FISCAL SYSTEM DESIGN AND ECONOMIC EVALUATION FOR PETROLEUM RESOURCE DEVELOPMENT IN GHANA

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ABSTRACT

Petroleum fiscal regime defines the extent to which the host government and the prospective investor can apportion risks and share project rewards.

Ghana's petroleum industry has become an attractive place for most investors because the current fiscal regime governing the industry is based on old petroleum tax laws and systems. In this study the petroleum fiscal regime currently used in Ghana was modelled, reviewed and evaluated. A proposed progressive fiscal regime was then put forward which has a sliding scale royalty tied to production to increased the government share (GTake). The models incorporated successfully monte carlo simulation using @risk software to account for risk and uncertainties in decision making.

This study addresses the petroleum industry structure and performance of the modelled fiscal regimes of Ghana. An optimum fiscal regime should be efficient, effective and equitable. The fiscal regime optimality were evaluated by testing the IRR which accounts for the efficiency, FLI which accounts for effectiveness and GTake which accounts for equity in order to achieve pareto optimality. Other range of profitability indicators were also tested in the economic evaluation and they are contractor's take (CTake), Net present value (NPV), Profitability index (PI), Present value ratio (PVR).

The deterministic result of the analysis shows that, the government take (GTake) increased when the proposed fiscal regime was put forward from 30.15% to 69.85%. The Internal rate of return (IRR) for the fixed royalty is 21% and the sliding scale royalty is 16%. Both values are positive which means there is value for every dollar invested. This study will help both investors and Government in decision making.

KEYWORDS: Petroleum fiscal regime, Sliding scale royalty, Government take, Monte carlo simulation, Internal rate of Return(IRR), Front-end loading index(FLI), Pareto optimality.

DEDICATION

This thesis is dedicated to the entire Ashikwei family, especially Lovelace, Yvette , Caleb and my dear lovely friend, Dr Florence Obeng-Ninso. Also to the one that sacrificed everything for me to become who I am now Mr Ebenezer Amarh Ashikwei and his wife, my mum Mrs Abigail Amarh Ashikwei

All glory to God.

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All the glory must be to the Lord, for he is worth of my praise. No man on earth should give glory to himself, all the glory must be to the Lord.

Dad and Mum, again I thank you for all the sacrifices you have done all through my academic pursuit. My story would not be complete without you.

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The story will not be complete if I don't mention the following; Isaac oyedepo, Abraham Ojeme, Manasseh Asiedu, kweku Spio and Mr Emmanuel Adjetey.

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CHAPTER ONE

Background

Oil is the world's number one strategic product. It is of important concern to developed and developing countries that rely more and more on imported oil and gas products. It is also of essence to exporting nations, many of them among the poorest countries in the world the Middle East aside. For countries with petroleum resources the contribution from the petroleum sector to the country's budget is often dramatically greater than the contribution to the country's gross national product (GNP).

For example if the petroleum sector were to represent say 10% of GNP it would likely represent from 30 to 40% of the country's budget. There are two reasons for this: first, relative to most other industries, petroleum is very profitable; second, the effective tax rate (Host Government Take) for the petroleum industry compared to other industries is usually about double or more (Johnston, n.d.).

Most Host government take revolves around 40% to 85% of the revenue made from petroleum resources. The word average GT is 64%, emphasising that Ireland has a very low GT of 25 % and Yemen has a very high one at 95% (Gaspar et al, 2012)

Fiscal terms are the most important terms of a natural resource contract as they delimit and define the amount of profit and economic rent that will accrue to each party throughout the life of the contract.

A country's fiscal regime is a very important determining factor for investors who would like to invest or channel their resource in a petroleum project because it defines the extent to which the host government and the prospective investor can apportion the risks and rewards of the project. A well-defined petroleum fiscal system may attract investors into a country whilst a non-lucrative petroleum fiscal system may turn away investors(Higgins, 2013)

The Gulf of Guinea (GOG) is an attractive place for investment in the oil and gas industry and Ghana is no exception. The Ghanaian petroleum fields since May 2006 has attracted investors like Tullow oil (Amoako-tuffour, 2011). Following seismic acquisition and interpretation, Tullow and its partners drilled two successful exploration wells in 2007 (Adongo, 2017)The wells discovered the major Jubilee oil field in the Gulf of Guinea's Tano Basin. The Jubilee Cretaceous turbidity reservoir straddled both licenses; Deep Water Tano and West Cape Three Points. In May 2013, the plan of development for TEN was approved by the government of Ghana and Tullow commenced its second major Operated deep water development (Adongo, 2017).

The main types of fiscal systems are concessionary fiscal regime (Royalty and Tax) and the contractual (Production sharing contract). Under the concessionary fiscal regime (Royalty and Tax) which high percentage of the hybrid type which Ghana uses, Government revenue or take can only be increased by the increase of income tax, royalties, bonuses etc. On the other hand, under a PSC regime, it can be done through taxation and oil split.

1.1 Ghana E & P structure

Both onshore and offshore petroleum exploration took place in 1896 by the West Africa oil and Fuel Company (WAOFCO). They continued with their exploration but intermittently between 1896 and 1967.Fortunately in 1970, the first discovery of oil took place off the coast of saltpond by a consitium led by signal/ Amoco and the field was developed and set into operation by a US company called Agripetco in 1978. In that same year when the field was developed in November, Phillips petroleum drilled the south Dixcove-1 in offshore Cape three points in 900 metres of water. This operation brought about the establishment of an Alban source rock and a Turonian reservoir (Adongo, 2017).

In 2004 the country sold licenses for offshore oil exploration and production, commonly known

as blocks to different international companies and in the year 2007, Kosmos Energy discovered oil in commercial quantities in the Western region of Ghana. Development of the production site started right away with Tullow Oil the Operator and in December 2010 oil production was officially launched.
The Jubilee Field is situated in Deep water Tano (DT) and West Cape Three Points (WCTP) blocks; approximately 60 km offshore Ghana and 130 km west southwest of the port city Takoradi which provides shorebase infrastructure. Water depth within the Jubilee Field Unit area ranges from 1,000 to 1,700 m. The field covers 110 km^2, which is about the size of 155 football pitches(Adongo, 2017)

The start of oil production was preceded by three and a half years of intense work by the consortium partners with a capital investment of over $4.1 billion. The Mahogany-1 well was discovered in June 2007 and the Hyedua-1 well was also discovered in August 2007. The two discoveries were found to be in the same oil pool and a decision was taken to unitise the field at initial 50% WCTP: 50% DWT. But first redetermination completed in December 2011 at a split 54.37% WCTP and 45.63% DWT(Adongo, 2017).

The original commercial partners on the Jubilee field were Tullow Oil plc (34.70%), Anadarko Petroleum Corporation (23.49%), Kosmos Energy (23.49%), the Ghana National Petroleum Corporation (13.75%), Sabre Oil and Gas (2.81%) and the E.O. Group (1.75%). However, Tullow Oil Plc in May 2011 acquired the shares of E.O. Group thereby increasing its stake to 36.5%(GNPC, 1984b).

The Jubilee Field started by producing an average of 24,395 barrels per day for the three final days of November 2010. The production levels increased up to an average level of 37,932 barrels per day in December, 2010. According to Tullow Oil projections Ghana was supposed to be producing approximately 120,000 barrels of oil per day by June 2011. Unfortunately, this production level was not achieved by the end of 2011 due to technical production challenges faced with the wells. Ultimately, 278 million barrels of oil are expected to be recovered over 20 years of the phase 1 development (GNPC, 1984a)

However, the recoverable reserves of the field are estimated to be more than 600 million barrels with an upside potential of 1.8 billion barrels. Future phases of development may extend this period significantly and will depend on the success and information obtained during phase 1. Under the Ghana National Petroleum Act, 1983, Ministry of Energy is charged with the responsibility to "promote the exploration and the orderly and planned development of the petroleum resources of the Republic." The Jubilee Phase 1 Development is intended to fulfil that obligation. The project will also support the country's Growth and Poverty Reduction Strategy 2006 to 2009 in the priority areas of infrastructure and private sector development (GNPC, 1984a).

Income from the project through oil sales, taxes and royalties will contribute to the Ghanaian economy directly, and has the potential to reduce the Ghana balance of payments with respect to energy import costs, and facilitate economic growth and development. There will also be economic benefits through direct employment opportunities and indirectly through training opportunities and the development of oil and gas industry support and related enterprises (GNPC, 1984a).

The Jubilee project intends to use any available gas for reservoir pressure maintenance and improved oil recovery. GNPC is considering a separate gas export project comprising a gas export pipeline from the Jubilee field to a new receiving facility at the shore. The project could accommodate 70 million standard cubic feet per day of gas when in steady-state operation. The design of the FPSO, however, will allow all the gas to be re-injected so that continuous flaring can be avoided in the event that the receiving terminal is unavailable to receive all the gas due to unplanned events or planned maintenance(GNPC, 1984b).

1.1.1 The Tweneboa-Enyenra-Ntomme (TEN) Field

This field is made up of three fields: Tweneboa, Enyenra and Ntomme fields located in the Deep Water Tano. An amount $4 billion was spent on the project. The Tweneboa field (6 km east of Jubilee) was discovered in March 2009. In July 2010 the Owo-1 drilling confirmed the reasonably big amounts of the field. A maximum depth of 4,000 m has been drilled. It does not seem to be an underwater channel connection between the Tweneboa and the Jubilee field. Current production is at 31,600 barrels per day and expected to peak at 76,000 barrels per day. Further exploratory works were ceased as a result of the Ghana Côte d'Ivoire dispute but drilling operations on the field is expected to resume after the International Tribunal for the Law of Sea (ITLOS) ruling in late 2017 (Commission, 2016).

