

**ECONOMICS OF OFFSHORE OIL INVESTMENT PROJECTS AND
PRODUCTION SHARING CONTRACTS: A META MODELING ANALYSIS**

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ABSTRACT

This study investigated the impact of petroleum fiscal regime in production sharing contract on the economics of offshore oil production venture in Nigeria. The empirical analysis involved the use of meta-modelling technique which couples regression analysis into a discounted cash flow spread sheet model of typical oil project. The regression aspect of the analysis took into consideration the issue of stationarity of the variables involved to avoid the problem of spurious correlation. The stationarity property established for the variables assures of parameter stability and policy relevance of estimated coefficients. The empirical results have provided some important findings that could aid policy formulation aimed at promoting the viability of oil production venture and attractiveness of our petroleum fiscal regime to both domestic and foreign investor as well as government revenue improvement.

1.0 Introduction

The trend in fiscal terms is an important consideration in the assessment of the viability of an oil exploration and production investment project, particularly with the peculiar industry risk of the oil sector and the inherent uncertainty of the international oil market condition. There are two fiscal objectives, which are fundamentally conflicting, that must be optimized in the implementation of tax policies on petroleum production activities. The first is the maximization of government's revenue from the depletable resource, and the second, the preservation of appropriate, but not excessive incentives for the exploration and development of petroleum resources. This entails balancing these objectives at optimal levels. An excessive revenue-seeking tax level will lead to over taxation which will discourage investment in exploration, development and extraction and will eventually lead to fall in government future revenue. Similarly, excessive incentives will reduce government revenue, which will negatively affect government's development efforts in the entire economy (Broadway and Flatters, 1993).

Efforts directed at designing an appropriate regime of taxes that will help maximize social wealth creation through the oil sector will be better served by a process of robust analysis of the impact of their terms on the economics of oil exploration and production investment ventures. Overtime, Nigeria had adopted various petroleum fiscal regime with intent to ensure the competitiveness of our operating environment and the maximisation of revenue from oil activities. The question then is : what have been the impact of the terms of fiscal regime on the economics of upstream oil production venture in Nigeria?

In this study we set out to develop a model under the meta-analysis framework(which has the advantage of capturing the interactions among fiscal terms) to analyze the effects of petroleum fiscal terms on the performance profile of oil exploration and production venture in the presence of market uncertainty arising from unstable oil price in Nigeria. Specifically, the study seek to quantify the effects of petroleum fiscal terms, simulate the influence of changes in the fiscal terms and market uncertainty on the performance profile of oil exploitation and production venture. This study will be restricted to the fiscal regime for the upstream sub-sector of the Nigerian oil industry. The analysis covers the period 1986 to 2005 which captures the era in which the industry witnessed major changes in the fiscal

regime. Particular attention will be given to the production sharing contract because of its increasing importance in oil production in Nigeria.

2.0 Overview of Production Sharing Contracts (PSC)

In most countries of the world, the government owns all the mineral resources, but will offer to foreign oil companies' blocks to explore and develop. The host government gives the oil company the right to receive a share of the production (or revenue) in accord with a Production sharing Agreement (PSA) or Service Contract. The basic terms of a contractual system is usually determined through legislation, but many aspects may be negotiated. The terms of model contracts are frequently put forward by the host government as a basis for bidding and represent the start of negotiation between the contractor and government. The terms of model contracts are also frequently subject to renegotiation as political and economic conditions change, or as additional information become available. The operating company at its own risk performs exploration in a production sharing contract form of a petroleum fiscal agreement. Typically, a PSA has four components: 1) Royalty, 2) Cost Recovery, 3) Profit Oil, and 4) Tax. Royalty is computed as a percentage of the gross revenues of the sale of hydrocarbons, and like many elements in a PSA, may be determined on a sliding scale the terms of which may be negotiable or biddable. The oil company pays royalty to the government and is then entitled to a pre-specified share of production for cost recovery. The remainder of the production is split between the government and the oil company at a stipulated (often negotiated) rate. The oil company normally has to pay income tax on its share of profit oil (Johnson,1994b).

The PSC is today the toast of Nigerian Petroleum industry. It is an agreement born in response to the funding problem faced by the old joint venture (JV) arrangement as well as the desire of the Nigerian government to open up the sector for more foreign participation.

The PSC arrangement governs the understanding between the NNPC and all new participants in the new inland deep & ultra deep-water acreages.

Its main features are:

- The contractor bears all costs of exploration and production without such costs being reimbursable if no find is made in the acreage.

- Cost is recoverable with crude oil in the event of commercial find, with provisions made for :

(1) Tax Oil: This is to offset actual Tax, Royalty and Concession rental due and payable /deductible in full in the year.

(2) Cost Oil: To reimburse the contractor for capital investments and operating costs.

(3) Profit Oil: The balance after deduction of Tax Oil and Cost Oil, which is to be shared between the NNPC and the contractor in an agreed

Currently, Statoil, Snepco, Esso, Elf, Nigerian Agip Exploration Limited, Addax, Conoco and Petrobas, Star Deep Water, Chevron, Oranto Philips, are operating the PSC in the country. More details are in table one (Napims ,2007 and world Bank ,2004).

