INTERNATIONAL JOURNAL OF ECONOMICS AND FINANCE STUDIES
Vol 9, No 1, 2017 ISSN: 1309-8055 (Online)

A TECHNO-ECONOMIC POLICY FRAMEWORK TO ENHANCE THE CONTRIBUTION OF MARGINAL OIL AND GAS FIELD TO NIGERIA'S ECONOMIC GROWTH: A PETROLEUM INNOVATION SYSTEM APPROACH

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—Abstract —

The extent of intensified competition among firms at the global environment places technological innovation in a strategic position to promote economic development and foster the national competitiveness. This is particularly true for Nigeria. This study investigated the petroleum innovation system using the indigenous marginal field operators in Nigeria. The nature of interactions of the oil firms with other stakeholders in the industry was examined by analysing data collected from 108 participants. Data were analysed using descriptive analysis, financial modelling and logit regression. Arising from the analysis, a techno-economic policy framework was developed. The framework emphasised the benefits inherent in strengthening the interaction among the elements in the Nigerian petroleum innovation system and placed government at a strategic position in creating enabling environment for other stakeholders through policy and supports to fully enhance the contribution of marginal oil and gas field to economic growth.

Keywords: Technology innovation; Economic growth; Petroleum Innovation System

JEL Codes: O33, O43, Q32, Q38

1. INTRODUCTION

The dynamic and extent of intensified competition among firms at the global environment places technological innovation in a strategic position to promote economic development and foster national competitiveness. The question of how to fast-track the development process and foster sustainable innovation, in many emerging and developing countries, has aroused wide concern from government, industry and academia (Chan & Daim, 2012). The links between firms and other stakeholders are portrayed as a result of the technological and socio-economic interdependence of their knowledge. The majority of the development that had taken place in the industrialised countries have been attributed to high extent of technological innovation. The National Innovation System (NIS) has been the forefront of argument in achieving economic growth and competitiveness by many scholars for the past three decades. The NIS concept emphasises the interaction of actors involved in innovation and investigates how these interactions are shaped by social, institutional and political factors in a country (Fagerberg & Verspagen, 2009; Freeman, 1997 & 1987; Nelson, 1993; Lundvall, 1992). As a result of varied impacts of the policy of NIS on different sectors of the economy, the NIS cannot be generally used to determine what happens in different sectors of the economy. This led to the emergence of what is recently termed sectoral innovation system (SIS) or sectoral system of innovation.

The system of innovation approach generally views innovation as an interactive process among a wide variety of actors (Edquist, 1997; Akinwale, 2017). This system emphasises innovation as a collective process whereby no single firm can innovate in isolation, rather the firms interact with other firms as well as with non-firm organisations (such as universities, research centres, government agencies, financial institutions and so on) in any sector of the economy (Malerba, 2005). The types and structures of relationships vary from one sectoral system to another as a consequence of the features of the knowledge base, the relevant learning processes, basic technologies, characteristics of demand, key links and dynamic complementarities (Malerba, 2005). It is therefore necessary to have a policy that will be directed to a particular sector to foster the innovation system, as policy interventions that are not sectoral specific enacted at the national level may have little or no effects in some industries. This warrants the investigation of the Nigerian petroleum sector focusing on the indigenous firms that operate marginal oil and gas fields, using the sectoral innovation system to derive the appropriate policy framework.

There are so many oil and gas fields which have been left undeveloped by many international oil companies for more than ten years, which are therefore termed 'marginal fields'. These fields could contribute immensely to the oil and gas production of Nigeria and at the same time generate wealth and employment for the citizens if exploited (Akinwale, 2016a). This prompted the Federal Government to come up with initiatives to allocate these marginal fields to the indigenous oil and gas firms so that the local players are enabled to participate more in petroleum production (Akinwale, Akinbami & Akarakiri, in press). There has been some degree of development of these marginal fields by the indigenous players but the extent remains unsatisfactory to the government as majority of the indigenous firms still continue to struggle to produce after fourteen years of the last allocations.