Apart from these major findings, several other discoveries have been made in the Deep Tano/West Cape Three Points area since the commencement of oil export in late 2010. Earlier in 2010, Lukoil of Russia had announced an oil find in its Dzata field in the West Cape Three Points Blocks. On June 6, 2011, Kosmos Energy LLC announced a find in its Banda-1 well. This was followed the next day with an announcement by Hess Corporation of New York that it had discovered significant amounts of oil and gas resources much bigger than previous estimates (Adongo, 2017).

Anadarko Petroleum Corporation also announced in August 2011 that it had made a significant oil find in its Akasa-1 exploration well on the West Cape Three Points Block. Other oil finds in the same area in 2011 were made by ENi/Vitol and Tullow Oil PLC. In total, the companies engaged in the discovery have discovered more than 15 fields in the western Ghanaian sea territory. The exact positions of the wells have become of great interest, as in April 2010 the Government of Côte d'Ivoire enquired, if all drillings had taken place within the Ghanaian territory (Adongo, 2017).

Since then a Boundary Commission has been negotiating the exact maritime boundary. In particular the Owo-1 well in the Tweneboa field and the small Dana GH Western Tano field are located very close to the Côte d'Ivoire border. For these drillings precise locations have not been made public, but all the exact coordinates of the Jubilee wells have been published and it seems clear that they are within Ghanaian territory (Anon, 2010). Figure 1.1 shows some of the discovered fields in Ghana.

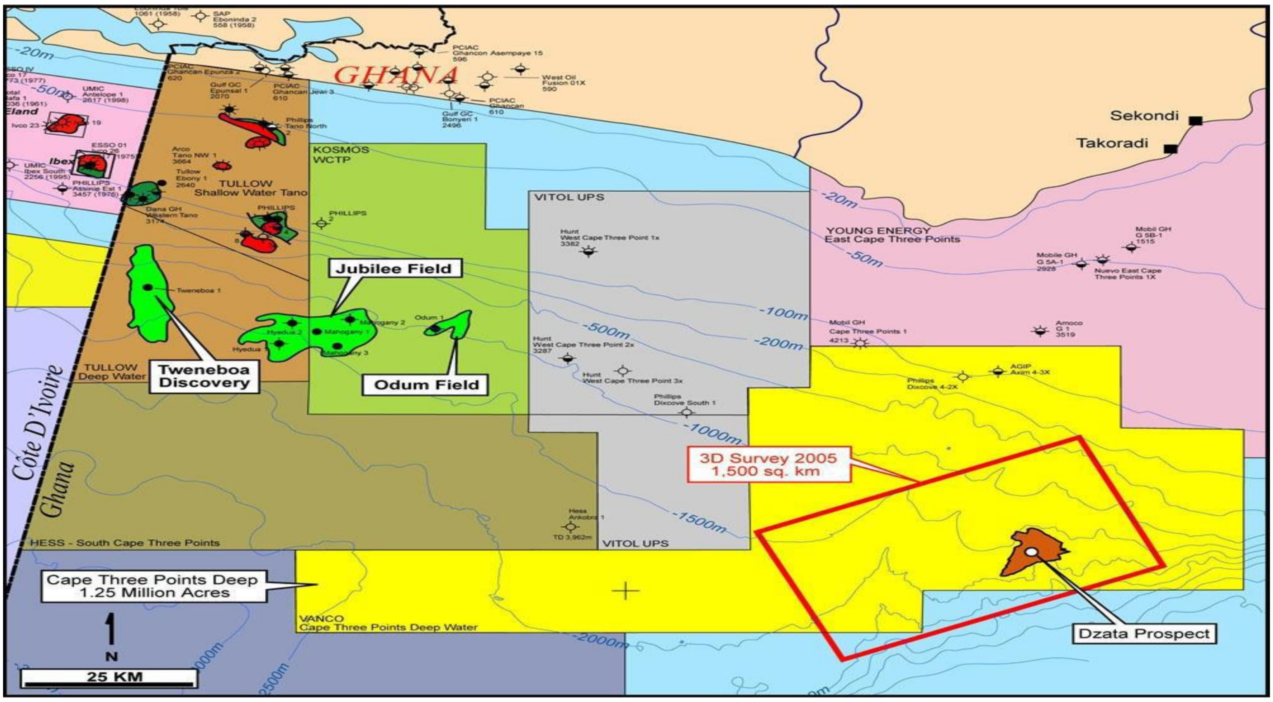


Figure 0.1 Jubilee Field

1.2 Problem Statement

Most of the current fiscal system designed which are being used now in Ghana are based on old petroleum tax laws and systems. These tax systems make the Government receive little revenue since the oil price is very volatile.

(Ghebremusse,2014) discovered that, out of the seven regimes used in the quantitative analysis, the Ghanaian regimes ranks sixth interms of government take. The Government take for the fiscal regime for Ghana is 39.96 %, that is below 40 %. They see it as very low that is they can't tell whether it's a deliberate act for the government to get more investors or they lack a good bargaining power on the side of the government.

1.3 Aim

Design a fiscal regime for petroleum resource development in Ghana in terms of efficiency, effectiveness and equity

1.4 Objective

- Design field development plan for the Jubilee oil field in Ghana.
- Review and evaluate the current fiscal regime used in the Oil and Gas industry in Ghana.
- Propose a new fiscal regime that will be efficient, effective and equitable inorder to achieve a pareto optimality.
- Estimate risk and uncertainty inherit in petroleum business decisions in Ghana

1.5 Research Questions

- What are the economic instrument that are used in the Ghana upstream petroleum fiscal system which makes the regime not optimal (Kankam, 2014)

- How will I make the new proposed fiscal system efficient, effective and equitable inorder to achieve pareto Optimality.

- What other additional insight can I provide to evaluate the profitability of an economic project and the risks involve.

CHAPTER TWO

(Kankam, 2014) Conducted a research on the topic, 'The Optimal Petroleum Fiscal Regime for Ghana (An Analysis of available Alternatives). He research on the Ghanaian regime is assessed based on the general principles of taxation and petroleum taxation in particular. The objective of this paper was to evaluate the Ghanaian upstream petroleum fiscal regime, including state and investors share, and to compare it with petroleum fiscal regimes of some six other oil producing Africa countries.

He discovered that, out of the seven regimes used in the quantitative analysis, the Ghanaian regimes ranks sixth interms of government take. The Government take for the fiscal regime for Ghana is 39.96 % that is below 40 %. They see it as very low that is they can't tell whether it's a deliberate act for the government to get more investors or they lack a good bargaining power on the side of the government.

He recommended that, they can try additional oil entitlement to profits the government because the current Ghanaian regime is not optimal.

(Ghebremusse, 2014) Research on the topic, 'Accessing the petroleum fiscal Regimes of Nigeria, Ghana and Cameroon'.

Oil production generates significant amounts of wealth for national governments in sub-sahara Africa. In the past thirty years, proven oil reserves in the region increased by 120% from 57 million barrels in 1980 to 124 billion in 2012.

He look at how balancing the interests of national governments against the need to attract foreign oil investment and incentivize companies to conduct petroleum related activities is key to the design of petroleum fiscal regimes.

His objective was to access whether the petroleum fiscal regimes in Nigeria, Ghana and Cameroon are tailored, country-specific policies will achieve a balance between generating tax revenue and attracting and incentivizing oil companies.

Also his paper utilizes an analytical framework consisting of four factors that should shape fiscal policy formulations.

He claims these four factors has been identified but no author brings them together to explain them.

The four factors are;

1. The extent of oil dependence
2. The stage of development of the oil industry
3. The government's financial position
4. State participation in the oil sector

He talked about fiscal instrument like royalties, resources, rent, taxes, auctions, corporate income taxes and contractual schemes.

Its unclear if stabilization clauses that could limit adjustments are included in the agreements. If so, the regime should be reformed to allow the state to increase rates and generates more revenue as the industry grows.

(M. Mian, 2010) Research on the topic, 'Designing efficient fiscal system'. He said, the ideal fiscal systems are designed in such a way that it is simple to apply and provide the contractor with a fair rate of return (ROP) on investment.

He provided information that can help design fiscal systems if it doesn't address the expected boundary conditions of the project under consideration.

That a poor fiscal system will either give more to the contractor at the expense of the host government or vice versa.

His paper points out one of the major outcomes that most analyst overlook during the designing of a fiscal system.

He concluded that, not the cumbersome of fiscal system that is necessary if the objectives of your design is not achieved.

(Chukwuemeka, 2011) conducted a research on the topic, Deepwater petroleum exploration and production in the gulf of guinea: comparative analysis of petroleum fiscal systems performance

Deepwater offshore exploration as much as it is a breakthrough in Petroleum exploration and production as it offers significant benefits over onshore production , which still poses challenges to the oil and gas industry.

Several studies have been done on the comparative competitiveness of petroleum fiscal systems (PFS) in the Gulf of Mexico, Brasil, Australia etc, but none has been done in the GOG. Therefore he desired to modelled an integrated PSF of the various fiscal regimes in GOG, to implement and purpose PFS in countries in the GOG and also analysed it as well as the uniqueness of each country.

He considered these objectives of reviewing the Petroleum exploration and production industry structure, conduct, performance of each country. Also review and describe available petroleum fiscal terms and instrument in the GOG.

The methodology he used to achieve the objectives are , he used generic data requirement usage for economic model which includes production data, technical cost data , fiscal system and oil price projection. Also, he used production profile in the study based on economic limit field development.

The results from the method was positive by designing and modelling various PFS for the countries at the GOG. This PFS gave various country's government higher petroleum revenue (Government take).

