Optimizing Production Sharing Contract For

Marginal Fields Development

by

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CERTIFICATION OF APPROVAL

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TRONOH, PERAK

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CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

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Hamden Bebaha

ABSTRACT

This study proposes an optimized production sharing contract that promote the development of marginal fields by protecting the contractor's downside while enabling the government to increase its rightful share in case of profitability increment.

A marginal field model is developed based on pseudo field that was assumed in reference to commonly accepted exploration and development data that are typical in Nigeria. The economic analysis of this model involves cash flow modeling, profitability analysis, and sensitivity analysis.

The parameters of the PSC are varied to analyze the effect of each provision, and to identify which combination of variables will ensure a fair division of benefits and risks between the government and the contractor.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Marginal oil fields are commonly defined as minor oil accumulations that are uneconomic under current terms. However, new developments in technology, engineering and construction practices, as well as flexible contracting procedures, have drastically reduced the expenditure of developing these projects [1]. Furthermore, marginal fields' development is encouraged by the existence of infrastructure built for the larger fields in vicinity such as: the extensive pipeline network, oil and gas process facilities, roads and support facilities.

The existence of these accumulations has been known since the early days of petroleum production. An overall of 116 minor fields was identified in Nigeria [2]. The identified fields contain 1.3 billion barrels of oil in place. 5 of these fields encompass 291 million barrels, while another 20 fields accommodate an overall reserve of 305 million barrels. It is estimated that there could be as much as 1 billion barrels of additional oil in smaller satellite accumulations around the large Prudhoe Bay and Kuparuk River fields in Alaska [3]. Companies have explored relinquished blocks in Equatorial Guinea and abandoned them because accumulations of 10 million barrels or less are generally unattractive at the current one size-fits-all production sharing terms dictated by the government of Equatorial Guinea [4].

In Nigeria, the ministry governing the petroleum resources defines marginal fields as any field characterized by any of the following traits:

- Fields which are not cost effective under current economic terms.
- Fields that has been drilled for more than 10 years but no progress has been made

- Fields that can be characterized by their traits (fluid properties) as unconventional and require special technology to be produced.
- Fields with low volumes of hydrocarbons in place

A different reserve classification has been adopted in Netherlands and the United Kingdom in regard to their reserve assessment. In Netherlands, a gas reserve is regarded as minor when it contains a volume of less than 4 MM m^3. On the other hand, the U.K regards the volume of 20 MM barrels of oil as its point of reference. The field's productive potential is another parameter used to categorize a field's marginality. In Indonesia a 10000 barrel per day potential is used to define the field marginality. While in Texas, the associated wells determine whether a field is considered to be marginal. Another factor to define the marginality of the field is the technology required to extract the hydrocarbons and how much does it differ from the conventional standard methods.

A determining factor in the practicability of the development of marginal fields is the type of contract to be used. Many countries adopt the philosophy of Production sharing contracts when dealing with international oil extraction companies. PSC terms vary from one country to another, but the general form of the contract take into consideration the technical and economic uncertainties of the project.

Production sharing contracts are widely used type of arrangement between a country and an international oil company or group of companies [6]. This agreement dictates the terms on which the oil resources pertaining to the government will be exploited and allocated. PSC's first time use was in Bolivia in the early 50's, however their first application identical to present form was in Indonesia in the 60's [4].Currently, PSC are very common in the Middle East and Central Asia.

PSCs allow an impartial and contractual relationship between the country and the IOC. The arrangement allows the two parties involved in the contract to dictate the terms regulating the oil exploitation and division. The oil pertains to the government and after certain point of production; a portion of the oil is allocated to the producing company as a compensation for the performed work. Basically, the state owns the oil and pays the IOC, by a portion of the extracted oil, to develop and produce the oil in question.

The contract is comprised of two parties, an international oil company and a state representative that can take the form of a government, ministry, or a national oil company. Usually the state is represented by a national oil company. The number of IOCs in the PSC has no effect on the constitution of the agreement since they are regarded as a single partner. The field operations are conducted by the IOC; however the option, of the involvement of the NOC in the field operations, is provided in many PSCs.

After production, the IOC has to pay royalty based on the overall productivity to the state. Royalty can represent either an instantaneous cash inflow to the country or costless volumes of hydrocarbons for the national benefits, or for the exportation purposes. In terms of cash, it is very important to determine the output value of the royalty accordingly. It is an advantage for the government if the actual price is less than the stipulated price. On the contrary, a stipulated price that is lower than the actual price is beneficial for the IOC. In both cases, the royalty is guaranteeing a base cash inflow to the state from the IOC despite the viability of the operated field.
Based on this principle, it is clear that when project generates a low profitability, the royalty will have more drastic effect on the IOC. This implies that the lower the profitability the higher is the adverse impact of the royalty on the IOC. The government total profit will be minimized when the royalty is treated as tax deductible. Consequently, it is in the government’s best interest to treat royalties as expenses.

Secondly, the contractor is allowed to recuperate a part of its expenses at a predetermined rate of production, known as cost oil. The particular characteristics of a field determine the level of cost recovery. IOCs necessitate an elevated cost oil ceiling on marginal fields as a way of guaranteeing the success of the company’s investment. The period necessary for the government to realize its take depends on the cost recovery limit.

All in all, the state possesses 3 main sources of income: royalties, taxes, and the profit oil share. Periodically, PSC permits uplifts to the IOC as an encouragement. With this incentive the IOC is allowed to regain a further share of the CAPEX.

In practice the PSC encompass in their terms a great number of variables ranging from the capital expenditure to the field operation.

1.2 Problem Statement

Current PSCs schemes are too rigid to promote the development of marginal fields. Many contracts aim to create a relationship whereby the mutual benefits of both the government and the IOC are respected. However most of these contracts fall short in their attempt to create an unbiased relationship whereby the state profits are protected without diminishing the upside of the contractor and thus the attractiveness of the field.

1.3 Objective

The aim of this study is to propose an optimized PSC that:

- Enables the development of marginal fields by reducing minimum field size and production requirements without prejudicing the state’s entitlement to share in upside.
- Allows the state to seize possible windfall gains without prejudicing the commercial viability of marginal fields.

1.4 Scope of Study

The overall research plan is to build a marginal field model which is not attractive under current economic terms. The parameters of this model are then modified in order to analyze the effect of changing these provisions on the profitability of this prospect. The parameters in question are: royalty, profit split, and governmental taxes. Adequate rates are proposed based on the sensitivity analysis of these parameters. These proposed rates will augment the attractiveness of this marginal field from the contractor’s point of view, while ensuring the state entitlement in case of profitability increment.

CHAPTER 2

LITERATURE REVIEW

(Bindemann 1999) categorizes Production Sharing Contract as the dominant model of contractual agreement in the oil industry. Under a PSC the government upholds national ownership of resources and the IOC acts as an independent contractor that takes charge of both the technology and finance required to develop a given project. Usually the state is represented by a national oil company. Furthermore, PSC are distinguished from other genre of agreements by the fact that the government possesses the hydrocarbon resources as well as the facilities. Another distinctive feature of the PSC is that it enforces the IOC to bear the complete risk during the development of the project with no guaranteed reimbursement.

