -0.85.$$

With the above outcome, there is a negative linear correlation between the number of oil wells drilled using new technologies and the price of crude oil. The result is significant at 5% level, where the critical equivalent is 0.75. Thus, the alternate hypothesis is accepted. For Hypothesis II, which had to do with the influence of oil prices on the formation of technology development strategies, the analysis is facilitated by the Tables and Chi-square (X^2) computations below:

Table 3: Chi-Square Computation Database (Hypothesis II)

Typologies of Technology Development Strategies	Total	Agree (%)	Indifferent (%)	Disagree (%)
Product	100	10	60	30

Source: Research Data, 2002 (Responses got through Questionnaire/Interview).

Table 4: Observed/Expected Frequencies (Hypothesis II)

Process	100	20	50	30

Competencies	100	10	40	50

Typology	Agree Of/(Ef)	Indifferent Of/(Ef)	Disagree Of/(Ef)	Total (%)
Product	10(13.3)	60(50)	30 (36.7)	100
Process	20(13.3)	50 (50)	30 (36.7)	100
Competencies	10(13.3)	40 (50)	50 (36.7)	100
Total	40	150	110	300

Source: Research Data, 2002 (Drawn/Computed from Table 4).

Table 5: Chi-Square Determination (Hypothesis II)

Observed Frequencies *(Of)*	Expected Frequencies (Ef)	(Of-Ef)	$(Of-Ef)^2$	(Of-Ef)* Ef
10	13.3	3.3	10.89	0.82
20	13.3	6.7	44.89	3.38
10	13.3	-3.3	10.89	0.82
60	50.0	10.0	100.00	2.00
50	50.0	0	0	0
40	50.0	-10.0	100.00	2.00
30	36.7	-6.7	44.89	12.23
30	36.7	-6.7	44.80	12.23
50	36.7	13.3	176.89	4.82
Total				$X^2 = 38.30$

Source: Research Data, 2002 (Drawn/Computed from Table 5).

The result in Table 5 is significant at 99% confidence level and 4 degrees of freedom, establishing that oil price dynamics influence technology development strategy formulation. Furthermore, Hypothesis III considered the influence of oil prices on formulation of technology improvement strategies. The analysis is exemplified by the tables below:

Table 6: Chi-Square Computation Database (Hypothesis III)

Hypothetical Statement	Scale Points	Response	No. of Companies	% of Response	Total
Your decision to improve your existing process and product technologies does not depend on the prices of crude oil.	I	Strongly Disagree	5	50%	0%
	2	Disagree	2	205	70%
	3	Somewhat Agree	2	20%	20%
	4	Agree	0	0	0
	5	Strongly Agree	1	10%	10%

Source: Research Data, 2002 (Responses got through Questionnaire/Interview).

Table 7: Observed/Expected Frequencies (Hypothesis III)

Response	Observed Frequency (Of)	Expected Frequency (Ef)	(Of-Ef)	$(Of-Ef)^1$	$\frac{fOf-Efl*}{Ef}$

Strongly	50	20	30	9000	45.0
Disagree	20	20	0	0	0
Somewhat Agree	20	20	0	0	0
Agree	0	20	-20	400	20.0
Strongly Agree	10	20	-10	100	5.0
Total	100	100	N.A.	N.A.	X2 = 60.0

Source: Research Data, 2002 (Drawn/Computed from Table 5).

The result in Table 7 is significant at 99% confidence and 4 degrees of freedom, establishing that oil price dynamic influence technology improvement strategy formulation. Essentially, changing oil prices may influence a project's budgeting provisions but would not necessary change the technology. In December, 1988, SPDC opted to let Western Atlas Geophysical foot the bill of acquiring 4D seismic for its offshore concessions in Blocks H, J, and K, and agreed to buy the data on a letter date, if the quality is acceptable and when funds are available. By extension, therefore oil firms as rational institutional investors, usually change their production function under the scenario of falling prices, as against rising prices which are associated with stable production function. With respect to technology development strategy, industry experts opined that the number of wells drilled depends on many factors, especially the success ratio of past drilled operations, the type of rock formation, and the drilled technology in use.

Discussion

In recent times, there is a gradual rise in the success ratio of drilled operations occasioned by advances in technology and a gradual decrease in the number of wells drilled. The drilling of one multilateral well or a horizontal well for instance would eliminate the need to drill ten vertical wells, but the cost of one multilateral well is in order of magnitude higher than the cost of a conventional well. The recovery ratio from the new technologies has also improved. The use of shared conductors has also reduced the number of wells drilled. Furthermore, the use of the enhanced oil recovery (EOR) technology, which consists of injecting steam or detergents into the smallest pores of rock had been known to have led to a sharp improvement in recovery ratio (Emmanuel, 1982). The immediate effect of the increase in recovery ratio would be the reduction n the number of exploration wells. The implication of this argument is that more wells were drilled in the 1970s and 1980s, than in the 1990s and beyond.