He conclusively. Designed automated economic model for deep water exploration and ventures using twenty (20) PFS from thirteen (13) countries to help for comparative study.

The economic model can estimate peak production rate, reserves, production period and decline factor based on the input parameters like STOIIP, percentage recovery, instantaneous production rate etc.

Stochastic simulation to account for uncertainties and risks was successfully incorporated in the model, which made it unique

He used a generic technical cost treatment to design his automated economic model to describe the deep waters for all the countries at the gulf of Guinea. But according to (M. Mian, 2010) every country has a unique fiscal system which is based on the objectives of that country. So every country has what that fiscal system wants to address and the benefit that every country wants to draw from it.

(Samanhyia & Samanhyia, 2016) conducted a research on the topic fiscal regime of ghana's oil and gas industry a precommercial production review.

A country's fiscal regime is very important deterministic for investors who would want to invest, because it defines the extent to which the host government and the prospective investor can share the risks and rewards of the project.

Ghana has adopted a fiscal system which mixes some elements of concession, production sharing agreement (PSA) and state participation many have described it as Hybrid system.

The amount of revenue Ghana receives largely from the upstream petroleum operation depends on effectiveness of the fiscal regime governing her oil and gas industry.

Now, there is no well define fiscal system for deep offshore jubilee field. Also the nature of investment packages coupled with weak laws and inadequate administrative capacity in the industry, makes Ghana currently earn relatively smaller share of petroleum revenue.

Hence, the objective of the journal is to do amend the current petroleum tax laws to safeguard revenue due the state from all petroleum operations in Ghana.

He made a study on Ghanaian oil field called the Jubilee field and termed it as the world's fastest well tracked development because it took three years and four months from discovery to production whereas the average in the world was 6 to 7 years.

Some of the tools that he considered are, the Petroleum income tax law of 1987(PNDC law 188), Internal revenue act, 2000 (Act 592), Value added tax, 1998 (Acts 546), the Customs Excise and preventive service (Management) law of 1993 (PNDCL 330).

There are two main types of fiscal systems, Royalty/ Tax system and Production sharing Contracts. Ghana Practices the Royalty/ Tax systems which makes the government gets little income since the laws are very old.

Conclusively, some amendments and adjustments were made on the laws to give the state alittle more than she was collecting to boost her economy.

(M. Mian, 2010), researched on the topic, "Designing efficient fiscal systems". Mian focused his paper on the design issues of the fiscal systems for the exploration and production of hydrocarbon. He discussed that an ideal fiscal system has it variable that affect the outcome of it.

He said that, fiscal agreement are mostly between the host government and 1. An international oil company (IOC), 2. International National oil companies (INOC) or a consortium of IOCs and INOCs. He iterated that, there are three main types of agreement

1. The concessionary system (Royalty and tax system)
2. Production sharing contracts/agreements (PSC or PSA)
3. Service contracts (Pure Service contracts and risk service contracts)

Design analysed and compared two fiscal systems showing how GT and contracts ROR varies with varying boundaries conditions (field size and product prices). For fiscal system A which is a slightly modified version of the Kazakhstan fiscal terms includes progressive royalty, economic rent tax (ERT), Corporate tax and excessive profit tax. Fiscal system B is an alternative of fiscal system A which includes, progressive royalty of royalty 5% if the ROR ≤ 5% and 20%, if the ROR > 12%. Corporate tax of 30%, if ROR ≤ 10%. Also excess profit tax (EPT) rate of 6% if the contractor's pre-EPT ROR ≤ 15%.

The analyst typically used undiscounted NCF to calculate GT. The GT increased as the reserve increases. This is very logical as the HG should recover a higher percentage of the incremental benefits when the project profitability increases.

The comparison was good but would have been better if he did sensitivity analysis on the various indicators so to help in the decision of various parties.

(O. Iledare, 2007) researched on the topic "Analyzing the impact of petroleum fiscal arrangements and contract terms on petroleum exploration and production economics and the Host Government Take". He analysed the effects of fiscal terms and system parameters on the performance profile of exploration and production ventures and the corresponding government take under different fiscal arrangements.

He said that in the past three decades, nearly 200 percent of produced reserves in Nigeria were replaced by new reserves and this compares favourably with the global reserves replacement rate of 183% over the same period. He again stated that for the E & P to grow and affect the economy of Nigeria positively, the manner in which an E & P activity is funded and petroleum fiscal regime are designed specified and negotiated are of great significance. That such has made oil the engine that has driven the Nigeria economy over the past 30 years contributing nearly 80% of government revenue and 90-95 % of its foreign exchange earnings helping grow the GDP.

In his paper, he incorporated the fiscal system and terms which drives the E & P ventures and operations into a discounted cash flow model for the production sharing and joint venture agreement. He used the model to investigate the effects of the selected fiscal system metrics on the E & P profile performance and the corresponding government takes under technical uncertainty conditions. He used product prices and reserves as the technical parameter to examine using the discounted cash-flow modelling framework.

Conclusively, he used the discounted cash flow model to investigate the effects of selected fiscal terms and their corresponding government take under the PSC or JVA.

His empirical results show that, the contractor would like the PSC arrangement to the JVA under the defined terms in base case scenarios.

He also observed that, some fiscal parameters in the cash flow model have asymmetric response and some do not. For example, prices lower than baseline oil prices, the responsiveness tends to be more inelastic than at high prices.

He didn’t perform any sensitivity analysis to back his decision of PSC being better than JVA.

Table 2-1 Summary of the relevant literatures to my studies

Paper Topic	Author	Comment/Gap	Relevance to my study	Major Conclusion
The Optimal Petroleum Fiscal Regime for Ghana	Kankam, D. (2014)		• Used Discounted Cash flow model • Host Government take is 39.96% when using undiscounted CF and 37.18 % when CF is discounted	• Quantitative analysis on Seven regimes , Ghana's regime is ranked Sixth in Gtake • Second in Investor PBP based on post-tax discounted cashflow
Designing Efficient fiscal system	Mian, M. A.		• Historically, Gtake is calculated from Undiscounted NCF, but recommended the use of Discounted CF • Viability of a Fiscal system is judged by two economic instrument and they are Gtake and Contrator's ROR	• Using undiscounted CF to calculate the Gtake, The Gtake increases as reserves increases. • Inorder to attain equity in a fiscal regime, it must have appropriate BC
Analyzing the Impact of Petroleum Fiscal	Iledare, O. O. (2004).		• For better evaluation of Gtake in any of the type of fiscal regime, the following	• Used discounted CF to investigate the effects of

Arrangements and Contractor Terms on Petroleum E&P Economics and the Host Government Take			profitability indicators are useful • Discounted net present value • Discounted Internal rate of return • Discounted return on investment	selected fiscal terms and their corresponding government take under the PSC or JVA.

Paper Topic	**Author**	**Comment/Gap**	**Relevance to my study**	**Major Conclusion**
Deepwater petroleum exploration and production in the gulf of guinea: comparative analysis of petroleum fiscal	Echendu,(2011)	Used generic cost treatment techniques for his model design for all the countries he designed the fiscal regime for	• Front – end loading index (FLI)which highlights the spread in the discounted and undiscounted takes • Used the @Risk tool to perform sensitivity analysis	• Stochastic simulation to account for uncertainties and risks was successfully incorporated in the model, which made it unique

systems performance			to measure the viability and Profitability of the project	• Designed automated economic model for deep water exploration and ventures using twenty (20) PFS from thirteen (13) countries to help for comparative study.
Samanhyia S. and Samanhyia F (2016),	Fiscal regime of ghana's oil and gas industry (a precommercial production review)	• Their analysis lacks any economic indication backing since there is no economic instrument to back their findings	• His analysis states that the current Ghana's fiscal regime is giving the state a little take	• The laws which regulates the upstream petroleum industry in Ghana were made over three decades ago which results in weak economic foundations for the fiscal system

2.1 Petroleum Fiscal system

Fiscal regime or fiscal systems includes all aspects of legislative, taxation, contractual and fiscal elements which describes the financial and contractual arrangements for the exploration and production of oil and gas (M. A. Mian, n.d.-b)

Petroleum fiscal systems purpose is to define how costs are recovered and the profits are shared between firms and the host governments (Chukwuemeka, 2011).

The mineral resource can belong to the state or individuals. In most countries in the Gulf of Guinea, an oil company (lessee) gets the mineral rights from the state government (lessor). The host government grants acreage position or enters into an agreement with a contractor. The host government is represented by either the minister of petroleum of that country or a national oil company. The main objectives of the mineral owner are sovereignty, economic growth and environment (quality of life).

Other minor objectives are the optimal exploitation and the use of mineral resources and satisfying domestic demand.

For host government to meet the above objectives, there may be these constraints.

I. Difficult to gain access to risk capital
II. May lack the required expertise

So because of these risks, the host government therefore engages a foreign oil company as a contractor to provide technical and financial resources for exploitation of the resources. There are two basic forms of fiscal arrangement. They are

a) Concessionary systems
b) Contractual systems.

Any of the form can be used to achieve the same purpose and they are used when the host government engages any foreign oil company. The most common provisions and regulations are as follows by Johnston D. (1994):

1. Type of permit, contract, or concession.

2. Size, shape, and geographic limits of area to be explored and developed.

3. Initial or primary term and extensions. If exploration efforts are successful, typical contract terms are for 20 to 30 years.

4. Fees and bonuses.

5. Relinquishment or surrender.

6. Selection and convertibility of acreage.

7. Assignment or transfer of acreage, lease, or concession

8. Royalty payments, sharing profits, and cost recovery

9. Tax obligations

10. Obligation to supply domestic markets first and building local refineries.

11. Employment and training of nationals

12. Equity participation by government and repatriation of capital by the contractor.

2.2 Types of Contract arrangement

There are basically two types of petroleum fiscal systems

1. Concessionary system, also called tax/royalty system
2. Contractual system

The concessionary system makes provision for private ownership of mineral resources, while in concessionary system, the state / government retains ownership of mineral resources (Marques, 2015).