3.0 Literature Review

3.1 Taxation And Non-Renewable Natural Resource Production

The theoretical literatures on mineral taxation like Hotelling (1931), Burness (1976), Levhari and Liviatan (1977), Zhang (1997), Conrad and Hool (1980), Dasgupta, Heal and Stiglitz (1980) captured the essence of these issues. The effects of taxation of non-renewable resources on resource allocation, revenue yield and stability, conservation and depletion dates were examined. Specifically Hotelling (1931) recognize the significant impact that appropriately designed taxation can have on the extraction and production of non-renewable natural resource. In his analysis he showed that property tax encourage more rapid extraction of resource and so could be used when there is evident slowness (in order to charge high prices later) in extracting the resources. Burness (1976) analyzed the effects of resource taxation under the assumption that the costs of resources extraction are not affected by cumulative amount of extraction an assumption that leads to the conclusion along with others

that taxes such as Brown tax, a resource rent, or a pure profit tax are non distortionary, whereas franchise taxes (a specific tax on output), advalorem taxes or property taxes are distortionary, However, Levhari and Liviatan (1977) incorporated the effects of cumulative extraction in their model and modified earlier conclusions. For example, as against the standard Hotelling conclusion that a flat rate severance tax always prolongs the depletion date of a mine, Levhari and Liviatan(1977) showed that the impact of tax is ambiguous.

In his own analysis, Zhang (1997) considers how the key parameters of the tax regime may distort the decision to develop a field for exploitation and how much economic rent of oil production are recouped. He showed specifically, that there exist a unique up-lift rate (deduction allowance for capital expenditure and its supplements) which ensure neutrality, irrespective of the tax rate levied on the revenue after the allowance is exhausted.

The foregoing discussion provide compelling theoretical evidence that the taxation of non-renewable resources is evidently non-neutral and could have important inter temporal distributional effects which call for caution on its design and implementation. Therefore it is pertinent to note that, where private markets allocate natural resources optimally or close to this without government interference and coercion, tax policy should strive for neutrality, that is, there is no dislocation from the market solution. However, where tax policy can aid in ensuring that private decision markers utilize non-renewable resources in the most efficient manner from the point of view of society, special taxes should be design and implemented. This may alter the decisions of producers with regard to level of output, technology, or location.

3.2 Review Of Empirical Literature On The Effects Of Fiscal Regime On The Economics of Oil Production

How do fiscal systems affect the economics of non-renewable resources production? The attempt to provide satisfactory answer to this question has gotten response from many researchers. The conclusion from many analyses relating to oil production is that the type of agreement between the host country government and an operator of an exhaustible resource venture is not the issue, it is the structure of the agreement and fiscal arrangement within that agreement (Al-Atter and Alomair 2005, Iledare 2001). However various analysis have had to

examine the effects of fiscal terms and system parameters (geological and other physical consideration) on the performance profile of exploration and production ventures and corresponding government take (rent collection) under different fiscal arrangement. Some of these will be examined presently.

Slade (1984) examined the impact of tax policy on the supply of exhaustible resource using numerical technique to analyze the model of a variables profit function for a particular copper producing firm. Using this technique her findings are that the principal effects of taxation are the tilting of the extraction path, changes in cumulative ore extraction, and changes in cumulative metal production. The author further showed that higher rates of output-price appreciation, royalties (depletion allowances) lead to higher (lower) rates of extraction in earlier years which are later reversed. Under these circumstances, the imposition of the royalties has the opposite effect from what is often assumed.

In the work of Kemp (1992), the efficiency of petroleum fiscal systems in UK, Norway, Denmark and Netherlands in collecting the prospective economic rents from the development of new fields in circumstances where there are significant uncertainties regarding development costs and oil prices were examined. He proceeded via a financial modelling approach to analyze the effects of the fiscal regimes in the four countries His findings are that the fiscal system in UK was automatically progressive in relation to development cost variations and oil price changes. The level of government take is generally tolerable and the system is unlikely to deter the development of new field. In Norway, as he reported, the system produces a significantly high level of take, with little incentives for small fields. In present value terms the system is regressive when 10% real discount rate is employed. Under adverse combinations of development costs and oil price development disincentive can emerge. In the case of Denmark as he noted the fiscal regime is progressive in current money terms with respects to both oil price and development cost changes. In present value terms the fiscal system is broadly proportional under the same likely cost conditions. The level of government take is higher than in UK, but only under adverse combinations of costs and oil prices will investment be inhibited. In the case of Netherlands he reported that the system is moderately progressive in current money terms, but regressive in present value terms. He

opined that this case of Netherlands is the consequence of the gross royalty plus the modest pace of depreciation permitted.