It is therefore, contended that the development of new deep offshore technologies should not be derived by the price of oil, and that since the offshore industry has come to stay, it would progress through falling and rising oil. The negative correlation between product technology-development strategies and prices of oil could also be explained by the attitude of industry chieftains as rational investors. Key participants in the industry point to the fact that when oil prices fall, firms tend to cut back on the number of new projects carried out and instead implement measures geared toward minimizing the cost of operations. Furthermore, the number of oil mining blocks acquired by a company may be limited by several factors such as: i. Resources available for the acquisition of blocks,

ii. Legislation on the number of blocks that can be acquired by any firm,
iii. Need to have indigenous companies participate in the industry, and
iv. Limited oil bearing landmass of a nation.

Also, if previous exploration works have not been carried out on the blocks, they will not be drilled even when oil prices are high. The seismic data on them have not been acquired and so cannot be readily developed. The history of the oil industry has shown that deliberate government policy could influence the level of exploration activities in the industry. For example, during the period 1993-1998, government decided to reduce investment in exploration activities and to invest in the development of the already explored acreage. During this period, the NNPC could not finance her share of the joint venture cash-call regularly causing the firms not to develop new field. Lately, the use of alternative funding has been proposed, requiring joint venture partners to fund the NNPC share of the joint-venture cash and recover their investment in terms of oil

produced.

In spite of these realities, most studies tend to support the position that prices of products significantly influence the technology employed (Porter, 1985). They suggest that, as far as the price of supply is concerned, the EOR technology, for example, will require two prior conditions for its utilization. First, the price of crude oil must be such that it will make its use profitable. At oil prices less than 16 dollars per barrel, only very few wells will be profitable to use the EOR technology. For the US oil fields, the EOR technology will only be profitable at an oil price of 50 dollars per barrel. Secondly, the investment required to employ lie EOR technology in all the oil fields exceeds by far the capital available in the US and international Markets (Emmanuel, 1982).

Participants in the Nigerian oil industry argue that at low oil prices, the rig count in the industry reduces, because of the migration of rigs to other regions. Experts in the industry also reported the difficulty of moving rigs in and out of Nigeria; therefore, companies prefer long-term contract before they can bring them into Nigeria. Oil exploration and production companies in the bid to reduce cost to the levels that can be financed by oil revenues, would usually reduce the level of exploration and implement cost reduction initiatives.

The decision of the government to *re*duce investment in exploration activities also, was not unconnected with the fact that oil prices fell n 1990 to 1994 and stabilized at low levels from 1994 to 1996. the effect of the squeeze in funding was the drive to find better ways of working. Experiences in Elf Petroleum Nigerian (EPN) Limited now (Totafinaelf) are similar to those of SPDC. In 1993, EPN suspended the planned field development of ('fun and Emu fields due to financing constraints. The low financing level forced a rethink, which led It a 30 percent reduction in capital cost. The cost savings was attributed to improved technology, whit ii reduced the number of platforms from 4 to 2 (OPEC, 1996). Today, lotafmaelf and SPDC are • *i* the forefront of the use of the alternative funding arrangement.

Current literature is also replete with analyses of the relationship between the prices of products and the product life cycle, cost of productions, demand and supply and competitive advantage of firms (Nagle, 1984). They considered products emanating from industries, in which the manufacturers determine prices, and the affei.ied firms can adjust prices, during the product life cycle to reflect the changes in the determinants t f prices. The determinants of prices in such industries include the pricing strategies, buyer's perception of quality, demand and supply, level of competition from substitute products, cost of production and technologies employed (Dabbagy, 1990; Agundu, 2001).

In the oil industry, forces outside the control of any individual company determine prices of crude oil. This necessitates a different approach to the selection and use of technologies. Prices in this type of industry should influence the logic used in the selection and deployment of technologies to be employed and therefore the technology strategies. These prices change with time, while quality remains relatively stable.

Recommendations

In the light of the fore-going findings and discussions, it is highly recommended that:

i. Product, process and competences technologies should be developed when rising product prices occasion slack resources,

ii. Oil firms should improve on their ex. sling technologies under a scenario of falling prices, and from the point of view of resource available.

iii. Rising oil price should support the strategies of adopting new technologies (products, processes and competences)

iv. Falling oil prices should support the strategies of improving existing technologies.

Conclusion

Oil prices prevail as the critical determinant of corporate profitability in the Nigerian petroleum sector. The prices of products in any competitive environment relate to the cost of production as well as the means or technology of production. Thus, firms that produce the same quality of goods at lower cost, if they sell at lower prices, achieve lower cost advantage. On the other hand, firms that produce a higher quality product, at the same cost could sell at premium prices and achieve differential advantages. The investment in technology development then changes the production function of the firm, repositioning it for synergistic returns to scale. Since the input/output relationship for any production system is a function of the technological level of the plant,

equipment, labour, and materials employed by the firm, any improvement in technology which permits a manufacturing company to produce a given quality with fewer raw materials and less energy and labour, or a training programme which increases the efficiency of labour, usually results in a new production function. This is equally the conviction of many renowned scholars in this academic sphere. Key players in the oil and gas sector of Nigeria and other developing economies should be guided and guarded accordingly. This will bring about the increased capacity building and enhanced efficiency required to take the sector to greater heights in the years ahead.

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