The contractual systems are further reclassified into;

a) Production-sharing contracts (PSC)
b) Service contracts (pure service contracts, Risk service contracts)

The main difference is whether the fee is taken in cash (Service) or in kind (PSC). The PSC is also referred to production-sharing Agreement (PSA). The difference between pure and risk service contracts is primarily based on the fees either being flat (pure) or profit (Risk). Some countries offer concessionary arrangement as well as service or production-sharing contracts(M. A. Mian, n.d.-b)

Table 2-2 Summary of risk and reward in fiscal regimes ((M. Mian, 2010)

Contract Type	Contractor	Host Government
Concession	All risks/all reward	Reward is function of production and price
Production-Sharing Agreement	Exploration risk/Share in Reward	Share in reward
Joint Venture	Share in risk and reward	Share in risk and reward
Pure Service Contract	No risk	All risk

For production sharing contracts (PSC), the state contracts for the services of a contract (IOC) to explore for and when they are able to discover, they then exploit the hydrocarbon. It is the responsibility of the contractor to finance the petroleum operations. In accordance to the terms in the contracts, hydrocarbon production is shared between the host government and the contractor. The contractor will receive a share of production as reimbursement of its cost and as compensation in kind (Cost oil), the reminder of the oil (Profit oil) will be shared between state and contractor (Back et al, 2003).

2.3 Overview of Ghana's oil and gas fiscal Regime

Ghana's petroleum fiscal regime is a set of laws, regulations and agreements which regulates the petroleum operation in Ghana and also defines the economic benefits share between the host government and the contractor's from petroleum exploration and production (GNPC, 1983).

Ghana has therefore adopted a fiscal system which mixes some element of royalty and tax regimes, production sharing agreement and state participation. This has led the fiscal regime of Ghana to be described as "Hybrid". Almost all fiscal systems are a blend of others fiscal systems and Ghana's is no exception. Ghana's fiscal system has got a blend of concessionary and PSA(Kankam,2014).

The key laws that govern the Ghana's fiscal regime are :

- 1992 Constitution of the Republic of Ghana
- Petroleum exploration and production law, 1984
- Petroleum income tax law, 1987 (PNDCL 188), (Income tax Act, act 896)
- Petroleum commission Act (Act 821)
- The Ghana National Petroleum Corporation law, 1983 (PNDCL 64)
- Petroleum (Local content and local participation Regulations, 2013 L.I 2204)

Other taxes and fees are surface Rentals, Withholding tax, annual training fees, technology allowance.

- Royalty
- Government participation (Initial interest, additional interest)
- Petroleum income tax
- Additional oil entitlement (AOE)

For Royalty, the gross production percentage of hydrocarbon is gives as oil production- ranges from 4% - 12.5% of gross production and gas production, ranges from 3% - 10% of gross volume(GNPC, 1984a)

The petroleum income tax law (PITL) sets default rate at 50% unless a petroleum agreement makes another alternative. Other taxes and fees includes surface rental fees and withholding tax on subcontractors

- Annual training fees and one-time technology allowance

An additional payment is to be given to the government if the so the AOE becomes more progressive overtime. So Ghana’s fiscal Regime system arithmetically gives a government take of 56% and contractor 44%(Commission, 2016)

CHAPTER THREE

All economic evaluation activities consider the future because their activities today will affect the future. The evaluation engineer must predict the return from investments in wells, plants, etc (Chukwuemeka, 2011). Before a petroleum project evaluation engineer will achieve a successful prediction or forecast, he must know annual production, future operating costs and prices, taxes, inflation rate, participation factors, risk factors and future investments required to keep the project alive.

The methodologies required for petroleum project evaluation to determine its profitability will be discussed in this chapter. This entails description of fiscal system applicable to improve the government take for offshore jubilee field of Ghana, fiscal system for onshore Ghana, sensitivity analysis for various economic indicators will be incorporated. An economic model will be built using excel spreadsheet after the pattern presented by (M. A. Mian, n.d.-b) and (iledare,2019)

In performing a comparative analysis of the existing fiscal system used in Ghana's exploration and production industry, the newly proposed modelled that will be built to improve the government take which will contain all the economic indicators in the existing except some economic indicators will be added to the proposed one to improve on the government take.

In the proposed fiscal system, front-end loaded government take will consist of non-technical cost treatment of royalties, bonuses, rentals and crypto taxes. Also cost recovery economics will be modelled in the proposed fiscal system with cost recovery limit (CRL) specifications applied before calculating the share for the government take before CITA. The Government take and the contractors take would be established.

Simulation analysis which accounts for uncertainty and risk in the deterministic results is performed and the probability of success of the venture to changes in production rate, reserves and oil price using @Risk is also modelled. The objective functions is to analyse the economic instruments which are the Net present value (NPV) of the government take (G-Take) and the Internal Rate of Returns (IRR) using an assumed hurdle rate (discount rate) of 12 %.

3.1 Production Profile

The petroleum production development used in this study is based on three methods namely:

1. Field development plan with linear build up;
2. Field development plan with non-linear build up phase; and
3. Economic limit field development plan.

They all have a connection between reserves and initial production. The plateau of the profile for the oil field development plans is a fraction of the reserves and optimum production capacity with economic limit. Production capacity is determined by the number of wells, equipment and facilities. Initial production rates affect the rate of production decline as well as the ultimate recovery (Chukwuemeka, 2011)

For the purpose of analysis in this research, field development plan with linear build-up and the conservative exponential (constant percentage) decline curve analysis was used for production forecasting, with the underlying premise that past factors affecting production in the past remain the same as depicted in figure 3.1.

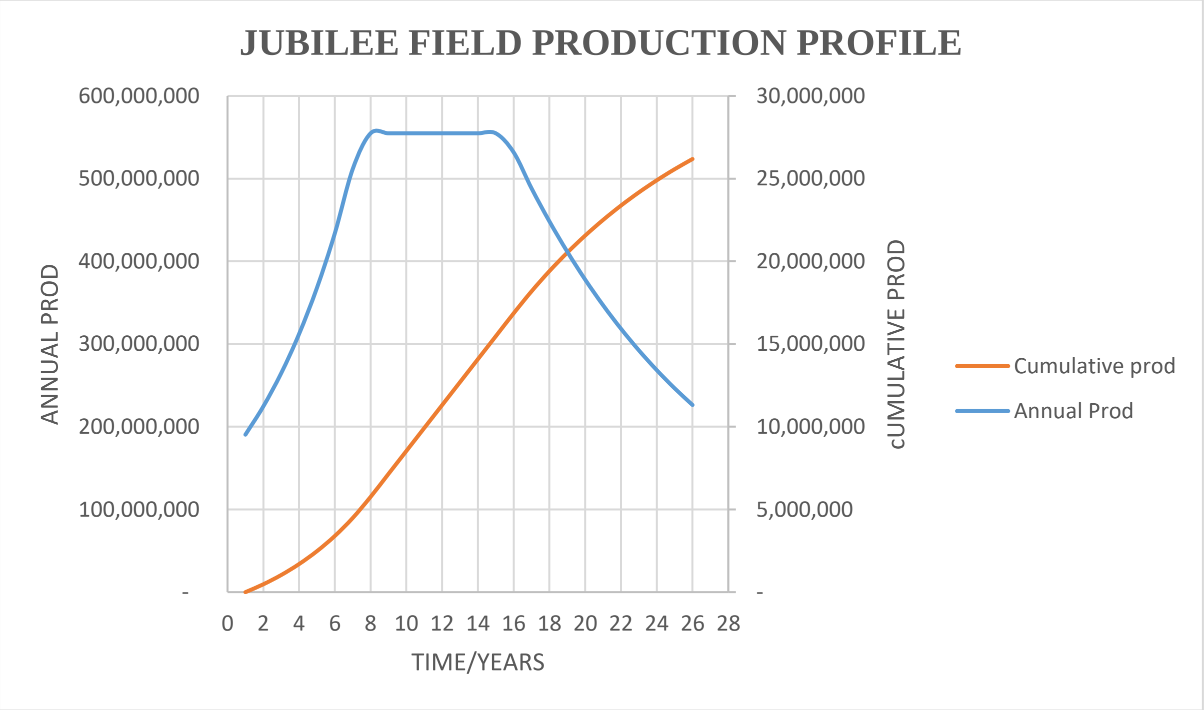


Figure 3.1 Jubilee field production profile

3.1.1 Field Development Plan

Typical reservoir production phases in any field development plan include;

- Development build-up phase;
- Plateau phase; when production stays constant until nearly half of oil production has been produced. The period of stay depends on ultimate reserves
- Decline phase; which continues until production cost can no longer be covered. The

producing lives depend on reservoir characteristics.

The essence of the development plan is to have good production capacity. The production capacity which is a measure of the justifiable flow of petroleum as a result of discovery venture, and infrastructure installed would have to generate enough revenue to reimburse for the expenditures and be economical (Chukwuemeka, 2011)

3.1.1.1 Development Build-Up Phase

This is the initial phase in every new field development plan. In this phase new wells were drilled, completed and production facilities mounted. The well does not flow at its full potential at this early stage but gradually builds up to full potential. The process of build-up is a function of the initial production rate, peak/plateau production rate, build-up period and build-up rate (Chukwuemeka, 2011).