In another study by Iledare (2001) on the analysis of the impact of petroleum fiscal arrangements and contract terms on petroleum exploration and production economics and host government take in Nigeria where a discounted cash flow model of a hypothetical field was used. The author incorporated the fiscal regimes and terms governing the exploration and production ventures into the model to investigate the effects of selected fiscal terms and parameters on the performance profile of exploration and production ventures and the corresponding government takes under production sharing contract (PSC) and Joint Venture (JV) agreements. The finding suggests that government participation in exploration and production (E&P) ventures in Nigeria through Joint venture arrangement does not optimize economic gain for E&P firms, neither does government participation necessarily maximize the fair market value of petroleum resources received by the government. In addition the analysis found strong evidence to suggest that (PSC) arrangement can be more favourable to E & P firms in terms of economic returns than the (JV) under the general and analogous fiscal parameters and terms specified in the study. The empirical results further suggest an asymmetric response of E & P economic performance indicators to product prices, discount rate, installed capacity and enhanced oil recovery process (EOR).

In Iledare and Kaiser (2006) a more robust analysis was presented on the impact of petroleum fiscal regime on offshore E & P project economic and take statistics. In this study the authors adopted a meta modelling analysis of production sharing contracts fiscal arrangements whereby a cash flow simulation model incorporated with regression analysis is developed and applied to derive relationships that specify how net present value, internal rate of return and government share of rent (take statistics) vary as a function of the system parameters. The regression results show that contractor take increase with an increase in commodity price and profit oil and falls with the royalty and tax rate. As the contractors discount factor is increased, or the government discount factor is decreased take declines. In the case of the present value of the project, it increases with price, cost oil and profit oil and decreases with the tax rate and corporate discount factor. This analysis shows that the value of the profit oil

split is apparently a more significant parameter than the selection of cost recovery (above four-to-five times more significant).

Using the same methodological approach of meta-modelling, Kaiser and Pulsipher (2004) analyzed the effects of fiscal regimes (both concessionary and contractual systems) on offshore E & P project economics. The deepwater Gulf of Mexico was used as a case study (Na kika) to show the impact of concessionary arrangement and deep water Angola field was used as a case study (Girassol) to show the impact of fiscal terms in contractual arrangement. The analysis showed similar pattern as reported in Iledare and Kaiser (2006) for PSC fiscal arrangement while the case of concessionary fiscal arrangement (the generic form of the JV) a 1% increase in royalty rate impacts take, present value and rate of return slightly more than a 1% increase in the tax rate. The analysis further provided a procedure to determine whether a particular fiscal regime is progressive or regressive. Specifically the model coefficients all have expected signs, the fits are robust and all coefficients-except the government discount factor –are highly significant.

The concern of Osmundsen (1998), is the estimation of a model of dynamic taxation of non-renewable natural resources under asymmetric information about reserves. In a two period model it was shown that specific cost characteristics of non-renewable natural resources extraction (stock effect) make it optimal to distort (reduce) both the extent and the pace of extraction. Extending the model by endogenising the choice of terminal period, it was also found to be optimal to distort the number of extraction periods as a response to asymmetric information. This suggests that accounting for information asymmetry reduces the reliability of the result obtained earlier; however this complication becomes eroded when considering multi-period case.

Boyd and Khosrow (1994) examined how energy cuts, offset with income tax increase affect production, consumption and total welfare in the Philippines economy. Using a general equilibrium approach the result of their analysis showed that energy tax cuts expand the energy sector but decreases output of the manufacturing sector regardless of the level of energy tax reduction. This result run along the same vein with the earlier empirical work

which use essentially numerical analysis, that taxation operationalised in fiscal regime has important impact on the economics of natural resource production venture.

Kunze et al (2002), embedded time series econometric estimates into Pindyck's (1978) theoretical model of exhaustible resource supply to the analysis of state taxation, exploration and production in the US oil industry. The theoretical results obtained from the model determine the optimal time path of exploration and production as well as how these paths are affected by alternative forms of taxation. Estimates of the model's underlying equation then were obtained using publicly available data on drilling, drilling costs, production costs, reserve addition and other variables, of US States that produces significant amount of oil over the period 1970-1997. The central conclusion of their paper was that oil production is quite inelastic with respect to changes in state severance taxes(a form of output tax).

4.0 Theoretical Framework and Methodology

4.1 Theoretical Framework

The model for assessing the impact of tax policy (fiscal regime) on the production decision of a firm in the non-renewable resource industry follows Slade (1984), Broadway and Flatters (1993), Kaiser and Pulsipher (2004) and World Bank (2004). The model characterizes the profit maximization behaviour of a representative firm contingent on the operating fiscal parameters. We consider a firm which is simultaneously involved in exploration, investment in mining facilities and extraction. Inventories are excluded so that sales equal extraction. In the exploration stage, the firm hires current input L of price W and produces a depletable asset according to the strictly concave function $S(L)$ ¹. The production function is $Z(K, F)$ where F is the current use of previously discovered asset. It then invest in mining capital K at a price Q to make the asset ready for extraction. The firm extract an amount Y and sell it at a price P . Assuming that the tax regime facing the firm is fully described by R and T , where R is the royalty and T is the tax paid.

Though most system are more complicated, but for our purpose this will suffice.