(Fernandez 2008) considers the innate instability of the current PSC contracts as the reason why certain fields are not promoted to development even though they are fairly profitable. The derivation of PSC terms often produces inefficient contracts that make the development of marginal fields financially prohibitive. A marginal field, although still commercially attractive, is small and therefore its project economics are greatly affected with even the slightest change in PSC terms.

The norms and measurement utilized to grade the marginality of a given oil field may be condensed into a general form proposed by (Svalheim, 2004):

"A field that may not produce enough net income to make it worth developing at a given time: should technical or economic conditions change, such a field may become commercial."

Additionally he stated that the development of marginal fields exhibits a typical pattern of challenges, such as:

- Predictions of oil and gas prices

- Determination of the field properties
- Volumetric calculations
- Cooperation between the operators
- Existing facilities and their usefulness to the field development
- Rate of return used by the investors
- Laws and regulations of the host country

On that account, the government has to find the optimal contract in such a way that there is no possibility to rearrange the allocation of goods in a way that makes one party better off without harming the other (Hall and Lieberman 2001). According to Bindemann (1999) the main factors that such contracts should address are:

- Existence of commercial hydrocarbon accumulations
- Type of resource (i.e. oil, gas, and/or condensate)
- Amount to be deposited
- Profitability of the project
- Technology required
- Commodity uncertainties
- Risks associated with the situation of the host country

(Fernandez 2008) debates that the economics of the current contracts, whether they are production-based sliding scale or fixed production share, are too rigid to allow for the commercialization of marginal fields. The strictness of the production share splits amplify the risks associated with the uncertainties. In contrast a rate-of-return based scale would ensure development projects for marginal fields to be beneficial because the government's take is not dictated prior to exploration. This type of flexibility encourages the development of marginal fields, consequently stimulating the economic growth of the country by creating cash-generating projects, increasing local investment, and creating jobs.

Unlike fixed production share or production-based sliding scale, a rate-of-return based contract will allow the government to obtain more profit in case of incremental production. Essentially the rate-of-return based contract has a dampening effect: IOC possible profit from prices increment is minimized, while the drawback is protected.

The main purpose of the sliding scale systems is to create a relationship whereby the government percentage augments as profitability increases. In general, it is better for both parties when the NOC share is taken as a percentage of the profitability, but sliding scales taxes and other attempts at flexibility are lacking efficiency since they are based on profitability instead of production rates. Therefore, the objective of the rate-of-return based contract will be to optimize the state's goal to bring bypassed oil to market by reducing minimum field size and production requirements without prejudicing the state's entitlement to share in upside. Regardless of the volatility of uncertainties in the exploration and production stages, a fair division of profits between the NOC and IOC will be achieved. As a result of such PSC terms, marginal fields will be developed, thereby stimulating the economy and creating jobs stemming from renewed industry investment in the country.

According to (Johnston 2003) the main purpose of the so-called flexible systems is to establish procedures to honor the interests of both the host country and the IOC ultimate objective of a flexible system is to create a framework that can honor the interests of both the host government and the IOC and present an unbiased agreement for both major and marginal discoveries. Such systems are becoming standard in the industry, as many countries are now including new economic terms to their PSCs. The production based sliding scale remains the most widely used method today for flexible PSC, which classically oblige a slighter proportion for the IOC as the profitability of the project increases. However such system remains inadequate because the current terms are essentially based on gross revenues and do not take into consideration any of the other uncertainties that affect a project. Contrarily, IRR contracts take directly into account such things as production profiles, commodity prices, capital and operating costs, and time value of money because government take is based on project profitability.

Royalties, bonuses, cost recovery limits, and other forms of taxation are all a type of guarantee to the NOC that it will generate a cash inflow in the beginning of the project development, however (Johnston 2003) argues that such fiscal conditions actually hinders activity in the country, as evidenced by the low expected IRR of the marginal fields when compared to their otherwise healthy IRR under no taxation.

CHAPTER 3

METHODOLOGY

A model was proposed which represents a typical marginal field in the Niger-Delta Area. The input data used in this model are based on generally accepted exploration and development information that are provided by (Ayodele and Frimpong, 2003). The Price input was changed from $20/bbl to $100/bbl in order to confirm with today's average prices. After changing the price, the project became very profitable and did not represent a marginal field anymore. Therefore, it was necessary to reduce the production inputs to compensate the price increment.

3.1 Production Modeling

In this model, the recoverable reserve is 5,442,500 barrels. A production rate of 1,500 barrels of oil per day is expected within the first three years with 3 wells (500 barrels of oil per day per well). In the fourth year, 3 additional wells would be drilled giving a total capacity of 1,918 barrels per day till the end of year seven. By the end of the eighth year, the production capacity will drop to 1,096 bbl/day and then decline gradually until it reaches a minimum of 274 bbl/day at the 12th year, marking the end of the project life. The oil production mentioned above is quite reasonable when compared to the typical oil production from adjacent marginal fields in the area.

3.2 Cash Flow Modeling

In this project, the modeling of the cash flow was completed using Microsoft Office Excel spreadsheet. Most of the necessary inputs data were based on current international rates, prices and costs provided by (Ayodele and Frimpong, 2003). The Inputs data are listed in table 1:

Table 1. Inputs data for the cash flow model

Estimated Project Life (n)	12 years
Total Initial Capital	$60Millions
Operating Expenses per Barrel	$12/bbl
Oil Price	100/bbl
Discount Rate	18%
Royalty	15%
Cost Ceiling	50%
Contractor Profit Split	40%
Governmental Tax (year 1 to 5)	60.75%
Governmental Tax (Year 6+)	80%
Depreciation Rate (Declining Balance)	10%

3.3 Mathematical Modeling

The annual production was computed for the first year by multiplying the daily production rate by 365, the number of days per year. The revenue for the same year was calculated by multiplying the annual production by the assumed oil price ($100). Then the royalty rate was multiplied by the annual revenue to compute the royalty fees paid by the contractor to the government. The revenue was multiplied by the cost ceiling rate to determine the cost ceiling.

After that the cost incurred was computed by adding the capital expenditure to the operating expenses for that year. Then the cost incurred was added to the cost carried forward to determine the cost bank. The cost carried forward in the first year was zero, since no cost has been carried yet. Next, the cost recovered was determined by selecting the minimum value of either the cost bank or the cost ceiling. After that the unrecovered cost was calculated by subtracting the cost recovered from the cost bank.

The profit of the project was then determined by subtracting both the royalty fees and the cost recovered from the annual revenue. Subsequently, the profit split scheme (40%contractor /60% Government) was used to generate both the contractor profit split and the government profit split. The next step was to determine the contractor cash entitlement which represents the total amount of cash received by the contractor. The contractor's cash entitlement is the sum of the cost recovered and the contractor profit split. Then the operating expenditure is deducted from this cash entitlement to calculate the contractor's income before taxes.