Turning these marginal oil and gas fields to commercial fields requires both technological innovation and socioeconomic factors which could influence their hydrocarbon production. While technological innovation has become the most important source of capacity building and profitability in the firms, economic viability of a project cannot be relegated as technologically inclined business that is not economically viable are not likely to be pursued by firms. Thus, both the technological and economic factors are to interact to determine the viability of the marginal oil and gas field projects.

This study adopts a sectoral innovation system in the petroleum sector to investigate the techno-economic factors influencing the development of marginal oil and gas field in Nigeria. An innovation system defines the ecosystem of related entities and ensures that potential innovation resources are effectively harnessed and utilised (Chan & Daim, 2012; Akinwale, Adepoju & Olomu, 2017). The sectoral innovation system framework often links various sectoral innovation resources (education and research institutes, firms and banks) towards technological and economic outputs (new and improved products, new and improved processes, profits, employment). It is well documented in the literature that technology policy should generate innovation with a view to constructing co-evolution among heterogeneous players with different degrees of competitive advantage. Each player is required to recognise and develop its core competence through learning inspired by other players (Fukuda & Watanabe, 2008).

There are studies (Chan & Daim, 2012; Siyanbola, Oladipo, Oyewale, Famurewa & Ogundari, 2012; Adeyeye, Jegede & Akinwale, 2013) on sectoral innovation system mainly in the pharmaceutical and biotechnology, chemicals, telecommunications, transportation, manufacturing and services sectors, but there

is a dearth of study in the petroleum sector (Akinwale, 2016b). Furthermore, the authors are unaware of any study thus far that has examined the innovation system which has captured the nature of interaction with all other stakeholders in the Nigerian petroleum sector. This paper, therefore, seeks to fill such gap in the literature by developing a techno-economic framework from the results obtained through surveys conducted among the key stakeholders of the Nigerian petroleum system.

The petroleum innovation system (PIS) in this study involves the network among the oil and gas that operate marginal fields, the government which are expected to provide policy for an enabling environment for financial institutions which are expected to provide credit funds for other stakeholders and the universities which are expected to provide knowledge support for the industry.

2. METHODOLOGY

Primary data were obtained from the stakeholders through the use of questionnaire and secondary data were collected through a literature study from journals, textbooks, annual reports and magazines on the operation of marginal oil field in Nigeria.

2.1 Sample and data collection

The sample in this study comprised 150 indigenous oil firms out of an average total of 178 firms that engage in production and servicing at the upstream sub-sector in the Nigerian petroleum industry. Purposive sampling technique was used to elicit information on profile and activities of the company from the managing director or senior management of the firms. In this regard, information on the types of technology and innovation capabilities present, nature of economic and fiscal uncertainties, the extent of linkage with other stakeholders in terms of knowledge (from universities), finance (from banks), and fiscal regime (from government), among others, were obtained from the firms.

In order to examine the level and nature of interactions among the major stakeholders in the petroleum innovation system and develop a techno-economic policy framework, data were collected using a similar version of the Community Innovation Survey (CIS), developed by European Union, which has a long tradition of research on innovation. A section relating to the interactions of the oil firms with each of the other stakeholders in the industry as well as a section on fiscal and economic matters was included in the questionnaire. Of the 150 questionnaires which were administered through hand submission and online

monkey survey forms between January and March 2015, 108 (n=108) completed questionnaires were returned providing a response rate of 72 percent.

2.2 Methods of data analysis

The methods used in analysing the data include descriptive, financial modelling and logit regression.

Descriptive analysis used consists of frequency distributions and mean ranking. Financial modelling using monte carlo simulation (MCS) was adopted to determine the economic/fiscal variables causing the most variability in the determination of net present value (NPV) of the marginal oil and gas projects (Akinwale & Akinbami, 2016). The MCS describes the risks and uncertainties associated with the primary variables in the form of probability distributions (Adamu, Ajienka & Ikiensikimama, 2013). The primary variables considered are oil price, total oil and gas recoverable reserves, development expenditure, operating expenditure, taxes and abandonment cost, petroleum profit tax, royalty tax; while the post-tax NPV is the subject of interest, which is the dependent variable. Therefore, the level of impact of each of the primary variables is observed on the post-tax NPV. Logistic regression otherwise known as logit regression is also used to determine the factors that influence the extent of interaction with each stakeholder considered in the petroleum innovation system. Ordered logit regression is used in this case since the dependent variable is measured in terms of the extent of interaction with other stakeholders in the system, and this is sequentially ordered (Brooks, 2014) using a 5 point Likert-scale ranging from “Not at all/ Very low” to “High extent”.