¹ we are deleting time subscript for simplicity

$$NCF_t = GR_t - R_t - CAPEX_t - OPEX_t - BONUS_t - PO/G_t - T_t \quad (4.5)$$

$$R_t = R(GR_t) \quad (4.6)$$

$$T_t = T(GR_t + 0.5DEP_t - R_t - CR_t) \quad (4.7)$$

$$CR_t = CAPEX / I_t + OPEX_t + DEP_t \quad (4.8)$$

$$PO/G_t = PO(GR_t - R_t - CR_t - T_t) \quad (4.9)$$

Where

NCF_t = After tax net cash flow in year t

GR_t = gross revenue which operationally for this study is obtained borrowing from convention in the literature (see Kemp, 1992; Iledare and Kaiser,2006;and Kaiser and Pulsipher, 2004) where

$$GR_t = g_t^o p_t^o y_t^o + g_t^g p_t^g y_t^g$$

And

g_t^o, g_t^g =conversion factor of oil(o),gas (g) in year t

p_t^o, p_t^g = average oil, gas benchmark price in year t ,

y_t^o, y_t^g = Total oil, gas production in year t

The conversion factor depends primarily on the API gravity and the sulphur content of the hydrocarbon, and is both time and field dependent. In this study we assume that the conversion factor of oil is one and total gas production in year t to be zero because for most of the period under consideration gas produced in associated gas fields are flared as operators in Nigeria attach very little economic importance to the gas produced owing largely to the absence of or inadequacy of infrastructure for gas gathering until recent times .In addition this simplifying assumption will make our analysis more tractable with little loss of empirical information.

R_t = Total royalties paid in year t

$CAPEX_t$ = Total capital expenditures in year t

$OPEX_t$ = Total operating expenditures in year t

T_t = Total tax paid in year t.

CR_t = Cost Recovery in year t

PO/G_t = Government profit oil in year t

DEP_t = Depreciation allowance in year t

$BONUS$ = Fixed payment like signature bonus and production bonus

R = Royalty rate

T = Tax rate

PO = Proportion of Government share of profit oil

$CAPEX/I$ = Intangible capital expenditure in year t

The after tax net cash flow vector associated with field F is denoted as

$$NCF(F) = (NCF_1, NCF_2, \dots, NCF_n), \quad (4.10)$$

and is assumed to begin in year one ($t = 1$) and run through field abandonment (or divestment) at $t = k$. The after-tax net cash flow vector serves as the basic element in the computation of an operator share of the rent accruing from the operation of a field (take) and the economic measures associated with that field.

The economic valuation for a field (f) and fiscal regime denoted by F , is done via the assessment of the present value of the cash flow vector $NCF(f)$ as follows.

$$PV(f, F) = \sum_{t=1}^k \frac{NCF_t}{1 + D^{t-1}} \quad (4.11)$$

$$\text{And } IRR(f, F) = \left\{ \frac{D}{PV}(f, F) = 0 \right\} \quad (4.12)$$

Where D is the discount rate that equates the present value to zero. Another valuation criteria is the contractor take (CT) and government take (GT) which is computed as follows

$$CT_t = TP_t - BONUS_t - R_t - PO/G_t - T_t \quad (4.13)$$

Where

$$TP = GR - TC$$

$$\text{And } TC = CAPEX + OPEX$$

With $CAPEX$, GR and $OPEX$ as defined earlier

$$GT_t = BONUS_t + R_t + PO/G_t + T_t \quad (4.14)$$

The cumulative discounted value of take could also be expressed thus:

$$NPVCT = \sum_{t=1}^n \frac{CT_t}{(1 + D^c)^{t-1}} \quad (4.15)$$

$$NPVGT = \sum_{t=1}^n \frac{GT_t}{(1 + D^g)^{t-1}} \quad (4.16)$$

Where

equations 4.15 is the net present value of the contractor take through years $n, n=1, \dots, k$

equation 4.16 is the net present value of government take through year $n, n= 1, \dots, k$

The present value of take, present value and internal rate of return varies with the selection of the price of oil (P), royalty rate (R), the tax rate (T), the contractor discount (D^c), and the government discount (D^g) in a complicated manner but it is possible to understand the interactions of the variables and their relative influence using a constructive modelling approach referred to as meta-modelling technique. Though the use of this technique is relatively new in this area of research it has been widely used in other areas (see Stanley 2001; Espey 1998; Glass 1976; Baaijens *et al* 1998; Dahuisan *et al* 2003; Card and Krueger 1995; Stanley 1998). This methodology is presented below. Essentially as it is applied here there are three steps.

Step 1: Bound the range of the variable of interest (X_1, X_2, \dots) = (P, R, T, D^c, D^g, \dots)

within a design interval, $A_i < X_i < B_i$, where the values of A_i and B_i are user defined and account for a reasonable range of the historic uncertainty associated with each parameter. The design space is user defined as

$$\Omega = \{(X_1, \dots, X_k) / A_i \leq X_i \leq B_i, i = 1, \dots, k\} \quad (4.17)$$

Step 2: Sample the component parameters (P, R, T, D^c, D^s) over the design space Ω and compute the economic and system measures

$$PV(f, F) = PV(P, R, T, D^c, D^s) \quad (4.18)$$

$$IRR(f, F) = IRR(P, R, T, D^c, D^s) \quad (4.19)$$

$$NPVCT(f, F) = NPVCT(P, R, T, D^c, D^s) \quad (4.20)$$

$$NPVGT(f, F) = NPVGT(P, R, T, D^c, D^s) \quad (4.21)$$

For each parameter selection.