Exponential build-up rate

$$q_b = q_i e^{-at}$$ *Equation 1*

$$a = -\frac{In(\frac{q_d}{q_p})}{t}$$ *Equation 2*

3.1.1.2 Development Plateau Phase

This is the next phase after the build-up phase. Plateau phase is characterized with constant reservoir pressure. At this phase the field is producing at its full potential and it is expected that all the facilities have been installed and most, if not all, wells drilled. Production workers tend to preserve this phase for as long as technical and economic feasibility permits. The plateau period is the period in which annual production is greatest and if price is favourable, much revenue is made to recover majority of the expenditures.

Annual production,

$$N_a = 365 * q_p \qquad \text{Equation 3}$$

Cumulative production

$$N_p = \sum_{t=1}^{tp} N_{a,t} \qquad \text{Equation 4}$$

3.1.1.3 DEVELOPMENT DECLINE PHASE

Decline phase is the latter stage of every field development plan that leads to relinquishment. It is the stage of development where reservoir pressure declines and may no longer support depletion, requiring external support such as artificial lift and various pressure maintenance techniques. The time to end production (abandonment) is determined by the economic limit of the project. Usually, this is when revenue generated no longer compensates for expenses and profit is not made. Technical, political, and social factors may also lead to abandonment.

In modeling the decline phase in this study, (Chukwuemeka, 2011) equations were used for the three different production development plan presented. The equations are as presented below;

Exponential decline phase

$$q_d = q_p e^{-at} \qquad \text{Equation 5}$$

$$N_p = \frac{q_p(1-e^{-at})}{a}$$ Equation 6

$$a = -\frac{ln(1-d)}{t}$$ Equation 7

3.2 Cash flow Models

Cash flow (CF) model is a model which defines flow of cash of an investment over a specific period of time. CF shows (Adeogun and Iledare 2018)

1. Cash receipts at the end of each year generated by the investment.
2. Cash disbursements of all costs (initially and subsequent costs) per year required for the operations
3. Total time span of the investments in year.

Cash flow diagram shows that a capital investment is an amount paid to receive expected Net cash inflows over the economic life of the investment (Mian, 2002). For economic analysis, the cash flow model is preferred to other models like financial profit model and tax profit model. This is because, it provides net cash flow and it places the timing of funds to and fro of projects more accurately.

Net cashflow is simply revenue (Cash received) less expenditure (cash spent) during a period usually one year and the projected over the economic life of the project (Chukwuemeka, 2011) Mathematically,

$$Net\ cashflow\ (NCF) = Receipts - Disbursement.$$ Equation 8

Cash disbursements are subtracted from the cash receipts that will generated either net negative or positive cash flow. The economic model developed in this study for Ghana's proposed PFS, considers the following cash flow items and treated them commonly as highlighted below.

1. Gross Revenue: This is the production stream (annual) multiplied by the projected price of the barrel production.

   GR= Price of the crude oil multiplied by marketed volume of hydrocarbon.

   Net revenue is share of marketed production multiplied by the net price.

2. Royalty is a part (fraction) of gross profit. It is a paying of homage to the mineral owners.

   In the model built for this thesis, both the fixed royalty and the progressive (Sliding royalty) was used.

$$Royalty = Royalty\,rate * GR \qquad \text{Equation 9}$$

3. State and Local taxes: These are taxes other than income taxes levied on petroleum production. They are paid either profits are made or not. These taxes includes social welfare fund, education taxes, etc.

4. Technical cost: They are CAPEX and OPEX.

   a. Capital expenditure (CAPEX): It is also referred to as front end costs. They are normally classified as investments – monies paid for benefits generating assets for more than a yrear. We have either tangible or intangible cost of CAPEX. Examples are surface equipment costs, drilling and well development cost, etc. The difference between tangible and intangible costs is :

- Tangible costs are capitalised and depreciated for after tax calculation purposes
- Intangible costs were expensed through amortization for tax calculation purposes.

b. Operation Expenses (OPEX): Its also called Lease Operating Expenditure (LOE). These are direct costs which comes with production and injection. Examples are well repairs and workover costs etc.

5 Income taxes: They are just fraction of taxable income on annual life basis. Every country has the way of dealing with it due to small business allowance, investment tax credits etc. Taxable income is net revenue less fiscally permitted cost deduction. These deductions include OPEX, royalty, depreciation, depletion allowance, expensed investments, payment of government.

$$Taxable\ income\ =\ Revenues - Royalty - fiscal\ costs. \quad \text{Equation 10}$$

Annual cash flow for E&P venture, Net cash flow can be modelled in this form.

$$NCF\ Gross\ Revenue - Royalty - Net\ taxes - Operating\ expenses - overheads - capital\ investments - Bonuses - Rentals + Property\ sales\ price. \quad \text{Equation 11}$$

3.2.1 Front Loaded Government Take Cash Flow

The importance of FLGT is to estimate equitably how costs are recovered and profits are shared among firms, the host government, IOCs and mineral owners (Iledare, 2007). The host Government normally tries to get as much economic rents as possible by getting royalties, bonuses, surface rentals, crypto taxes and taxes.

Front loaded government take is made up of economic rents which are extracted through taxes and crypto taxes, bonuses and royalties. Crypto taxes are indirect means through which the host government receives revenue through levies, importantly of duties and other financial obligations (Chukwuemeka, 2011)

At the time of transfer of rights, royalties and bonuses are some forms of extractions that occur in which are not based on profit.

Bonuses are made up of signature bonuses, production bonuses and discovery bonuses and discovered bonuses. When a lease is acquired, there is a lump sum of single payment which is done and it called Signature bonus. It can be determined by the legislation of the country through negotiation or bidding. During the discovery of hydrocarbon period, the bonuses paid are called discovery bonuses whilst during production, we pay production bonus. Normally, production bonuses can be tied to production of hydrocarbon. This usually explains a form of bonus called the jumping.

Table 3-1: Example of production bonus payment specification

	Negotiable		
Production Bonus	**Cum. Prod. Level (Mbbl)**	**Bonus (Mbbl)**	
	1000	200	Or Cash
	220000	1000	Or Cash
	500000	1000	Or Cash

My model will have Gross revenue that will form the base for royalty payment.

$$ROYt = R(\phi)\,(GRt - ALLOWt) \qquad \text{Equation 12}$$

The total allowance cost is donated by ALLOWt and the royalty rate R(ϕ) which normally depends on the location and the time the concession was leased and some incentive schemes, if there is. The Royalty rate R(ϕ), $0 \leq R(\phi) \leq 1$, may be in a form of fixed or sliding scale. There are three common types of royalties which are used in fiscal systems.

1. Fixed percentage royalty
2. Fixed payment royalty
3. Sliding scales royalty (Jumping scale and Incremental scale)

3.2.1.1 Before and After income tax cash flow

Consider economic evaluation without taking into account the effects of tax is misleading. The interest that you will pay on debt, depreciation, depletion and amortization expenses does affect the value and timing of the taxable income and also the tax payment which makes up the actual cash flow(Iledare, 2006)

In my model, the after tax cash flow was deployed. An assumed tax rate of 35% was used in the model.

3.2.1.2 Royalty/Tax Economic model and its components

Generally, the cash flow for Royalty and tax systems was governed by equation 3.4.4 as presented by (O. Iledare, 2007).

$$NCFt = GRt - ROYt - CAPEXt - OPEXt - BONUSt - TAXt - OTHERt \quad \text{Equation 13}$$

NCFt = After tax net cash flow in year t

ROYt= Total royalties paid in year t

CAPEXt = Total Capital expenditure in year t

OPEXt = Total Operation expenditure in year t

TAXt = Total tax paid in years t

GRt = Gross Revenue in years t

BONUSt = Bonuses Paid

OTHERt Other cost paid in years

$$Host\ GTake\ before\ tax = Deductible\ payment\ to\ Government + bonus \quad \text{Equation 14}$$

$$Contractor\ take\ before\ tax = GR - TCA - Host\ GTake\ before\ tax \quad \text{Equation 15}$$

After tax (ATAX)Model: Tax rate= 35%

$$TCA = Expensed + Depreciation\ costs \quad \text{Equation 16}$$

Expensed costs= Total OPEX

$$Taxable\ Income\ (TI) = GR - TCA - Gtake\ (without\ bonuses) \quad \text{Equation 17}$$

$$Tax = TI * Tax\ rate \quad \text{Equation 18}$$

$$Host\ Gtake\ after\ tax = Host\ GTake\ (before\ tax) + Taxes + Bonuses \quad \text{Equation 19}$$

$$Contractor\ Take = GR - TCA - Host\ GTake\ after\ tax$$
Equation 20

3.2.2 E$\mathcal{E}$ P Economics and System Measures

In this study, for capital budgeting and investors decision making, some economic instruments are used which will help in the deterministic decision analysis and also in stochastic analysis.

These are the following profitability measurements that are used in this study.

- Internal Rate of Return (IRR)
- Governmnet take (Gtake)/Contractor's take (CTake)
- Net Present Value (NPV)
- Profitability index (PI)
- Present value Ratio (PVR)
- Discounted Net Cash Flow
- Front Loading Index (FLI)

Discounted Take Statistics: The sharing of Net cash flow (which basis is determined by the fiscal regime) between the mineral owner (Host government) and the contractor are called host government take and contractor take respectively. It most at times varies as a function of time over the life of the field and the manner in which the host government and contractor value money. In this study, the host government and the contractor take are computed on a cumulative discounted basis in a year and also on a undiscounted basis.