3. RESULTS AND DISCUSSION

3.1 Descriptive analysis

Table 1 reveals that approximately 80 percent of the oil and gas firms sampled are private limited companies while the remaining 20 percent accounts for public limited companies. It also shows the mean ranking of the extent of interaction of the indigenous oil and gas firms with university academia, financial institutions and government agencies. The table shows that the level of interaction with financial institutions is medium with the mean rank of 2.50 out of the total of 5; whereas the level of interaction with government agencies and universities is low with mean rank of 2.43 and 2.31 respectively. This result indicated that the

general level of interactions among the elements of petroleum innovation system is low.

Table 1: Nature of Company/ University and Department of the Respondents

Respondents' categories				
	Oil & Gas	**University**	**Financial institutions**	**Government Agency**
Respondents' characteristics	%	%	%	%
Nature of Company and University				
Public Limited	19.8	-	100	-
Private Limited	80.2	-	-	-
Federal University		83.7	-	-
State University		16.3	-	-
Oil and Gas Firms' interaction with Other Stakeholders	**Mean ranking**			
Financial Institutions	2.5			
Government Agencies	2.43			
University Academia	2.31			

3.2 Factors influencing the extent of interaction among the Nigerian petroleum innovation system

This section revealed different variables that contribute to the interaction between the oil and gas firms and other stakeholders using ordered logistic regression.

3.2.1 Interaction of oil firms with Universities

Table 2 reveals the factors that influence the extent of interactions of oil firms with the Universities. Factors such as engagement of academic staff in project/consultancy (X1), Joint research with academics (X2), student internship (X5), workshops and conferences organised by the oil firms (X6) have significant impact on the level of interaction with the university academia with probability values less than 10 percent ($p<0.1$) level of significance whereas using of university laboratory facilities (X3) and licensing of university held patents by the oil firms (X4) did not have significant impact on the interactions with the university as their probability values are greater than 10 percent level of significance.

The positive coefficient indicates the likelihood of all the variables increasing the extent of interaction of the oil firms with the Universities except X3 which is negative and indicated a lower likelihood to foster the firm-university interaction. The negative coefficient of X3 might be due to the poorly equipped level of university laboratory facilities.

Table 2: Extent of interaction of oil firms with the university academia

Explanatory Variables	B	Std Error	z-Statistic	Prob (p-value)
Engagement of academic staff in project/Consultancy **(X_1)**	0.374	0.084	4.438	0.000
Joint research with the academics **(X_2)**	0.328	0.071	4.639	0.000
Laboratory facilities **(X_3)**	-0.110	0.083	-1.333	0.187
Licensing of University held patents **(X_4)**	0.079	0.075	1.053	0.296
Student internship **(X_5)**	0.215	0.065	3.282	0.002
Training, workshops and conferences **(X_6)**	0.197	0.062	3.180	0.002
Constant	-0.001	0.247	-0.004	0.997
Pseudo R-squared	0.575			
Prob(LR statistic)	0.000			
Method	ML- Ordered Logit (Quadratic hill climbing)			

Pseudo R-squared of 0.57 showed that the model fits the data, and the Prob (LR-statistic) of 0.0002 implies that all the independent variables are jointly significant in influencing the level of interaction with the universities.

3.2.2 Interaction of oil firms with financial institutions

The result shows that project financing credit (X1), invoice discounting facility (X3), interest rate concession (X4) and bank guarantee (X5) have significant impact on the extent of interaction with the financial institutions in Nigeria at 10 percent ($p<0.1$) level of significance while Overdraft Facility (X2) was not significant. All these variables were also positively related to the extent of interaction with financial institutions except interest rate concession which was negatively related. Access to credit and funding had been recognised as important factors driving the linkage among the stakeholders in the innovation system. The negative coefficient of interest rate concession may be due to the low level of concessions given to the indigenous oil firms by the financial institutions.