Step 3: Using the parameter (P, R, T, D^c, D^s) and computed functional values of $PV(f, F)$, $IRR(f, F)$, $NPVCT(f, F)$ and $NPVGT(f, F)$ construct a regression model based on the system data:

$$\varphi(f, F) = k + \alpha P + \beta R + \gamma T + \varepsilon D^c + \delta D^s \quad (4.22)$$

And for each functional

$$\varphi(f, F) = \{NPVCT(f, F), NPVGT(f, F), PV(f, F), IRR(f, F)\} \quad (4.23)$$

This procedure is sometimes referred as a “meta” evaluation since a model of the system is first constructed, and the meta data is simulated from the model in accord with the design space specification. The cash flow Meta data are then analyzed and linear models describing the system constructed. If linear models do not suffice to adequately represent the meta data, then non linear terms can be incorporated into the analysis. The design base, cost structure, and production profile is assumed fixed and so the relationships derived relate to the manner in which the system variable interact under a given development plan and fiscal regime. After the regression model is constructed and the coefficients ($k, \alpha, \beta, \gamma, \varepsilon, \delta$) determined, if the model fit is reasonable and the coefficients statistically relevant, the value of the system

measures $\varphi(f, F)$ can be estimated for any value of (P, R, T, D^c, D^s) within the design space.

4.3 Analytical Procedure

The implementation of the methodology adopted for this study (meta-modelling) is in three stages which are: (1) the computation of the economic measures like *NPV*, *IRR*, *NPVCT* and *NPVGT*; (2) Generation of meta data series; (3) Regression analysis of the meta data. This three-stage procedure is presented as follows:

4.3.1 Computation Of Economic Measures

Following the examples in the literature the study will be conducted on a model oil field which are hypothetical, but representative of Nigerian oil and gas projects (Kemp, 1992; Kaiser and Iledare, 2006; Kaiser and Pulsipher, 2004; Gamponia and Mendelsohn, 1985; World Bank, 2004; and Tordo, 2007). To investigate the impact of fiscal regime for a specific field, it is necessary to calculate the after-tax cash flow under the fiscal system and to examine the factors that influence the economic performance of a field. To this end a hypothetical medium size offshore petroleum project development was specified based on Tordo (2007) and World Bank (2004), where recoverable reserve volume was 160 million barrels. Other characteristic details of the model fields are presented in table three. Other relevant components of the cash flow model to be used for the computation of the economic measures include:

(i) Tax rate (ii) Royalty rate (iii) discount rate (iv) government discount rate (v) contractor discount rate (vi) government proportion of profit oil

For the model, the tax rate (T) is 50 % as per the provision of the operating contract the royalty rate (R) is 10%, while the government share of profit oil is 20%. In the case of discount rate for computation of the net present value of the project in each field we used 15% following World Bank (2004). However in the case of the discount rate for the computation of the contractor take and government take we followed the guideline suggested by World Bank (1993:147) that the company discount rate should be higher than the government discount. So for this work we used 15% for the company and 12% for the government in each of the model.

.The foregoing are presented in a tabular format in table four. Furthermore, the projected annual production, capital expenditure and operating expenditure for each model field is presented in table five.

Using the above parameters the cash flow model was implemented in excel spreadsheet software package .The results are presented in table seven. With the computation of the economic measures and take statistics the stage is now set to investigate how the fiscal terms and market uncertainty impacts the economic performance of the project in the model . This is done via the meta-modelling technique articulated earlier and specified in equations 4.17 to 4.23.

4.3.2 Generation of Meta Data Series

This aspect represents the implementation of equations 4.17 to 4.23. The design space used for this study follows Kaiser and Pulsipher (2004), though with some few modifications to reflect the content of the operating fiscal regime in Nigeria. This is presented in table eight.

The probability distribution chosen for oil price reflects the fitted distribution for the historical realization of the variable. Uniform distribution was used for other variables because they are essentially policy maker determined; the oil price is not, therefore we used the probability distribution that best fit the historical realization of it. To implement this aspect of generating the meta data we used a specially designed software package for this kind of analysis called Crystal Ball. The software is an add-in to excel. It performs an iterative recalculation of values of the economic measures of the cash flow model already developed in spreadsheet when there are changes in any or all of the parameters that drives the cash flow model. This software uses a Monte Carlo simulation procedure to enable us generate for each trial values of the key parameters (P, R, T, D^c, D^g) a corresponding value of the economic measures ($NPV, IRR, NPVCT, NPVGT$) as equations 4.18 to 4.21 indicate. The trial values are however restricted to the design space specified above and the probability distribution assigned to the parameters. For this study we sampled 500² trials for each of the four models .The descriptive statistics of the results are presented in tables

² For most studies the parameters are found to stabilise at 500 data points ,see Kaiser and Pulsipher (2004)