$PV_x\,(\tau^c) = \frac{PV_x\,(CT)}{PV_x\,(CT)+PV_x\,(GT)}$ *Equation 21*

$PV_x\,(\tau^g) = \frac{PV_x\,(GT)}{PV_x\,(CT)+PV_x\,(GT)}$ *Equation 22*

Where,

$PV_x\,(CT) = \sum_{t=1}^{x} \frac{CT}{(1+D^c)^{t-1}} = present\ value\ of\ contractor\ take\ through\ year\ x$ *Equation 23*

$PV_x\,(GT) = \sum_{t=1}^{x} \frac{GT}{(1+D^c)^{t-1}} = present\ value\ of\ contractor\ take\ through\ year\ x$ *Equation 24*

$D^c = dicount\ factor\ for\ cotractor$

$D^g = discount\ factor\ for\ government$

Net Present value (NPV): NPV at the beginning of the year t, of the cash flow model is computed as ;

$NPV(f,F) = \sum_{t=1}^{k} \frac{NCF_t}{(1+D)^t}$ *Equation 25*

The present value or worth of a future dollar is the dollar that when invested today at a particular interest rate to yield that dollar at that time in the future. Its normally the value of a project’s annual net cash flows over the life time of the project , assuming end of year cash receipts.

Intern al rate of Return (IRR):

$IRR(f,F) = \{D|PV(f,F) = 0\}$ *Equation 26*

IRR is defined as the discount rate at which the NPV of an entire cash receipts and disbursement reduces to zero.

$NPV = \sum_{t=1}^{k} \frac{NCF_t}{(1+IRR)^t} = 0$ *Equation 27*

Profitability Index (PI): A PI or investment efficiency ratio normalises the value of the project.

$PI(f,F) = 1 + \frac{PV(f,F)}{PV(TC)}$ *Equation 28*

Front-End loading index (FLI). Its generally highlights the spread in the discounted and undiscounted takes. FLI=0 signifies an ideal conditions in which there is no front-end loading at all. When FLI becomes higher, it means the fiscal regime is more front-end loading which more or less becomes less attractive to the investors.

CHAPTER FOUR

4.1 Estimated Deterministic Results

The deterministic results for the economic model built in chapter three is presented in this chapter. Understanding the bias among petroleum economists in subscribing to the same methodology and /or terminology in modern analysis of fiscal systems (Johnston, n.d.) this study examines and evaluate the fiscal regime of Ghana using the following decision instruments.

- Internal Rate of Return (IRR)
- Government take (Gtake)/Contractor's take (CTake)
- Net Present Value (NPV)
- Profitability index (PI)
- Present value Ratio (PVR)
- Discounted Net Cash Flow
- Front Loading Index (FLI)

The above economic instrument will help evaluate the current fiscal system that Ghana oil and gas industry is using and also evaluate the proposed fiscal regime to make it efficient, effective and equitable. This will help the IOCs to make decisions.

4.2 Model Assumption

1. Oil price of $80/bbl was used for the model
2. An assumed discount rate of 12 % is used for the discounting purposes
3. A royalty rate of 5% was used for the fixed royalty model
4. For a progressive fiscal regime, a sliding royalty was used and the royalty was tied to production. This are the assumed royalties.

5. For the field development of the jubilee field data, an initial daily production of 24 MBPD was used.
6. A tax levy of 35% was used
7. An assumed rate of 5% of the development capex was used for the fixed opex.

Table 4-1 Royalty rate tied to annual production

Sliding Scale Royalty Annual Prod (MMB/Y)	Royalty Rate
30	0.05
60	0.075
90	0.1
100	0.125
120	0.15

4.3 Field Development input

For the field development plan for the jubilee field using exponential decline, the input variables are summarized in table 4.2. Together with the assumptions made in the input variable as seen in table 4.1, the estimated reserves is 538 MMBBL. The estimated build-up rate 76MBOPD.

Table 4-2 Jubilee field development input data

Time to plateau	7 years
Discount factor	12 %
Oil price	$ 80/BBL
Plateau rate	76 MBOPD
Build-up initial rate	24 MBOPD

Table 4-3 Jubilee field development calculated values

Reserves	538 MMBBL
Maximum Plateau Rate	76 MBOPD
Build-up production	116 MMBBL
Plateau production	222 MMBBL
Decline production	200 MMBBL
Decline factor	0.09 Years
Production life	26 Years

Initial daily production for the build-up was assumed to be 24 MBOPD. The build-up period is linear with an instantaneous rate of 24 MBOPD. The estimation for the plateau is to last for 8 years ending 15 years of production. As of this time, it is estimated that 115 MMBBL would be produced for the build-up phase which will take 7 years and the plateau phase of 8 years would have produced 222 MMBBLs. The decline phase is estimated to produce 200 MMBBLs after the cumulative production of both the build-up and the plateau phase production and its estimated to take 11 years with a decline rate of 0.09. The entire life that 538 MMBBLs will produce is 26 years.

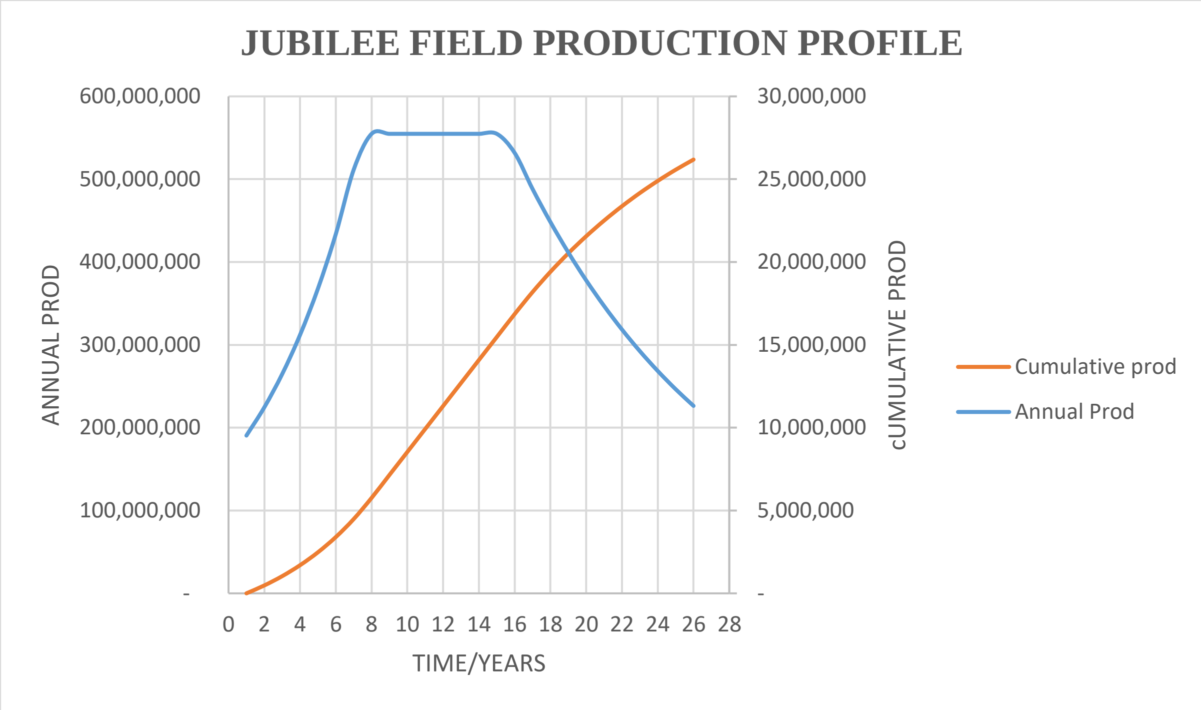


Figure 4.1 Jubilee field production profile

4.4 BASE CASE MODEL

To analyse the field- development plan profile of the jubilee field, the assumption made are displayed in the table 4.4 below. The production profile with a linear build-up was used for the comparison purpose of the analysis.

Table 4-4 Base case input data

Production period	26 years
Exploration period	3 years
Discount Rate	12 %
Reserves	538 MMBBLs
Peak production Rate	76 MBOPD
Oil Price	$ 80/BBL

4.5 GHANA'S FISCAL SYSTEM DECISION ANALYSIS GUIDE

To analyse the economic viability of the project, some common economic instrument which are normally used in the oil and gas industry are Net Present Value (NPV), Profitability index (PI), Present value Ratio (PVR) ,Discounted Net Cash Flow Front Loading Index (FLI), Payout period(DPO), Growth Rate of Return(GRR), Internal Rate of Return (IRR),Government take (Gtake)/Contractor's take (CTake) with some decision rules.

Table 4-5 Capital Decision Rules Budgeting (Iledare O. 2019)

Profitability Measure	Accept If @ r*	Reject If @ r*
NPV	>0	< 0
IRR	> r*	< r*
PI	>1	<1
PVR	>0	<0
FLI	~0	~1

In order of the comparative analysis between the current and the proposed one, the models in appendix A and B are grouped into fixed royalty and sliding royalty.

4.5.1 PERFORMANCE OF THE CURRENT FISCAL REGIME OF GHANA

Using the decision rules in table 4.5. For Government profitability after the project, the undiscounted net present value of the government is $MM 4.483.21. This value is greater than zero (NPV>0) which signifies that value will be added which such a fiscal regime, the undiscounted government take is 30.15% and discounted government take at a discount rate of 12% is 41.75% which makes the fiscal regime equitable. Also at a discount rate of 12%, the front-end loading index is 0.39. From table 4.3, for a project or a fiscal regime to be very effective, then the FLI should be between 0 and 1. Now, the fixed royalty fiscal regime is very effective and the favours the contractor more because it’s slightly above zero.

From table 4.7, which shows the profitability of the contractor. The NPV is $MM 3,976.02. The value is greater than zero which indicates value addition for the contractor if he ventures into the business.