Table 3: Extent of interaction of oil firms with the financial institutions

Explanatory Variables	B	Std Error	z-Statistic	Prob (p-value)
Project financing credit (X_1)	0.160	0.062	2.567	0.012
Overdraft facility **(X_2)**	0.058	0.048	1.206	0.231
Invoice discounting facility **(X_3)**	0.190	0.055	3.450	0.001
Interest rate concession **(X_4)**	-0.063	0.036	-1.784	0.078
Bank Guarantee **(X_5)**	0.582	0.067	8.746	0.000
Constant	0.173	0.101	1.716	0.090
Pseudo R-squared	0.468			
Prob(LR statistic)	0.000			
Method	ML- Ordered Logit (Quadratic hill climbing)			

3.2.3 Interaction of oil firms with the relevant government agencies

Table 4 indicates that all the independent variables considered in this model, namely government financial support for technology innovation to develop marginal field (X1), government effort in training people (X2), government policy directed to marginal field development (X3) and government research and development funding relating to marginal field (X4) are statistically significant in influencing the extent of interaction of oil firms with the relevant government agencies.

Table 4: Extent of interaction of oil firms with the relevant government agencies

Explanatory Variables	B	Std Error	z-Statistic	Prob (p-value)
Government financial support for technology innovation to develop marginal field **(X_1)**	-0.291	0.090	-3.247	0.002
Government effort in training people **(X_2)**	0.367	0.086	4.290	0.000
Government policy directed to marginal field development **(X_3)**	0.368	0.096	3.851	0.000
R&D funding relating to marginal field **(X_4)**	0.512	0.095	5.377	0.000
Constant	0.111	0.171	0.650	0.517
Pseudo R-squared	0.676			
Prob(LR statistic)	0.000			
Method	ML- Ordered Logit (Quadratic hill climbing)			

3.2.4 Constraints preventing the oil firms from interacting with other stakeholders in the petroleum innovation system

There are some impediments which prevent the exploration and production oil firms from interacting with other stakeholders in the petroleum innovation system. Table 5 displays the degree to which some of these constraints prevented the

interaction with other stakeholders through their mean ratings. Lack of adequate research facilities by most universities in Nigeria was rated high (3.55) as the major factor preventing interactions while incompetence of academics to undertake industrially oriented research was rated low (2.45) and the least constraining factor. Factors such as low capital base of Nigerian banks, low commercialisation potential of university research outputs, most banks perceiving oil field development as very risky, high interest rate charged by banks, lack of awareness of who to meet at university for collaboration, inadequate mechanisms to interact with other stakeholders and low number of university academics who are interested in interacting with oil companies were among factors considered impeding oil firms from interacting with other stakeholders in the PIS. Moreover, some of the participants perceived that there is low commercialisation potential of university academia which prevented them from licensing or patenting their research outputs. This was corroborated with response from interview with some academia that associated the low commercialisation potential with lack of entrepreneurial spirit among the academia, poor funding of their research activities and lack of motivation to commercialise their research outputs as this was not part of the factors considered for their promotions. Hence, there was no interest by academia to interact with the industrialists (Etzkowitz, 1998). Few of the respondents from the oil firms also asserted that they were not aware of who to meet at the university for collaboration.

Table 5: Constraints preventing oil firms from interacting with others stakeholders in the petroleum innovation system

Constraint Variables	Mean Rank
Most Universities lack adequate research facilities	3.55
Low capital base of Nigerian banks	3.44
Low commercialisation potential of university Academia	3.43
Most banks perceive oil field development very risky	3.35
High interest rate charged by banks	3.35
Unawareness of who to meet at university for collaboration	2.92
No adequate mechanism to interact with universities and indigenous supplier	2.85
University academics are not even interested to interact with oil companies	2.74
Incompetence of indigenous equipment supplier to produce required equipment	2.47
Incompetence of academician to undertake industrially oriented based research	2.45