4.3.3 Regression Analysis of the Meta Data

In the investigation of the impact of the fiscal terms on the economic measures, the fiscal regime are assumed to be described fully by the values of R , T and PO which are calculated thus: royalty rate R is calculated as a percentage $0 \leq R \leq 1$ of gross revenue and the income tax T is calculate as percentage, $0 \leq T \leq 1$, of taxable income and PO also as $0 \leq T \leq 1$ of profit oil .Other consideration like royalty/tax holidays, domestic market obligations, or negotiated term are ignored .The regression models are then constructed for $NPVCT(f, F)$, $NPVGT(f, F)$, $PV(f, F)$ and $IRR(f, F)$ for 500 data points . Since the generated series mimics time series variable we begin our analysis by checking the time series properties of the meta data. Also several specification and diagnostic tests are undertaken to authenticate our results and establish their robustness. For model specification and selection, redundancy tests were performed and Akaike information and Schwarz criterion were used for model selection. The sensitivity of the economic measures were examined to track the elasticity of the economic measures to changes in policy variables.

4.4 Data Requirements and Sources

The data used for this research are secondary and are sourced from NAPIMS annual reports, Annual Statistical bulletin of Organization Of Petroleum Exporting Countries (OPEC) ,NNPC annual statistical bulletin various issues.The data for oil price was collected from OPEC statistical bulletin 2007,data for royalty rate and government share of profit oil were sourced from NAPIMS annual reports and NNPC annual statistical bulletin.

5.0 Empirical Results And Discussion

5.1 Cash Flow Model Results

The results from the computation of the economic measures revealed some interesting characteristics of the economics of oil production ventures in Nigeria. The cash flow model result is presented in table seven. The cash flow model result showed some impressive results about the economics of oil projects in Nigeria. The model project still returned a positive and large NPV after tax .The contractor take and government take over the life time of the project is equally positive .In addition the IRR is quite impressive as it is above the standard hurdle rate for most contractor in Nigeria (World Bank,2004) .

5.2 Regression Model Results

The major focus of this research is to investigate the impact of petroleum fiscal terms on the economics of oil production ventures in Nigeria. In this subsection we present results from regression analysis of the Meta data to show how changes in the fiscal terms impact on the values of the economic measures. The discussions begin with the presentation of the descriptive characteristics of the meta data ; followed by the examination of the time series properties of the variables and lastly we present the analysis of the estimated equations.

The general statistical characteristics of the generated meta data are presented in table 8 and 9 .The results of the unit root tests indicate that all the variables in the model does not have unit root, they were found to be integrated of order zero. This implies that the parameters obtained from their inclusion in an ordinary least square regression will not only be reliable but also stable over time. The unit root test were carried out using the Augmented Dickey-Fuller (ADF) test . With the assurance of the stationarity of the variables we proceed to estimate via the OLS technique.

5.2.1 Analysis and Discussion of Estimated Equations

Estimated regression results for the model field is presented in table 11 below . Four equations were estimated for the model field to capture the impact of oil price, tax rate , royalty rate, government discount and contractor discount on the economic measures of a model oil field like *IRR, NPV, NPVCT, NPVGT* . The discussion begin with the examination of the impact of fiscal terms on the internal rate of return (*IRR*) ,followed by that of net present value of project (*NPV*) equations ,*NPVCT*, and *NPVGT* equations respectively

5.2.1.1 Estimated Equations

Model one shows the result of the estimated equation for *IRR*. The result shows that oil price, tax rate royalty rate and government share of profit oil are the major determinants of the profitability of an oil production venture when we use internal rate of return as our evaluation criteria. The oil price exert a positive impact on *IRR* in the model oil field examined. The elasticity relationship is such that a 10% increase in oil price will result in 6.0% increase in *IRR*. In the case of royalty rate, the impact is consistently negative implying that increasing the level of royalty rate reduces the profitability of oil production venture no matter the size of the field or the geological terrain. However the elasticity relationship is such that 10% increase in royalty rate induces 14% reduction in *IRR*. The impact of tax rate and government share of profit oil are negative and significant.

The characteristic of the result of the equation estimated for NPV is similar to those estimated for IRR. The results for NPV equation is shown in table 11. The estimated equation revealed that oil price, tax rate and royalty rate and government share of profit oil are major determinants of the net present value of an oil project, while the impact of oil price is clearly and consistently positive, that of royalty rate is clearly negative and statistically significant, that of tax rate and government share of profit oil is equally so. The elasticity relationship is such that 10% increase in oil price will induce 93.0% increase in NPV. In the case of royalty 10% increase in royalty rate will result in more than 90% decrease in NPV.

The results of equations showing impact of the fiscal terms on the present value of cumulative contractor take (NPVCT) is presented in table 11. The result shows that the prevailing international oil price and perception of the contractor as to how risky the business environment of the country is (discount factor of the contractor) and tax rate are the major consistent determinants of the profitability of a project when measured via the NPVCT. The impact of oil price is also positive as in other equations while that of contractor discount and tax rate are negative. This indicates that the more risky the contractor perceives the operating environment the less viable economically will a project be to the contractor or operator. For those variables like oil price and contractor discount rate the elasticity relationship is such that a 10% increase in the price of oil will induce 12.2% increase in the NPVCT, whereas a 10% increase in the discount rate of the contractor will induce 26.0% decrease in the NPVCT.