The internal rate of return (IRR) of the regime is 21%. This value is greater than the assumed discount rate of 12%.This means that, the fiscal regime is efficient and profitable because the interest earn from the investment is high. To further test the profitability of the fiscal regime for investors, the profitability index (PI) was calculated. The PI is 2, which is greater than 1, which means more money is made from the investment. Also the present value ratio (PVR) was also calculated with its value 1, this value is greater than 0, which also testifies that the project is profitable.

From table 4.6 and 4.7, you can observe that the undiscounted contractor take is 69.85% and that of the government take is 30.15%. Also considering the discounted takes, the contractor take is 58.25% and that of the government is 41.74%.

For equity on the government shares on takes, I proposed a new fiscal regime that can improve on the government take. The new proposed fiscal regime is progressive with a sliding royalty.

Table 4-6 Results for Fixed Royalty Rate Model

PROFITABILITY INDEX FOR GOVERNMENT	
DISCOUNTED RATE	12%
UNDISCOUNTED GOV TAKE	30.15
NET PRESENT VALUE (NPV $MM)	$4,483.21
DISCOUNTED GOV TAKE	41.74
FLI	0.38

Table 4-7 Results for Fixed Royalty Rate Model

PROFITABILITY INDEX FOR CONTRACTOR	
DISCOUNTED RATE	12%
UNDISCOUNTED CON TAKE	69.85
UNDISCOUNTED NET PRESENT VALUE (NPV $MM)	$3,976.02
DISCOUNTED CONT TAKE	58.26
INTERNAL RATE OF RETURN (IRR)	21%
PVR	1
PI	2

4.5.2 PERFORMANCE OF THE PROPOSED FISCAL REGIME

From table 4.8, the NPV for the government is $MM 7,724.72 which is greater than 0. This indicates value addition on the government portion of the investment. Considering the government take for both discounted and undiscounted take. The undiscounted take is 45.49% which is higher than the fixed royalty regime which is 30.16%. Also the discounted government take for the proposed regime is 83.67% which is also higher than the fixed royalty which is 41.74%. So the equitability of the new proposed fiscal regime was achieved. Considering the effectiveness of the proposed regime, the FLI was calculated. The FLI is 0.84 which is greater than zero but less than one. 0<0.84<1. This values make the regime very effective. From the same table, considering the viability of the contractor's portion of the investment, the NPV of the contractor is $MM 1507.23 which is higher than zero meaning, value is added if the contractor invests in the project. The IRR which is the measure of how efficient the regime is, was calculated to be 16 %, which is greater than the assumed 12%. This means the investment is doing well and there is yield for every dollar invested under the fiscal regime. Although the IRR is the proposed one is less than the value in the fixed royalty, but both values are greater than the assumed value it signifies that both fiscal regimes are efficient.

The Profitability Index (PI) is 2, which is greater than 1, meaning profit is made out of the investment. The present value ratio is 1, which is greater than 0. This means value is added to the IOCs which will invest in the venture.

Table 4-8 Results for sliding scale royalty

PROFITABILITY INDEX FOR CONTRACTOR	
DISCOUNTED RATE	12%
UNDISCOUNTED CONT TAKE	54.51
UNDISCOUNTED NET PRESENT VALUE (NPV) $MM	$1,507.23
DISCOUNTED CONT TAKE	16.33
INTERNAL RATE OF RETURN (IRR)	16%
PVR	1
PI	2

Table 4-9 Results for sliding scale royalty

PROFITABILITY INDEX FOR GOVERNMENT	
DISCOUNTED RATE	12%
UNDISCOUNTED HGOV TAKE	45.49
NET PRESENT VALUE (NPV) $MM	$ 7,724.72
DISCOUNTED HGOV TAKE	83.67
FRONT-END LOAD INDEX(FLI)	0.84

CHAPTER FIVE

5.1 MODEL SIMULATION AND ANALYSIS

5.1.1 STOCHASTIC SIMULATIONS

The important issue of high level risk and uncertainty associated with a high capital industry which could make success rate to be relatively low is analysed with the stochastic simulation (Chukwuemeka, 2011)

In this chapter, the simulation analysis will help the IOCs to understand the fiscal regime for the petroleum resources in Ghana and how their investment returns would be.

In the stochastic analysis for this economic model, @Risk was used.

@Risk is a revolutionary software system for the analysis of business and technical situation with risk exposure (M. A. Mian, n.d.-a) It uses monte carlo simulation in its risk analysis to define uncertainties values.

Ten thousand iteration in a single simulation were performed on four (4) basic input variables and applied to ten (10) profitability indicators. The distribution functions imposed ranges from triangular and lognormal. The basic inputs are discount rate, oil price, reserves and percentage of development capex.

Table 5-1 Input variables and Distribution

Input variables	Stochastic distribution	Min	Mean	Max
Reserves (MMBBLs)	Lognormal	535	538	541
Discount Rate (%)	Lognormal	10	12	15
% of development capex	Triangular	4	5	6
Oil price ($/BBL)	Triangular	50	80	120

Using the results from @Risk monte carlo simulation, analysis were conducted on the following with an objective function of 90% and 10% confidence levels. The output variables are are Net Present Value (NPV), Profitability index (PI),Present value Ratio (PVR), Discounted Net Cash Flow Front Loading Index (FLI), Internal Rate of Return (IRR),Government take (Gtake)/Contractor's take (CTake).

5.1.2 MONTE CARLO SIMULATION ANALYSIS OF FIXED ROYALTY MODEL

Figure 5.1 and figure 5.2 below shows the level of certainty of the undiscounted Government take. The probability signifies that, there is 5 % chance that the government take will be less than 29.34 % and there is 95 % chance that, the government take will be 31.17 %.

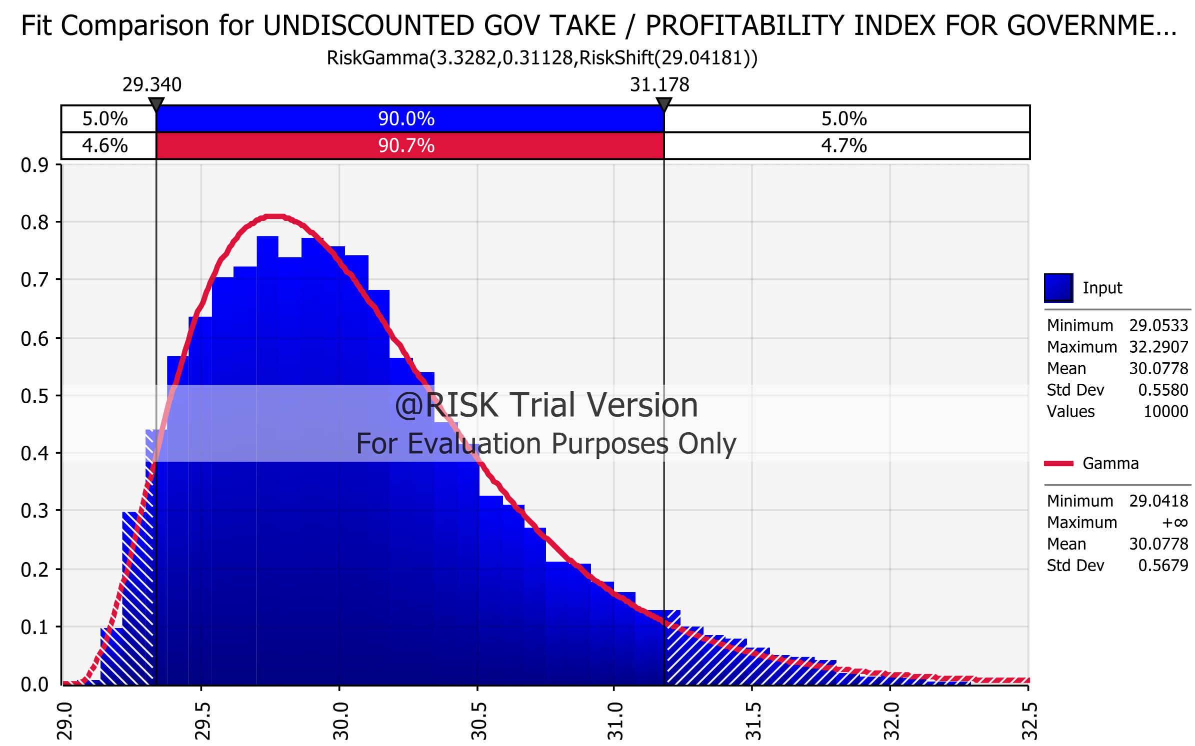
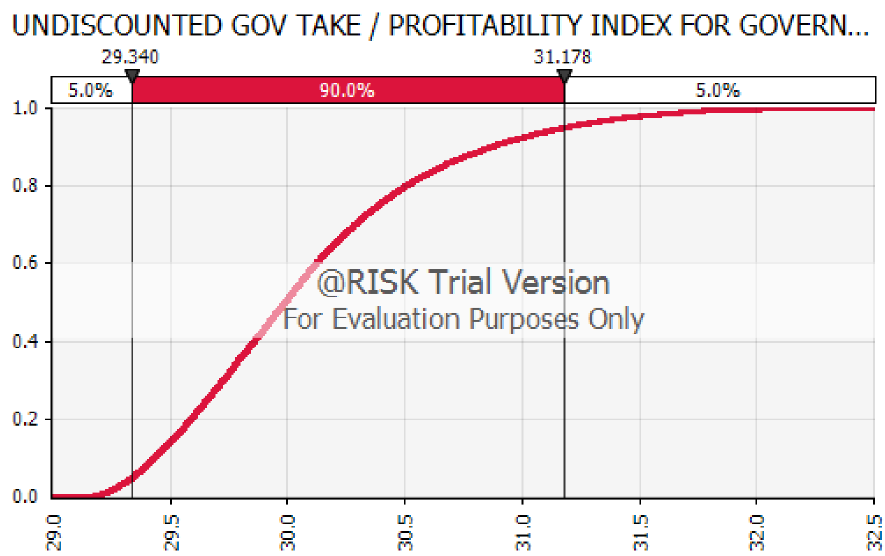


Figure 5.1 Undiscounted GTake



	UNDISCOUNTED GOV TAKE / PROFITABILITY INDEX FOR GOVERNMENT
Cell	Profitability ind & fix..
Minimum	29.0533
Maximum	32.2907
Mean	30.0778
90% CI	± 0.00918
Mode	29.7834
Median	29.9881
Std Dev	0.5580
Skewness	0.8569
Kurtosis	3.5069
Values	10000
Errors	0
Filtered	0

Figure 5.2 Undiscounted GTake

Figure 5.3 and figure 5.4 shows the simulation results on NPV for Government portion of the profit. At 90 % confidence level, both values are positive meaning value will be added to such a project. From fig 5.3, there is 5% chance that the NPV will be less than $MM 2,927 and there is 95 % chance that, it will be less than or equal to $MM 6002.