After that, the capital allowance is determined by multiplying the depreciation rate by the capital expenditure. The capital allowance is then subtracted from the income before taxes to compute the taxable income. The computed taxable income is then multiplied by the tax rate corresponding to that year to deduce the taxes paid to the government. The taxes paid are then subtracted from the income before taxes to deduce the contractor's income after taxes.

Next, the contractor's net cash flow after tax is determined by subtracting the cash out from the contractor cash entitlement. The cash out is the sum of the capital expenditure, operating expenditure and taxes paid. The present value of money is taken into consideration, by dividing the Net cash flow each year by the compounding factor, when computing the net present value for both the contractor and the government. This process is repeated for each year of the project life.

Finally, the Profitability index of the project is computed by dividing the present values of all cash inflows by the initial investment cost. Similarly the internal rate of return is generated using Microsoft excel spread sheet IRR function. Table 2 summarizes the algorithm used in this mathematical model.

Table 2. Mathematical model algorithm

Annual Production	Daily Production * 365
Revenue	Annual Production * Price
Royalty	Royalty Rate * Revenue
Cost Ceiling	Cost Ceiling Rate * Revenue
Cost Incurred	CAPEX + OPEX
Cost Bank	Cost Incurred + Cost Carried Forward
Cost Recovered	Minimum of Cost Bank or Cost Ceiling
Unrecovered Cost	Cost Bank – Cost Recovered
Project Profit	Revenue – Royalty – Cost Recovered
Contractor Profit	Contractor Profit Rate * Profit
Government Profit	Government Profit Rate * Profit
Contractor Entitlement	Cost Recovered + Contractor Profit
Income Before Tax	Contractor Entitlement - OPEX
Capital Allowance	Depreciation Rate * CAPEX
Taxable Income	Income Before Tax – Capital Allowance
Tax Paid	Tax Rate* Taxable Income
Income After Tax	Income Before Tax – Tax Paid
Cash Out	OPEX+ CAPEX + Tax Paid
Net Cash Flow after Tax	Contractor Entitlement – Cash out
Contractor Net Present Value	Contractor NPV/ ((1+r)^n)
Profitability Index	PV of future cash flow/ Initial Investment
Internal Rate of Return	Using IRR function in Excel spread sheet
Government Net Present Value	Sum of (Royalty + Government Profit + Tax) /((1+r)^n)

The original model outputs are summarized in the following table:

Table 3. Original model outputs

Contractor Net Present Value	-549040.8842
Profitability Index	0.985660453
Internal Rate of Return	17%
Government Net Present Value	328429515.1

It is the objective of this study to optimize this production sharing contract in order to increase the attractiveness of this field. Therefore, the next step is to vary certain parameters in order to increase the profitability of this prospect. The parameters in question are: Royalty, Profit Split, and Governmental taxes.

The royalty rate is varied between zero and its current value (15%). Next the profit split is varied between its current value 40% and 60%. Lastly, the government taxes are varied between 40% and 80%.

These terms were selected based on the fact that the government has the power to change such parameters to offer a source of relief to the contractor and to increase the attractiveness of this marginal field. Other parameters, such as the capital expenditure, operating expenses, and capital allowance are attached to the project itself and cannot be altered by the government.

This variation of parameters will be conducted separately, meaning that while varying a specific parameter, the other parameters will be held constant and the calculations will be carried in the same manner as in the original model. For each Iteration, the calculation will be carried out for the whole life of the project, and the profitability analysis will determine how much effect does each parameter has on the overall economic of the project. After that adequate rates are proposed to augment the attractiveness of this marginal field from the contractor's point of view.

The next step is to carry a sensitivity analysis to the oil price changes. Two alternative prices of oil will be proposed, \$80/bbl and \$120/bbl respectively. For each price the calculations will be carried out for the whole life of the project , and the profitability analysis will be used to determine how much effect does this change has on the overall economic of the project from the point of view of both the contractor's and the government. The purpose of this sensitivity analysis is to ensure that the proposed rates earlier will be able to protect the contractor's profit while ensuring the state entitlement in case of profitability increment.

3.4 Work Schedule

The following figure illustrates the time line followed in this project.

Details on Weekly work	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Briefing & Update		●												
Results Compiling			▬	▬	▬									
Presentation of the Results to the Supervisor				▬	▬	▬								
Submission of Progress Report							●							
PRE-SEDEX / Poster Exhibition									●					
Submission of Technical Paper												●		
SEDEX 33												●		
Final Oral Presentation														●

Figure 1. Gantt chart

CHAPTER 4

RESULTS AND DISCUSSION

The Algorithm used is explained in the mathematical model discussed earlier. The inputs data are provided in the cash flow model. The calculations were made using Microsoft Excel spreadsheet. The Calculations for the first 6 years and the last 6 years of the project are attached in appendices A and B respectively.

From the computed results it can be seen that this project has a negative present value of $549,040, with a profitability index of 0.985660453 and an internal rate of return of 17%. These values indicate that the economic and fiscal incentives, proposed in this production sharing contract to develop this specific marginal field, are not favorable to the contractor. In fact the contractor will not have the chance to break even.

However, the total amount of royalties, fees and taxes that will be collected by the government throughout the life of this project is 328,429,515. This is a quarter billion in today's dollar term that the government is going in fact to lose it since the project will not be developed because it is not economically attractive from the contractor's point of view.

In attempt to render the project more attractive from the contractor's point of view, the previously discussed solution is put to action and the variation of parameters is carried out in the predetermined method.

4.1 Royalty

The royalty was varied between 0% to 15%, by increasing the rate by 1.5% in each iteration. All the other parameters were held constant. At a rate of 0% royalty the project's IRR became 23% instead of 17% which was observed at the initial royalty rate of 15%. Changing the royalty from 0% to 15% caused the project's IRR to change from 17% to 23%. This means that the contractor's IRR increased by a factor of 35%. The effect of this variation is illustrated in the following figure:

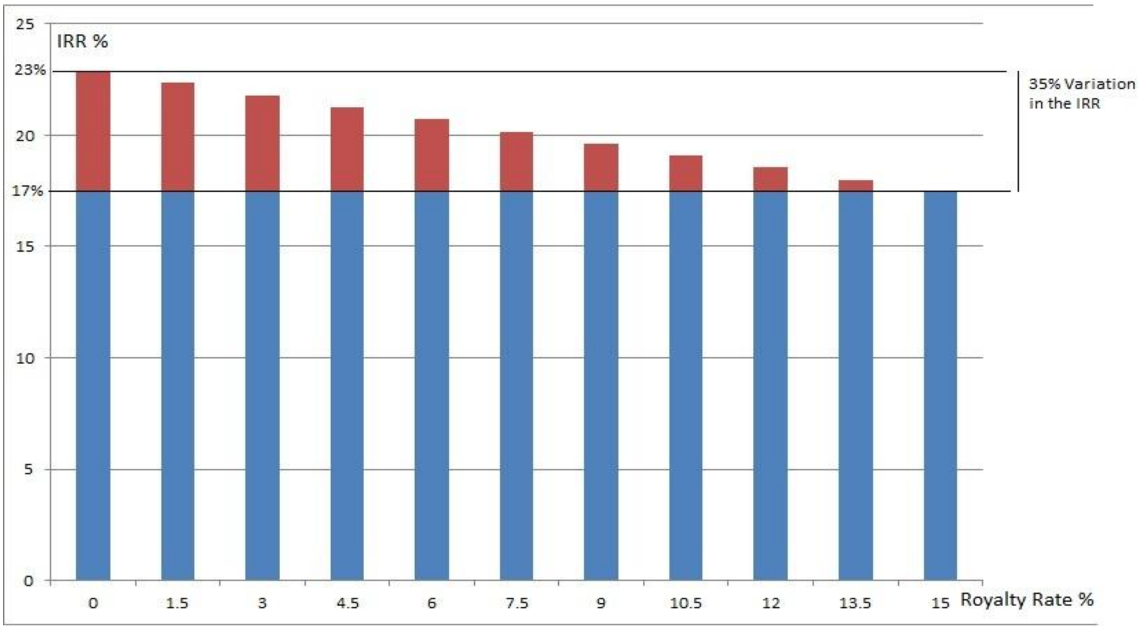

Figure 2. Effect of variation of the royalty rate on the contractor

From the government's point of view the change in royalty rate had a little effect on the government revenue. The state net present value represents all the accumulations of royalties, profit share, and taxes that the government received throughout the life of the project. In accordance with the variation of the royalty from 0% to 15% the government net present value varied from $318,919,843 to $328,429,515 which means that the government lost $9,509,672 when the royalty rate was zeroed. However this loss of $9,509,672 represents a minimal reduction in the government total revenue since it represents only 2.89% reduction in the governmental net present value. The effect of this variation is illustrated in the following figure:

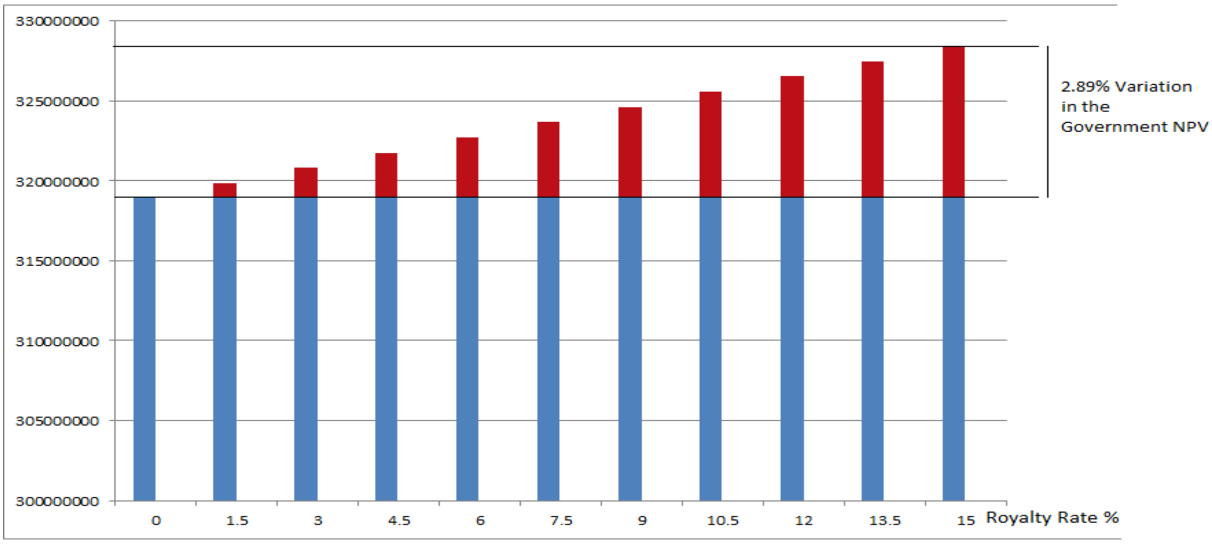

Figure 3. Effect of variation of the royalty rate on the government

4.2 Profit Split

Similarly, the contractor's profit split was varied between its current rate 40% to 60%, by increasing the rate, in each iteration, by a factor of 2% while the rest of parameters were held constant. This variation caused the Project's IRR to change from 17% to 27% which corresponds to 58% increase in the original IRR. This is illustrated in the following figure:

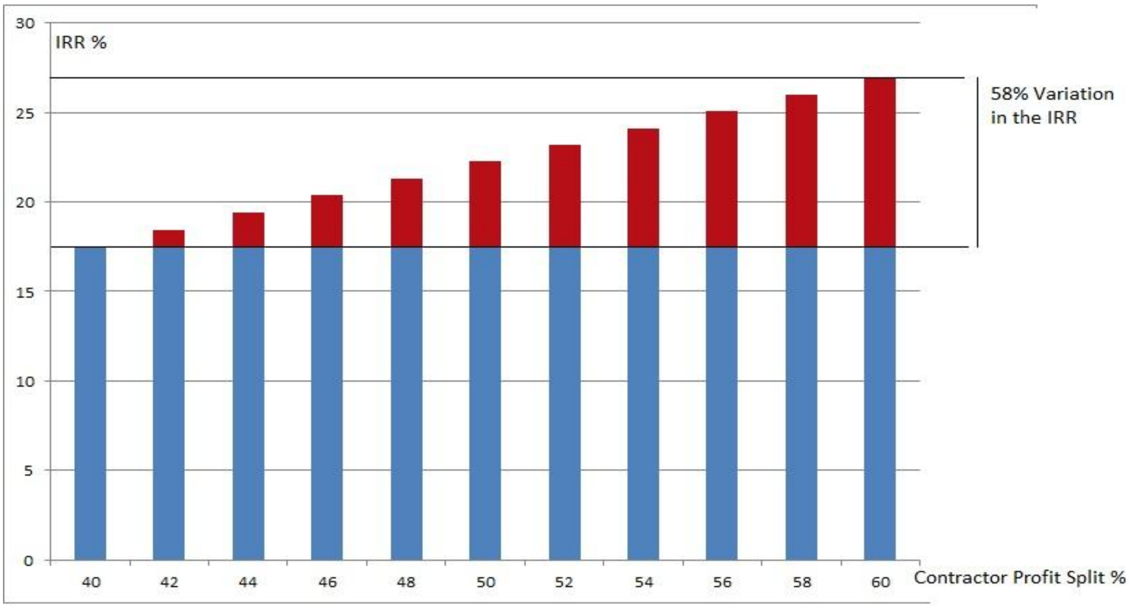

Figure 4. Effect of variation of the profit split rate on the contractor

Increasing the contractor's profit split means automatically that the government profit split is decreased by the same percentage entitled to the contractor. Due to this variation, the governmental revenue decreased from $328,429,515 to $309,735,490 loosing $18,694,025 which corresponds to 5.69% decrease in the state's net present value. The variation in profit split has twice the effect on the government of that of the royalty. This is demonstrated in the following figure:

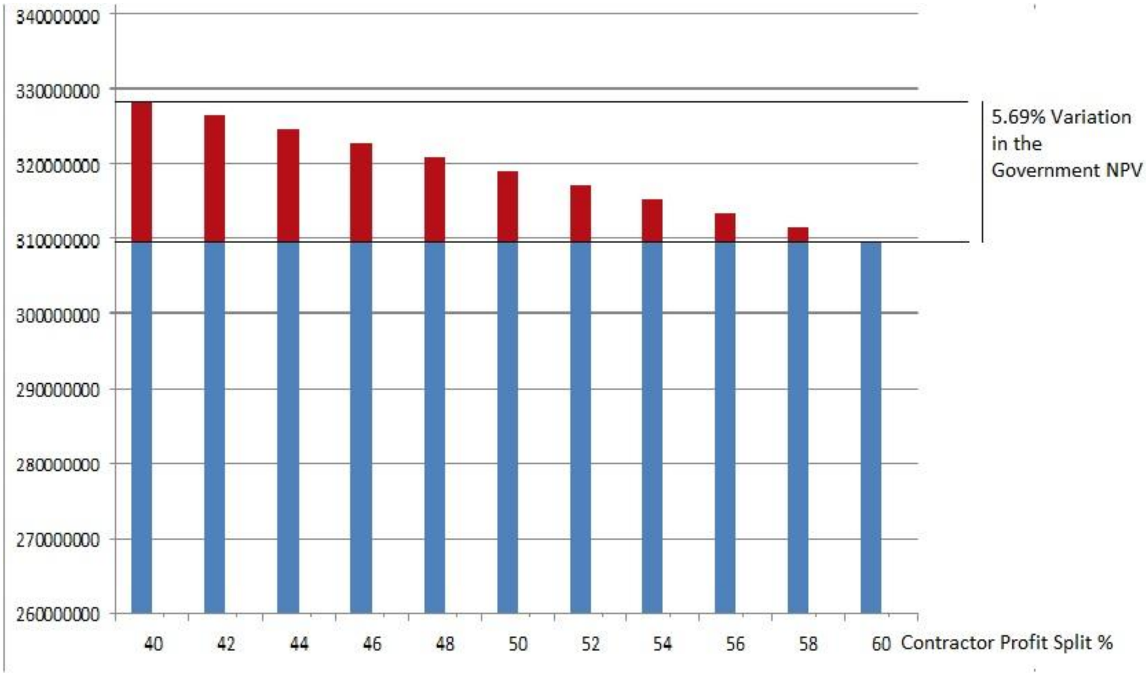

Figure 5. Effect of variation of the profit split rate on the government

4.3 Taxes

Lastly, the tax rate was changed from 40% to 80% on a 10 steps interval. In each iteration, the tax rate was increased by 4%. This change of tax rate had a drastic change on the project's IRR and caused it to decrease from 36% to 6%, which corresponds to 83% decrease in the project IRR. This fluctuation of the project profitability is illustrated in the following figure:

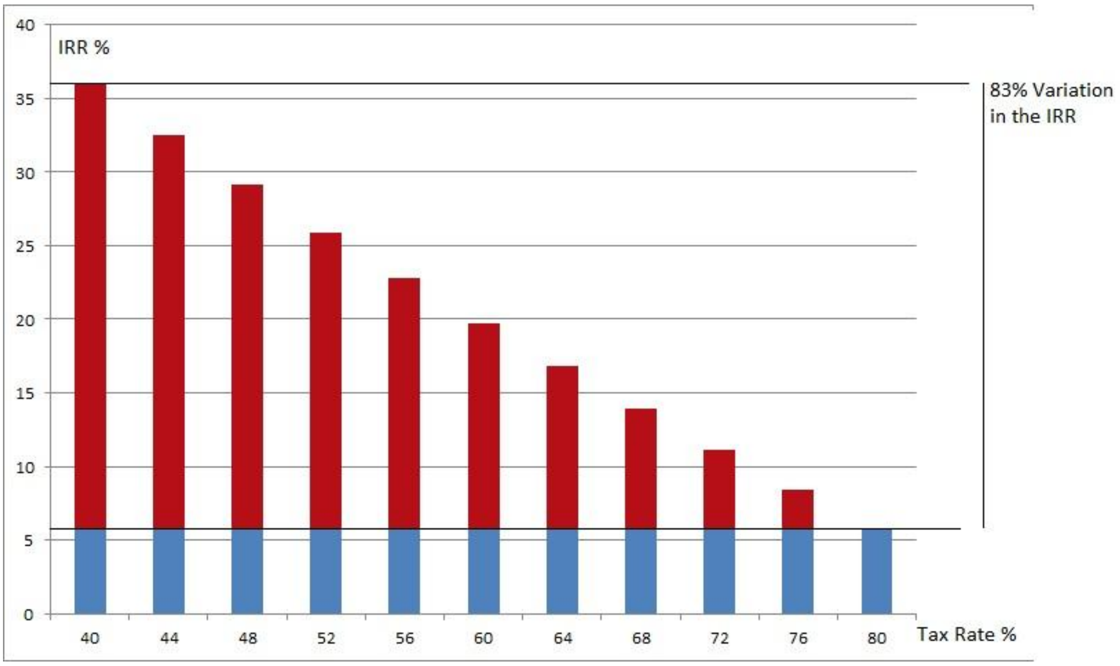

Figure 6. Effect of variation of the tax rate on the contractor

However, this increase in the tax rate from 40% to 80% caused the government revenue to increase from $295,362,299 to $348,931,363 respectively. Increasing the tax rates caused the government to increase its revenue by $53,569,064 which corresponds to 18% increase in the state's net present value. This effect of tax rate variation is demonstrated in the following figure:

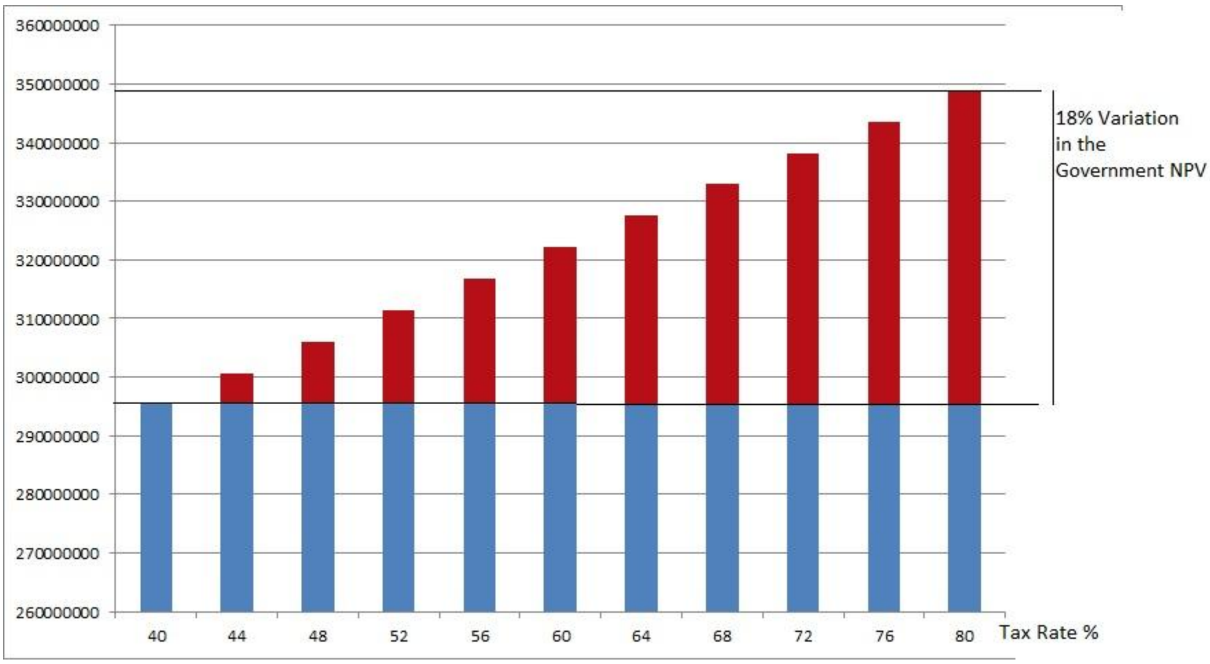

Figure 7. Effect of variation of the tax rate on the government

Royalty, profit split, and tax rates have direct effect on both the contractor profit as well as the governmental revenue. This effect varies greatly according to the variance of the parameter in question. As demonstrated by the previous graphs, the effect of varying each parameter is not similar.

Furthermore, the effect of varying the same parameter varies from the contractor to the government. For example, the effect of varying the royalty rate from 0% to 15% is considerable on the contractor. This royalty rate change shifted the IRR from 17% to 23%. However, the royalty rate does not have the same power over the governmental revenue. The change in the royalty rate changed the governmental revenue by a factor of 2.89% which is marginal compared to the extent which affected the contractor (35% change in the IRR).

Similarly, the effect of varying the profit split and the tax rates was considerably higher on the contractor than the government. The profit split variation caused the contractor's IRR to change by a factor of 58%, However it only changed the government revenue by 5.69%. The tax rate variation had the highest effect on both the contractor and the government.

It caused the project's IRR to change by a factor of 83%. From the government's point of view, the tax rates variation caused the state's net present value to change by a factor of 18%. The following figure illustrates the effect of varying the royalty, profit split, and tax rates on the contractor and the government respectively.

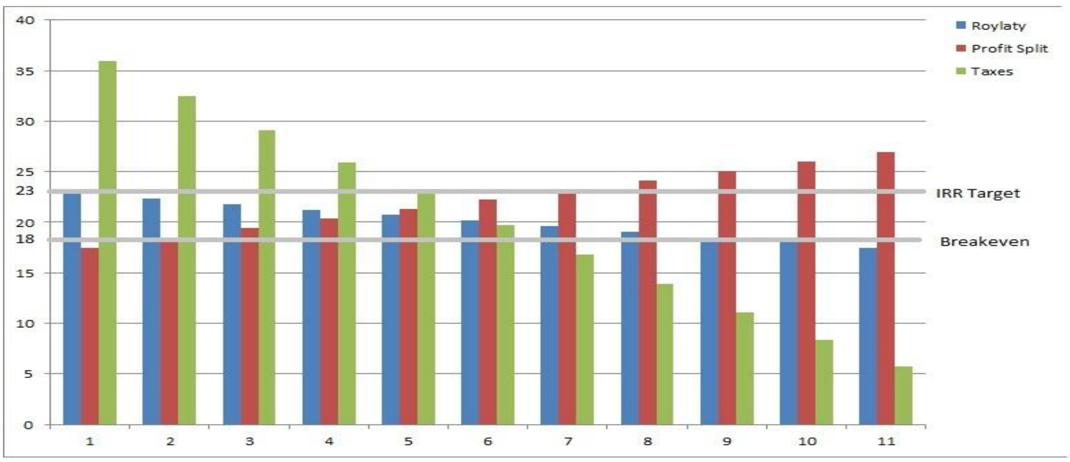

Figure 8. Effect of variation of the parameters on the contractor

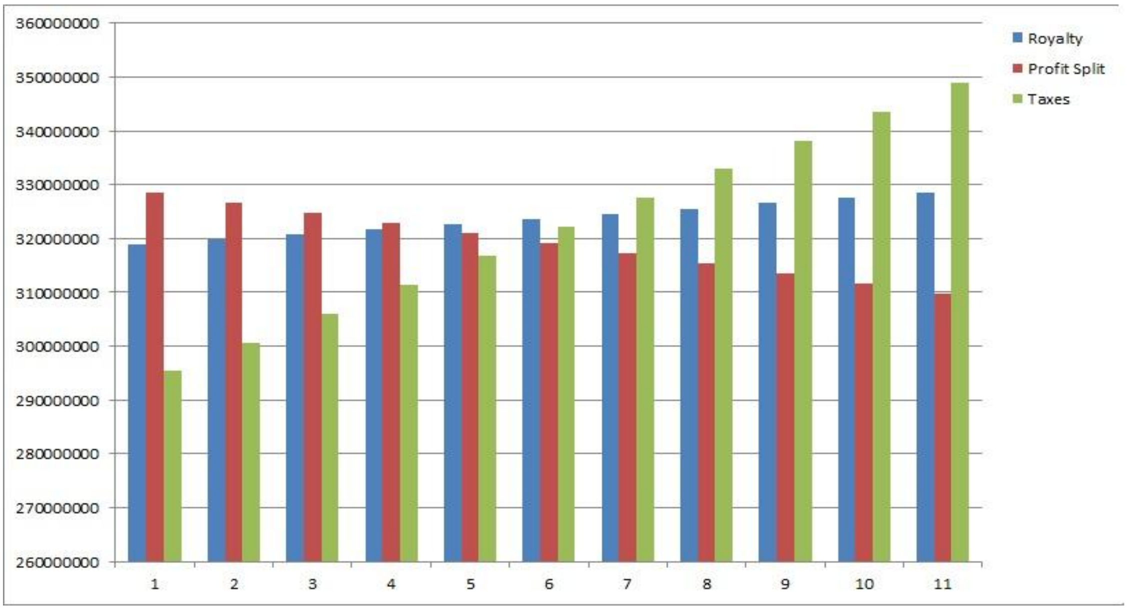

Figure 9. Effect of variation of the parameters on the government

4.4 Proposed Rates

Based on the variation of parameters, the tax rate proposed is 65% fixed throughout the life of the project. The royalty rate is proposed to be kept at its original rate which is 15%. Similarly the contractor's profit split is maintained at 40%. These parameters are only applicable in case the actual price of the oil equals the stipulated price. Meaning that, there is neither increment nor decrement of profitability.