Table 11 also shows result of the estimated equations exploring the impact of fiscal terms on the present value of cumulative government take (NPVGT). As it is in all other equations the oil price variable is still positively related and consistently significant in its effect on profitability of oil production venture even in the eyes of the government when measured via NPVGT. The impact of government discount is evidently consistently significant and negatively related to NPVGT. The other variables' relationships are opposite to the experience in earlier equations, tax rate exert a positive and statistical significant impact on government take. The general performances of the models were quite satisfactory. The R.

Squared and Adjusted R. Squared were reasonably okay ranging from 0.68 to 0.96. This shows that between 68% and 96% of changes in the value of the *IRR*, *NPV*, *NPVCT*, *NPVGT* of the projects are explained by changes in the included explanatory variables in all the four models. The F. statistics corroborate this finding as it shows that the included variables are jointly significant in explaining movement in the profitability of oil projects when measured via the respective economic measures. The Durbin-Watson statistics also shows that the models are well behaved as there is no serial correlation problem.

The evidence suggests that high oil prices relegates the impact of other fiscal terms but when price is low the fiscal terms becomes an important consideration when investing in an oil production venture in Nigeria. Another important observation from the result of the analysis is that from the perspective of the investor royalty rate and tax rate exert a negative impact on the profitability of oil production venture while on the part of government it is very important positively for the maximization of rent collection from oil venture. As to the inherent risk involve in an oil project, the evidence suggests that it exert a significant negative impact both in the eye of an investor and the government alike.

5.2.2 Comparison Of Our Findings With Selected Studies

It was discovered that only few studies adopted comparable methodology with the one in this study as regards the investigation of the impact of fiscal regime on the economics of oil production venture. For instance while this study is based on meta-modelling analysis, others were based on scenario analysis, time series analysis, descriptive analysis. The most closely related to our study is Kaiser and Pulsipher (2004) and Iledare and Kaiser (2006). The findings from the empirical analysis carried out in this study did not significantly differ from results from other studies. The role of oil price in the determining the profitability of oil projects was found to be positive consistently statistically significant in this study just as Iledare and Kaiser (2006), Kemp (1992), and Kaiser and Pulsipher (2004) found. The negative relationship result found for royalty rate and tax rate was similar to result from other studies.

6. Conclusion and Recommendation

The econometric evidence obtained from this study suggest that movements in oil price and prevailing environmental risk had significant effects on the economic viability of oil investment projects. The impact of the fiscal terms were found to be not so severe. Since

the fiscal regime was found to be largely investment friendly, the existing fiscal regime should be maintained in order to moderate the effects of market uncertainty arising from oil price movement.

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APPENDIX

Table 1: Evolution of Petroleum Profits tax (PPT) in Nigeria 1959-2002

Items	Terms
Signature Bonus	US\$0.5-1.00 MM/block
Bid Bonuses	US\$ 10-30 MM/block
Royalty Oil	Up to 16.67%(subject to water depth)
Cost Recovery	100% after Royalty
Depreciation	5 year Straight line
Profit Oil(Government share)	
<i>Niger Delta</i>	60% (<30MBD) to 65%(>50MBD)
<i>Frontier</i>	20%(<350MMB)to 60%(>2BBl)
Tax (PPT)	50%
Consolidation	Ringfence for PSC;All E&P for PPT

Source: World Bank (2004)

Table 2: Royalty Regime For Offshore Oil In Nigeria

WATER DEPTH	RATE(%)
Less than 200 meters	10.0
201 -500 meters	12.0
501- 800 meters	8.0
801-1000 meters	4.0
Beyond 1000 meters	0

Source: NNPC/NAPIMS (2007)

Table 3: Key Project Parameters

Parameter	Model Field

Recoverable Reserve	160MBO
Field life ³	20years
Oil price ⁴	\$21.47/bbl
Total capital Cost(CAPEX)	\$372m
Full cycle operating Cost(OPEX)	\$0.7/bbl

Source: Adapted from Tordo (2007) and World Bank (2004)

TABLE 4: Other Key Parameters

Parameter	Value
Tax rate	50%
Royalty rate	10%
Discount rate	15%
Government discount	12%
Contractor Discount	15%
Government share of profit oil	20%

Source :Tordo (2007),World Bank (1993,2004),NNPC/NAPIMS(2007)

³ Most project contract in Nigeria are to have a life span of 20years World Bank (1993)

⁴ Based on the average oil price 1986-2005 ,OPEC(2007)

TABLE 5 : Model Projected Production, Capital Expenditure And Operating Expenditure

Year	Oil production (MBO)	CAPEX/I (\$Million)	CAPEX/T (\$Million)	OPEX (\$Million)
1986	0	0	29.75829	0
1987	0	0	22.32026	0
1988	0	0	111.5859	0
1989	0	0	81.85228	0
1990	0	0	63.23405	0
1991	2	28.10386	0	1.4
1992	4	14.03928	0	2.8
1993	12	10.54021	0	8.4
1994	28	7.025964	0	19.6
1995	22.4	3.50982	0	15.68
1996	19.04	0	0	13.328
1997	16.184	0	0	11.3288
1998	13.756	0	0	9.6292
1999	11.684	0	0	8.1788
2000	9.94	0	0	6.958
2001	8.28	0	0	5.796
2002	6.928	0	0	4.8496