Mean rank: Very low < 1; Low 1- 2; Medium 2- 3; High 3- 4; Very high > 4

3.3 Economic/ fiscal variables impacting on the viability of marginal oil field

This section examines the economic/ fiscal variables which have the most impact on the viability of a hypothetical marginal oil field in Nigeria. A number of assumptions were made in modelling the cash flow of a marginal oil project. Some of the assumptions are total recoverable reserves of 20 million barrels, economic limit of 10 years, real discount rate of 10 percent petroleum profit tax 67.75 percent, royalty 15 percent, education tax 2 percent, Niger Delta Development Commission tax 3 percent, Opex $4/bbl, Devex $6/bbl, base price $60/bbl, investment tax allowance 10 percent, production declining rate 20 percent among others (Akinwale & Akinbami, 2016). Table 6 displays the results of the cash flow modelling and sensitivity of the marginal oil field project. The results revealed that petroleum profit tax, royalty and oil price have much impact on the firm‘s NPV respectively. This is followed by devex/capex per barrel, real discount rate, total field production/recoverable reserves, opex per barrel and abandonment cost respectively. Figure 1 which is the Spider diagram further corroborated the results in Table 6 whereby petroleum profit tax, royalty and oil price are the most sensitive to the firm's NPV respectively as their curves are steeper than that of other parameters. This also indicated that petroleum profit tax, royalty, devex/opex, discount rate, opex and abandonment cost have negative relationship with the firm's NPV. On the other hand, oil price per barrel and total field production/recoverable reserves have positive relationship with NPV. The results are similar to what was obtained by Kemp & Stephen (2011), Akinwale (2011) and Adamu et al. (2013).

Table 6: Effects of economic/fiscal parameters on post-tax NPV using Oracle Crystal Ball with deviations of ±40%

	Post-tax NPV (in million dollars)				
Input Variables/ Parameters	**-40.00%**	**-20.00%**	**0.00%**	**20.00%**	**40.00%**
Petroleum Profit Tax (PPT)	171.23	100.28	29.32	-41.63	-112.59
Royalty Tax	76.9	53.11	29.32	5.53	-18.26
Oil Price per barrel	-15.88	6.72	29.32	51.92	74.52
Devex/Capex per barrel	52.78	41.05	29.32	17.59	5.86
Real discount Rate	42.49	35.74	29.32	23.24	17.51
Total Field Production	17.59	23.46	29.32	35.19	41.05
Opex	35.51	32.41	29.32	26.23	23.14
Abandonment cost	33.15	31.23	29.32	27.41	25.5

3.4 The techno-economic policy framework

The Nigerian oil and gas sector has been recognised as an important sector contributing largely to the country's income, foreign exchange earnings and GDP. However, this sector faces portfolio rationalisation by the international oil companies (IOCs) which drastically affect the production of the crude oil and country's income if the IOCs find more suitable investment which guarantees them high returns in another country.