In case of profitability increment, a new rate is introduced to ensure that these proposed rates take into consideration the impacts of uncertainties, principally the price fluctuations. This new term is called the price discrepancy rate (PDR) and it is a measure of the deviation of the actual price from the stipulated price. The discrepancy rate is basically a percentage of error representing how far the actual price deviated from the stipulated price. It is computed by the following formula:

$$PDR = \left|\frac{Stipulated\ Price - Actual\ Price}{Stipulated\ Price}\right| * 25\%$$

In case of price variation, two possible scenarios can be encountered: the actual price is less than the stipulated price (Profit Decrement) and vice versa. In both cases the price discrepancy rate can act as mitigating factor ensuring that in case of profit decrement the contactor's downside is protected and the damage caused by the price variation is fairly distributed between the contractor and the government. Similarly, this price discrepancy factor will allow the state to seize possible windfall gains in case of profitability increment and keep the contractor profit within the vicinity of the profit target.

In case of profit increment, the tax is not computed simply anymore by multiplying the taxable income by the tax rate (56%). The PDR is introduced into the equation to increase the tax rate gradually. The tax formula becomes:

$$Tax_{i+1} = Tax_i + PDR * Tax_i \text{ ; Where } Tax_{i=0} = 56\%.$$

The royalty is maintained constant at the initial rate (15%). The taxation scenario will start with the rate 56% as the initial value. Then the taxes will increase gradually by the pre-determined factor as per the tax equation above. For example if the actual price of the oil is found to be $120 instead of $100, then the PDR will equal=5%. Consequently, the taxes will increase by this factor in each year. The taxation scenario for the example mentioned above is summarized in the following table:

Table 4. Taxation scenario for profit increment case

Year	**Tax Rate**
1	56%
2	58.8%
3	61.74%
4	64.827%
5	68.0684%
6	71.4718%
7	75.0454%
8	78.7976%
9	82.7375%
10	86.8744%
11	91.2181%
12	95.779%

On the other hand, in case of profit decrement, the PDR is inserted into both the tax and royalty equation in order to mitigate the impact of price decrement on the contractor and to limit his lost, on the government behalf, to a certain limit. The new tax and royalty equations become:

$$Tax_{i+1} = Tax_i - PDR * Tax_i; \text{ Where } Tax_0=56\%.$$

$$Royalty_{i+1} = Royalty_i - 4 * PDR * Royalty_i; \text{ Where } Royalty_{i=0} =15\%.$$

Therefore, the taxation will start at the initial value 56% and then decreases gradually. For example if the actual price of the oil is found to be $80 instead of $100, then the PDR will be computed as 5%. This factor is used to decrease the taxes each year. the taxation scenario will be as shown in the following table:

Table 5. Taxation Scenario for profit decrement case

Year	**Tax Rate**
1	56%
2	53.2%
3	50.54%
4	48.013%
5	45.6124%
6	43.3317%
7	41.1651%
8	39.1069%
9	37.1515%
10	35.294%
11	33.5293%
12	31.8528%

Similarly, the royalty rate will start at the initial value 15% and then decreases gradually. the royalty rates are summarized in the following table:

Table 6. Royalty rate scenario for profit decrement case

Year	**Tax Rate**
1	15%
2	12%
3	9.6%
4	7.68%
5	6.144%
6	4.9152%
7	3.93216%
8	3.145728%
9	2.5165824%
10	2.0132659%
11	1.6106127%
12	1.2884902%

All in all, the taxation system is flexible as shown in the tables above. The taxes started at a rate of 56% and then decreased until a rate of 31%. Similarly, the royalty start decreasing from the initial rate 15% until it reached 1%. This sliding decrease in the taxation is meant as a source of relief to the contractor.

In the original model, the profitability index of the project is 0.98, the internal rate of return is 17%, the contractor net present value is -$54904, and the government net present value is $328,429,515. However the new proposed solution changed the project status to a profitable prospect. The new proposed solution is to maintain the same rates for royalty and profit split and fix the tax rate at 56% in case of price stability. Under the new proposed rates, the profitability index of the project is 1.135961366, the internal rate of return is 23%, the contractor net present value is $5,082,788, and the government net present value is $316,789,924.

This is a profitable prospect from the contractor's point of view, however to assume that the oil price will remain constant at $100/bbl is a big speculation. In fact the contractor is still at risk in case the oil prices decrease. Therefore, a sensitivity analysis was carried out to test how effective the new solution is in case of price fluctuation.

The first case is to assume that the oil price dropped to $80/bbl. In this situation, calculations were carried out and the PDR term was introduced as previously discussed. The tax rate started at 56% and decreased gradually until 31%. Similarly the royalty rate decreased from 15% in the first to end at the last year of the project life at 1%. Finally the profitability index of the project was computed and found to be 1.081749204, the internal rate of return is 21%, the contractor net present value is $ 3,269,740, and the government net present value is $222,701,986.

These results indicate that the profit decrement affected negatively both the contractor and the government. The internal rate of return of the project decreased from 23% to 21%. This decrease indicates that the contractor has undergone some loss and his profit has fallen below the target IRR (23%). But still the contractor downside was protected since the IRR did not fall below the breakeven point (IRR=18%). The contractor's lost $1,813,048 from the original net present value due to the oil price decrease. This lost accounts for 35% deviation from the original net present value. In the same manner, the government lost $94,087,938 from its net present value which account for 29% deviation from the original net present value when the oil price was still at $100/bbl. The percentages of deviation of both the government and the contractor are comparable, which indicate that the loss caused by the oil price decrease was fairly distributed between the government and the contractor.

The second case is to increase the oil price to $120/bbl. The tax rate started at 56% and increased gradually until 95%. The royalty rate, and all other parameters were held constant at their initial rates. Finally the profitability index of the project was computed and found to be 1.169182101, the internal rate of return is 24%, the contractor net present value is 5,882,616, and the government net present value is $413,312,651. It can be observed from the results, that both the government and the contractor benefited from the increase in oil prices. However most of the profit was seized by the government which was one of the main objectives of this study. The government increased its net present value by $96,522,727 which corresponds to 30% increase in the state entitlement. The contractor on the other hand, increased its net present value by $799,828 which corresponds to 15% increase in the original profit. The following figure demonstrates the percentage by which the contractor net present value varied due to price fluctuations.

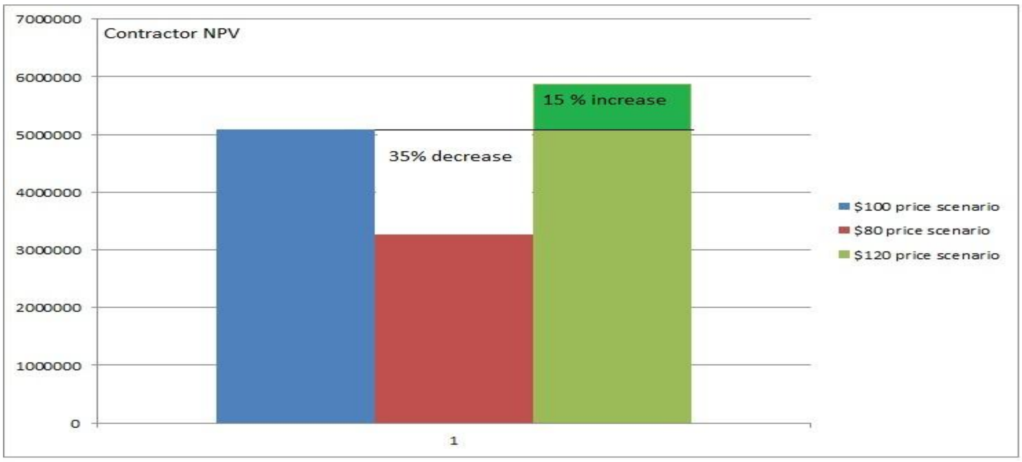

Figure 10. Effect of oil price variations on the contractor net present value

Similarly, the effect of price fluctuations on the government net present value is illustrated in the following figure:

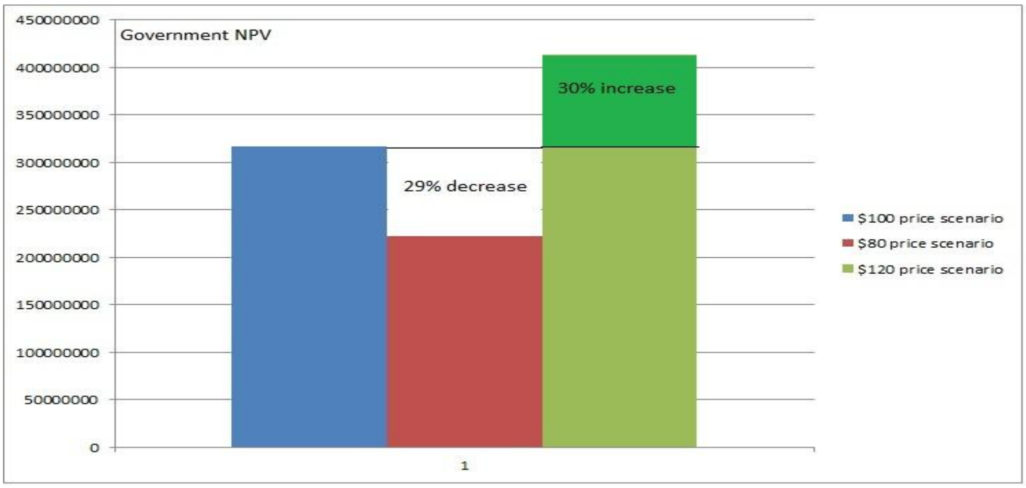

Figure 11. Effect of oil price variations on the government net present value

CHAPTER 5

CONCLUSION

The project is not profitable under current economic terms. This is a typical representation of marginal fields. They are not profitable under current production sharing contract terms. However, the current scheme could be altered in such a way that it will allow more relief to the contractor. This relief is represented by the decrement of governmental fees. Throughout the life of this project, a total amount of royalties, fees, and taxes would be accruable to the state. Therefore, the government has the total power to decrease its fees to a limit that this prospect becomes more economically viable.

This change renders the prospect more attractive from the contractor point of view and thus the project could be developed. Even though, the variation of parameters decreases the government’s revenue, the government still benefits from such changes since they promote the development of the marginal fields in the country. The only lost that the government will encounter is when the marginal field remains undeveloped. Because of that, it is in the benefit of the state to diminish its revenue in order to promote the development of marginal fields.

This Project is subjected to certain uncertainties such as the fluctuation of oil prices. The division of profit proposed takes into consideration the impacts of such fluctuations. The conducted sensitivity analysis proved the proposed rates to be protective of the contractor’s interest while at the same time it ensured the state’s right to entitlement in case of price increment.

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APPENDIX A CALCULATIONS FOR THE FIRST 6 YEARS OF THE PROJECT

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6
Annual Production	547500	547500	547500	700000	700000	700000
OPEX	6570000	6570000	6570000	8400000	8400000	8400000
Revenue	54750000	54750000	54750000	70000000	70000000	70000000
Royalty	8212500	8212500	8212500	10500000	10500000	10500000
Cost Ceiling	27375000	27375000	27375000	35000000	35000000	35000000
Cost Incurred	66570000	6570000	6570000	8400000	8400000	8400000
Cost Bank	66570000	45765000	24960000	8400000	8400000	8400000
Cost Recovered	27375000	27375000	24960000	8400000	8400000	8400000
Unrecovered Cost	39195000	18390000	0	0	0	0
Project Profit	19162500	19162500	21577500	51100000	51100000	51100000
Contractor Profit	7665000	7665000	8631000	20440000	20440000	20440000
Government Profit	11497500	11497500	12946500	30660000	30660000	30660000
Contractor Entitlement	35040000	35040000	33591000	28840000	28840000	28840000
Income Before Tax	28470000	28470000	27021000	20440000	20440000	20440000
Capital Allowance	6000000	5400000	4860000	4374000	3936600	3542940
Taxable Income	22470000	23070000	22161000	16066000	16503400	16897060
Tax Paid	13650525	14015025	13462808	9760095	10025816	10264964
Income After Tax	14819475	14454975	13558193	10679905	10414185	10175036
Cash Out	80220525	20585025	20032808	18160095	18425816	18664964
Net Cash Flow after Tax	-45180525	14454975	13558193	10679905	10414185	10175036
Contractor NPV	-38288580.5	10381337.98	8251934.533	5508576.187	4552136.02	3769154.26
Government NPV	32388859.22	31789070.6	31683858.37	45241844.89	44153334.09	43067597.71

APPENDIX B CALCULATIONS FOR THE LAST 6 YEARS OF THE PROJECT

	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12
Annual Production	700000	400000	200000	200000	100000	100000
OPEX	8400000	4800000	2400000	2400000	1200000	1200000
Revenue	70000000	40000000	20000000	20000000	10000000	10000000
Royalty	10500000	6000000	3000000	3000000	1500000	1500000
Cost Ceiling	35000000	20000000	10000000	10000000	5000000	5000000
Cost Incurred	8400000	4800000	2400000	2400000	1200000	1200000
Cost Bank	8400000	4800000	2400000	2400000	1200000	1200000
Cost Recovered	8400000	4800000	2400000	2400000	1200000	1200000
Unrecovered Cost	0	0	0	0	0	0
Project Profit	51100000	29200000	14600000	14600000	7300000	7300000
Contractor Profit	20440000	11680000	5840000	5840000	2920000	2920000
Government Profit	30660000	17520000	8760000	8760000	4380000	4380000
Contractor Entitlement	28840000	16480000	8240000	8240000	4120000	4120000
Income Before Tax	20440000	11680000	5840000	5840000	2920000	2920000
Capital Allowance	3188646	2869781.4	2582803.3	2324522.9	2092070.6	1882863.6
Taxable Income	17251354	8810219	3257197	3515477	827929.4	1037136
Tax Paid	13801083	7048175	2605757	2812382	662343.5	829709.1
Income After Tax	6638917	4631825	3234243	3027618	2257657	2090291
Cash Out	22201083	11848175	5005757	5212382	1862343	2029709
Net Cash Flow after Tax	6638916.8	4631825.1	3234242.6	3027618.3	2257656.5	2090290.9
Contractor NPV	2084122.177	1232242.25	729179.6309	578470.2855	365557.5746	286828.7195
Government NPV	44688390.2	24130799.53	11010156.84	10843220.51	4726328.134	4706054.992