2003	3.8128	0	0	2.66896
2004	1.9072	0	0	1.33504
2005	0	0	0	0

Source: Adapted from Johnson 1994b and Kaiser and Pulsipher (2004)

TABLE 6 : Design Space For System Parameters

Parameter(unit)	Design Space
Price of oil	LN* (13.53, 50.64)
Royalty rate	U**(0.01,0.16)
Tax rate	U**(0.5,0.85)
Contractor discount rate	U**(0.10,0.40)
Government discount rate	U**(0.08,0.30)
Government share of profit oil	U**(0.2,0.60)

• Lognormal distribution with end points (x,y)

••Uniform distribution with end points (x,y)

Source: Author

TABLE 8: Cash Flow Model Results

ECONOMIC MEASURES	MODEL FIELD 100 MBO
NPV	\$108.12 million

IRR	23%
NPVCT	\$108.12 million
NPVGT	\$511.51million

Source: Own Computation

Table 9: Economic Measures

	IRR	NPV	NPVCT	NPVGT
Mean	0.142331	1.127930	-39.42994	411.6728
Median	0.136761	-13.45365	-61.79438	311.5473
Maximum	0.402380	553.9626	654.1248	3834.139
Minimum	0.044724	-77.59420	-90.42617	73.00081
Std. Dev.	0.050792	64.62973	64.56745	348.7970
Skewness	0.943401	2.961182	4.106166	3.127842
Kurtosis	5.179657	18.78285	32.60894	22.96183
Jarque-Bera	173.1443	5920.263	19669.41	9116.839
Probability	0.000000	0.000000	0.000000	0.000000
Sum	71.16544	563.9648	-19714.97	205836.4
Sum Sq. Dev.	1.287335	2084324.	2080309.	60708031
Observations	500	500	500	500

Source: Own Computation

Table 10 : Fiscal Terms

	P	T	R	DG	DC	PO
Mean	21.70499	0.674696	0.088012	0.189839	0.250655	0.401180
Median	18.67588	0.676139	0.087376	0.188481	0.247240	0.402796
Maximum	86.75446	0.849695	0.159422	0.299703	0.399779	0.599853
Minimum	13.90814	0.500092	0.010734	0.080414	0.100043	0.200850
Std. Dev.	9.233437	0.102063	0.042891	0.064214	0.087420	0.118277
Skewness	3.131539	0.033522	-0.046365	0.008435	0.018039	-0.020030
Kurtosis	17.19104	1.793309	1.832205	1.812265	1.734360	1.777482
Jarque-Bera	5012.747	30.42911	28.59050	29.39584	33.39886	31.16990
Probability	0.000000	0.000000	0.000001	0.000000	0.000000	0.000000
Sum	10852.49	337.3482	44.00590	94.91944	125.3274	200.5899
Sum Sq. Dev.	42542.93	5.198037	0.917974	2.057601	3.813460	6.980725
Observations	500	500	500	500	500	500

Source: Own Computation

Table 11 :Unit Root Test

VARIABLE	ADF Statistics (at levels)	Order of Integration
IRR	-23.16389**	I(0)
NPV	-23.57634**	I(0)
NPVCT	-23.28988**	I(0)

NPVGT	-22.62719**	I(0)
P	-23.18236**	I(0)
T	-21.38458**	I(0)
R	-20.79650**	I(0)
DG	-22.49949**	I(0)
DC	-23.11364**	I(0)
PO	-22.98080**	I(0)
Critical value@1%	-3.443228	
Critical value@5%	-2.867112	
Critical value@10%	-2.569800	

* Significant at 5%

** significant at 1%

Source: Author's Computation

Table 12: OLS Regression Results

Model	1	2	3	4
Dependent Variable	IRR	NPV	NPVCT	NPVGT
Constant	0.332 (94..47) **	173.21 (24.34) **	155.13 (10.4) **	418.88 (6.99) **
P	0.0040 (84.37) **	5.487 (57.53) **	3.46 (19.49) **	23.12 (32.48) **

T	-0.311 (-73.12)**	-325.75 (-37.75)**	-188.77 (-11.75)**	215.85 (3.35)**
R	-0.128 (-12.63)**	-148.42 (-7.24)**	-47.61 (-1.25)	167.77 (1.09)
DG			17.67 (0.692)	-3659.3 (-35.79)**
DC			-415.11 (-22.06)**	11.22 (0.14)
PO	-0.135 (-36.95)**	-145.41 (-19.57)**	-93.48 (-6.744)**	55.80 (1.004)
R-Squared	0.964	0.909	0.68	0.826
Adj.R-Squared	0.964	0.908	0.68	0.824
D.W	1.96	1.981	1.91	2.02
F-Statistics	3310**	1230**	178**	390**

* t statistics in parenthesis

• Significant at 5%

•• significant at 1%

Source: Author's Computation

Table 12: Correlation matrix

	NPV	NPVGT
NPV	1	0.460486816 031

NPVGT	0.460486816 031	1
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Source: Author's Computation