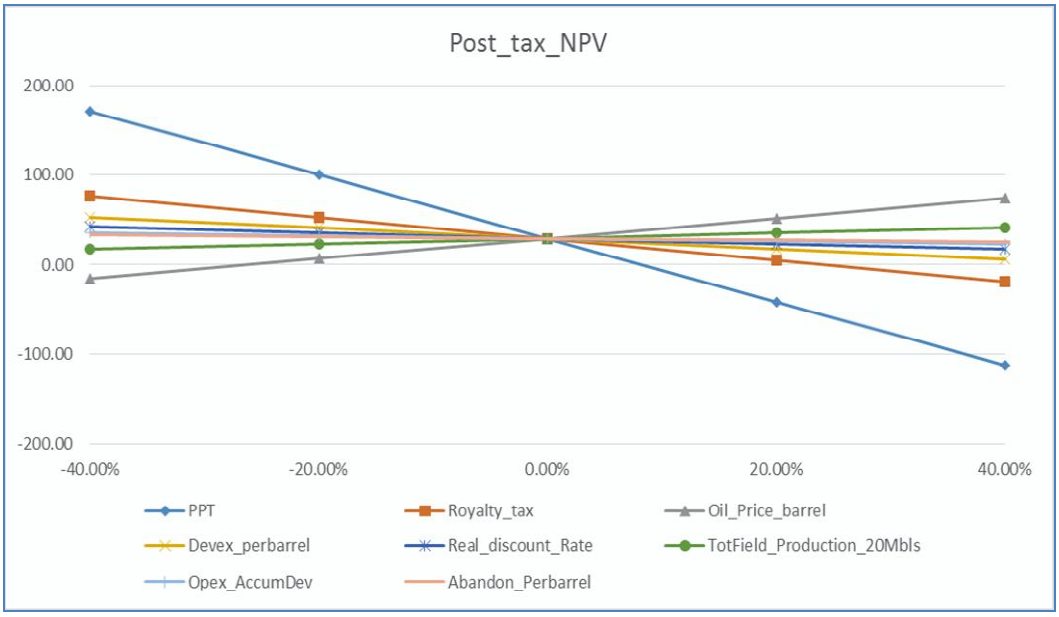

Figure 1: Spider chart measuring the effect of each parameter on field's NPV with the Steepness of the slope (Deviation of ± 40% using Crystal Ball)

The initiative of the Federal Government of Nigeria to develop the marginal oil and gas fields by the indigenous oil companies was geared toward increasing oil and gas production, increase crude oil reserves, develop indigenous technology capabilities in the oil and gas sector, and generate employment opportunities for the citizens. In order to achieve these objectives, a framework was proposed which emanated from the findings of this study. The extent of interactions among the indigenous stakeholders in the oil and gas sector has been revealed to be low. The suggested framework adopted the Petroleum Innovation System (PIS) which emphasises learning, acquisition, assimilation and application of transferred technologies by Nigeria's engineers and scientists in the oil and gas sector, as well as stronger linkage of the knowledge institutions, financial institution, government agencies and the indigenous oil and gas firms.

Government policies and actions should play a central role in driving the technological and economic factors required to enhance accelerated development of marginal oil and gas fields in the country as shown in Figure 2. Policies aimed at localising the oil and gas supply chain and strengthening indigenous technology capabilities at various levels must be upheld by the government. The appropriate petroleum industry bill (PIB) which is taking too long in the national assembly should be swiftly attended to and passed into law by the legislators to address some of the challenges facing the indigenous players in the sector. R&D investment is very crucial to the indigenous technology capabilities of the sector as the sector is being dominated by the foreign experts. Government should provide adequate oil and gas-related funding for the public universities so as to enable them have world class laboratories which are equipped to adapt the existing foreign technologies to the local environment as well as provide cutting-edge innovations relevant in the oil industry. The culture of academic entrepreneurship that builds on stronger ties between the university and industry should be enhanced. Monetary policy should also be used to encourage the commercial banks within the country to give concessions to the indigenous oil firms and university researchers when giving loans. This is expected to foster interaction between the financial institutions and other stakeholders in the sector.

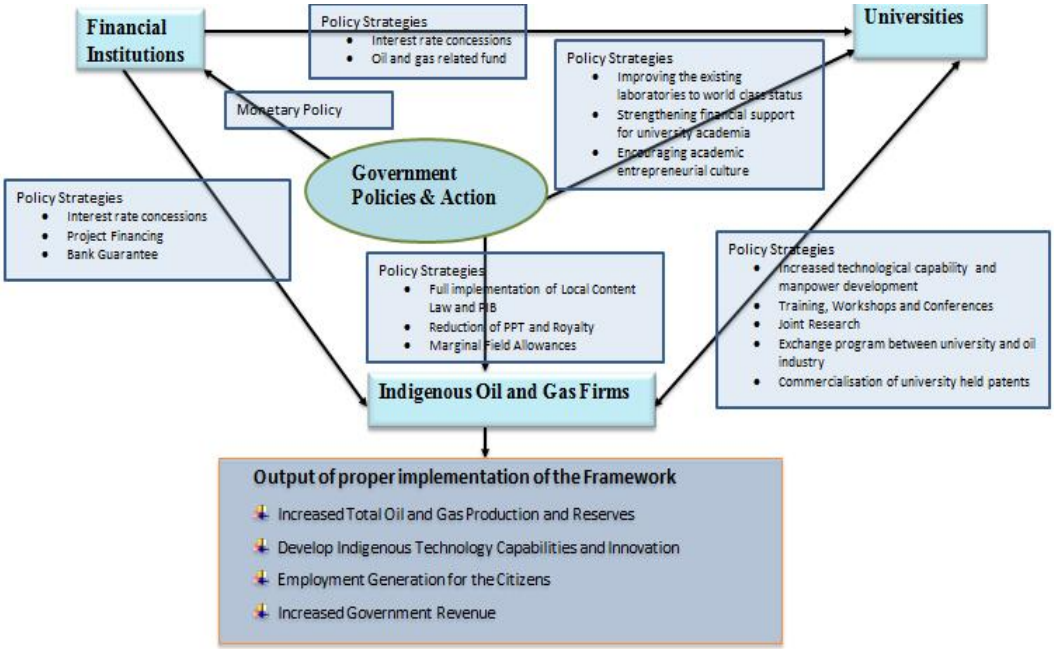

Figure 2: A Techno-economic Policy Framework to enhance marginal oil and gas field development in Nigeria

Many of the unviable marginal fields would become viable and the operators would be able to produce from these fields once the Nigerian government make the fiscal regime more suitable for the indigenous oil firms through reduction of petroleum profit tax and royalty tax. It may also require giving the indigenous marginal field operators certain allowances to make the fields more profitable. This, in the long run, would provide more income for the government since more fields, on which tax would be paid, become viable. Some of these allowances have been adopted in some countries such as increase in ring fenced expenditure supplement in United Kingdom Continental Shelf as well as brown tax in Norway for the new and small players in the industry.

Indigenous firms should also be mandated to adequately train the Nigerians working with them so as to easily learn, assimilate, adapt and reproduce some of the foreign technologies imported to execute their projects. The Nigerian government could provide a certain allowance to be deducted from the tax base for those firms that adequately provide R&D fund to train and develop their staff on technological capabilities. There should also be incentives for the indigenous oil firms to engage in collaborative research, consultancy and internship with the Universities. This will provide a greater understanding among university academics about the kind of research required in the industry and at the same time make the industrialists to provide the university academics and the students information on what is expected from them in the oil industry.

Finally, the political will of the Nigerian government is the key driving force of this framework. This requires the government to engage in a concerted effort toward using policies such as science, technology and innovation (STI) policy, energy policy, education policy and the final output of PIB once it is passed into law to create an enabling environment for other stakeholders and steer their actions towards a sustained oil and gas sector. If the Buhari-led administration is committed to effective implementation of this framework, there would be an accelerated development of indigenous technology and innovation capabilities, an increase in total crude oil production and reserves, and an increase in employment generation for the Nigerians which will finally lead to economic growth and development.

4. CONCLUSION

As the sectoral innovation systems are becoming globalised, it is essential to identify the influencing factors and how it could be adopted in developing countries towards their economic development. Therefore, developing an

appropriate framework through which the development could be achieved cannot be undermined. This paper examined the petroleum innovation system in Nigeria which is among the least but important sector when it comes to innovation system.

Some of the factors that were responsible for these various forms of interactions with the oil firms were also shown at 10 percent level of significance. Engagement of academic staff in project, implementation/Consultancy services, joint research with the academics, student internship, training and conferences were found to have significant impact in influencing the level of interaction of indigenous firms with the universities. While project financing credit, invoice discounting facility, interest rate concession and bank guarantee have significant impact on the extent of interaction with financial institutions; government financial support for technology innovation to develop marginal field, government effort in training people, government policy directed to marginal field development and government research and development funding relating to marginal field are statistically significant in influencing the extent of interaction with the relevant government agencies. The impact of petroleum profit tax, royalty tax and oil price seem to be the most paramount fiscal factors which affect the viability of the marginal oil and gas field operated by the indigenous players.

The techno-economic framework developed from the findings indicates that government policies and actions should play a central role in driving the technology and economic factors required to enhance accelerated development of marginal oil and gas fields by the oil firms while interacting with other stakeholders in the sector. The paper concludes that the appropriate implementation of this framework is expected to result in improving the contribution of marginal field to total production, GDP, employment and indigenous capabilities.

REFERENCES

Adamu, M., Ajienka, J. & Ikiensikimama, S. (2013). Economic analysis on the development of Nigerian offshore marginal fields using probabilistic approach. Advances in Petrol. *Exploration & Development*, 6(1), 11-21.

Adeyeye, A., Jegede, O. & Akinwale, Y. (2013). The Impact of Technology Innovation and R&D on Firms' Performance: An Empirical Analysis of Nigeria's

Service Sector. *International Journal of Technological Learning, Innovation and Development,* 6(4), 374–395.

Akinwale, Y., Akinbami, J. & Akarakiri, J. (In press). Factors influencing technology and innovation capability in the Nigerian indigenous oil firms. *International Journal of Business Innovation and Research*.

Akinwale, Y. (2017). The nexus between R&D, innovation and profitability of indigenous oil firms: A structural equilibrium model approach. 5th International Symposium of Computational and Business Intelligence, IEEE Xplore, 105-109.

Akinwale, Y., Adepoju, A. & Olomu, M. (2017). The impact of technological innovation on SME's profitability in Nigeria. *International Journal of Research Innovation and Commercialisation*, 1(1), 74-92

Akinwale, Y. (2016a). Harnessing science technology & innovation for enhancing marginal oil and gas field development in Nigeria: a comparative analysis. *International Journal of eBusiness and eGovernment Studies*, *8*(2), 47-63.

Akinwale, Y. (2016b). Indigenous technology and innovation capability building in Nigerian upstream oil and gas subsector: the academia perspective. *Advances in Management & Applied Economics,* 6(2), 49-70

Akinwale, Y. & Akinbami, J. (2016). Economic evaluation of Nigerian marginal oil and gas field using financial simulation analysis. *International Journal of Energy Economics and Policy*, 6(3), 563-574.

Akinwale, Y. (2011). Monte carlo risk analysis of oil and gas field development in UKCS: An overview of the effect of change in current tax system on small, medium and large field development in the UKCS. LAP Lambert, Germany.

Brooks, C. (2014). *Introductory econometrics for finance*. 3rd edition. Cambridge University Press, United Kingdom.

Chan, L. & Daim, T. (2012). Sectoral Innovation System and Technology Policy Development in China: Case of the Transportation Sector. *Journal of Technology Management in China*, 7(2), 117- 135.

Edquist, C. (ed.) (1997). *Systems of Innovation*. London: Frances Pinter.

Etzkowitz, H. (1998). The norms of entrepreneurial science: Cognitive effects of the new university-industry linkages. *Research Policy*, 27(8): 823–833

Fagerberg, J. & Verspagen, B. (2009). Innovation studies—The emerging structure of a new scientific field. *Research Policy*, 38, 218–233.

Freeman, C. (1997). Innovation systems: city-state, national, continental and sub-national. Paper Presented at the Montevideo Conference, Mimeo, University of Sussex, SPRU.

Freeman, C. (1987). *Technology Policy and Economic Performance: Lessons from Japan*. Pinter, London.

Fukuda, K. & Watanbe, C. (2008). Japanese and US Perspective on the National Innovation Ecosystem. *Technology in Society*, 30, 49-63.

Kemp, A. & Stephen, L. (2011). The Effects of Budget 2011 in Activity in the UKCS. *North Sea Study Occasional Paper*, No. 120: University of Aberdeen.

Lundvall, B. A. (1992). *National Systems of Innovation: Towards a Theory of Innovation and Interactive Learning*. London: Pinter Publishers.

Malerba, F. (2005). Sectoral systems of innovation: a framework for linking innovation to the knowledge base, structure and dynamics of sectors. *Economics of Innovation and New Technology*, 14(1-2), 63-82.

Nelson, R. R. (1993). *National Innovation Systems: A Comparative Analysis*. Oxford University Press, USA.

Siyanbola, W., Oladipo, O., Oyewale, A., Famurewa, A. & Ogundari, I. (2012). Academia-Industry Interactions in Nigeria Pharmaceutical Innovation System. *Procedia – Social and Behavioral Sciences*, 52, 279–289.