Fig 5.4 on the same NPV for the government shows the input variable that affects the NPV more. Oil reserves and oil price and 5% development capex is affecting it positively whilst discount rate is affecting it negatively. Meaning increasing the positive input parameters will increase the NPV for government take and the negative input parameters (Discount rate) will affect the NPV negatively if its increased.

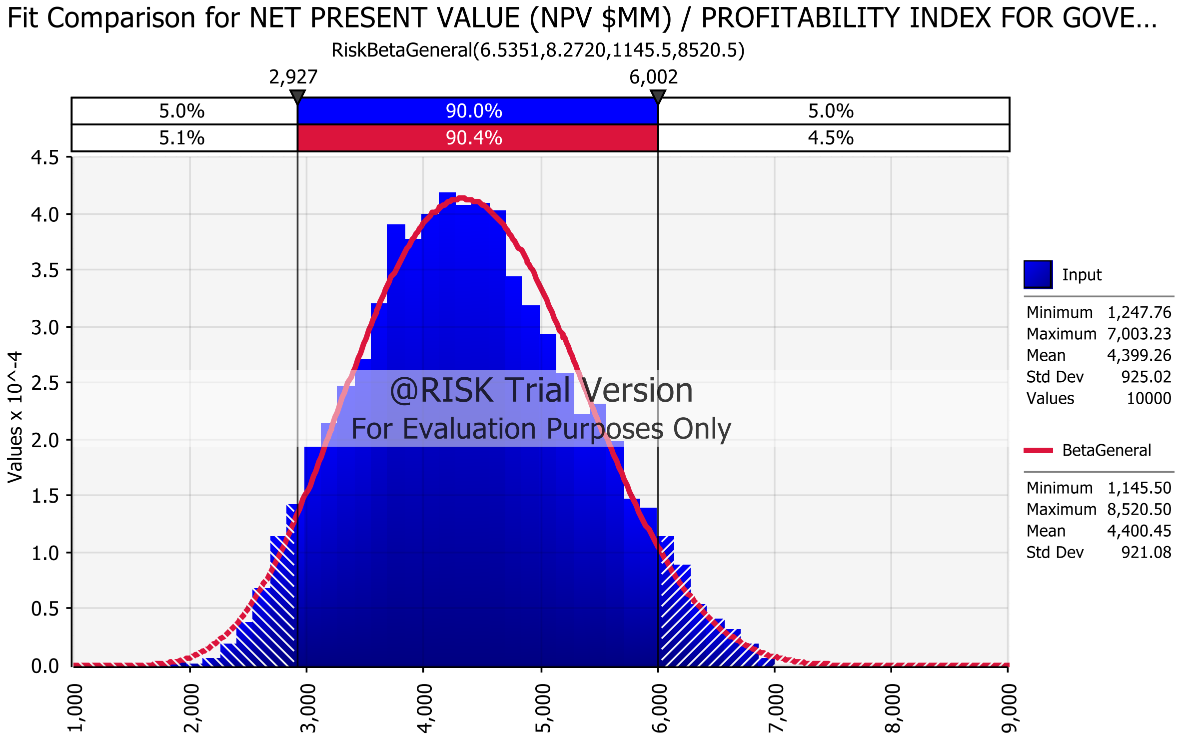


Figure 5.3 Net present value for fixed royalty for GTake

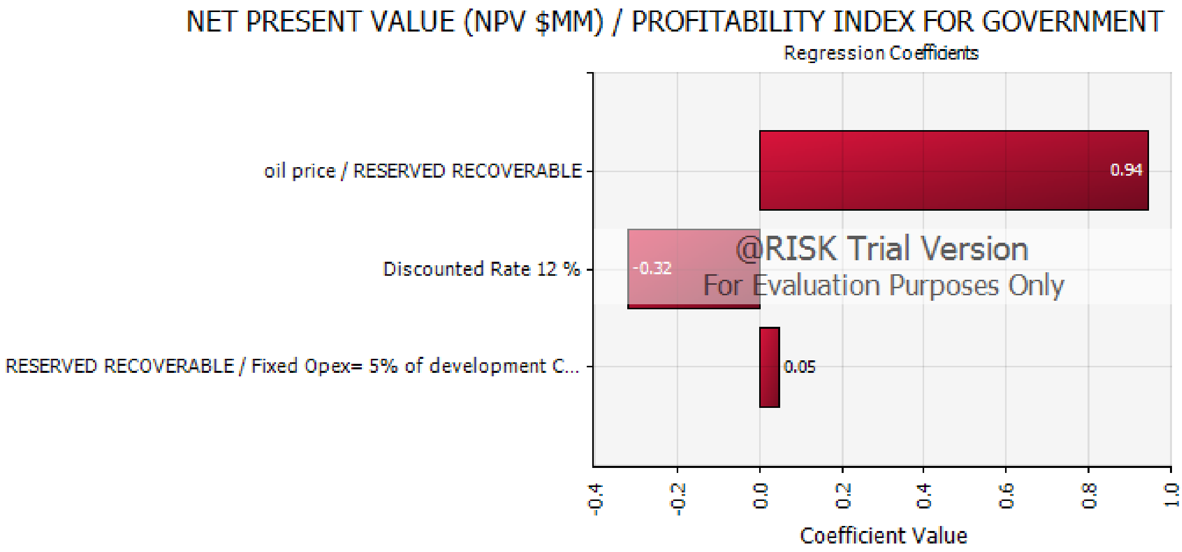


Figure 5.4 Stochastic Input variables that affects NPV output

Figure 5.5 shows the stochastic result of how the various input variables affect the front-end loading index of the fixed royalty model. The oil price and reserve recoverable are the variables affecting the FLI output much and they are affecting it negatively. This infers that, should incase the oil price and the reserves recoverable should increase, it will reduce the FLI and thereby favouring the contractor. On the other hand, discount rate is affecting it positively and should it be increased, it will increase the FLI.

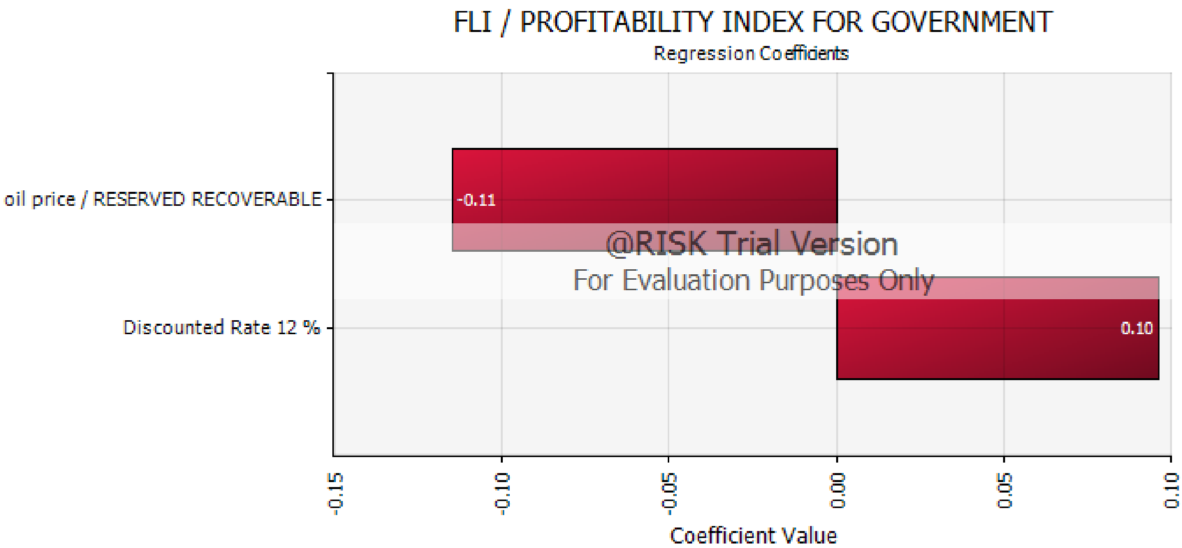


Figure 5.5 Stochastic Input variables that affects FLI output

Figure 5.6 and figure 5.7 shows the stochastic results for undiscounted contractor take and the input variables that affects it output respectively. At a confidence level of 5%, the contractor take will be less than 68.82%. Also at a 95 % confidence level, the contractor take will be less than or equal to 70.66%. From figure 5.7, which shows the input variable and their effects, you can observe that, oil price and reserve recoverable are positively affecting the contractor take. So increase in those input variables will increase it. The same for the 5% fixed opex.

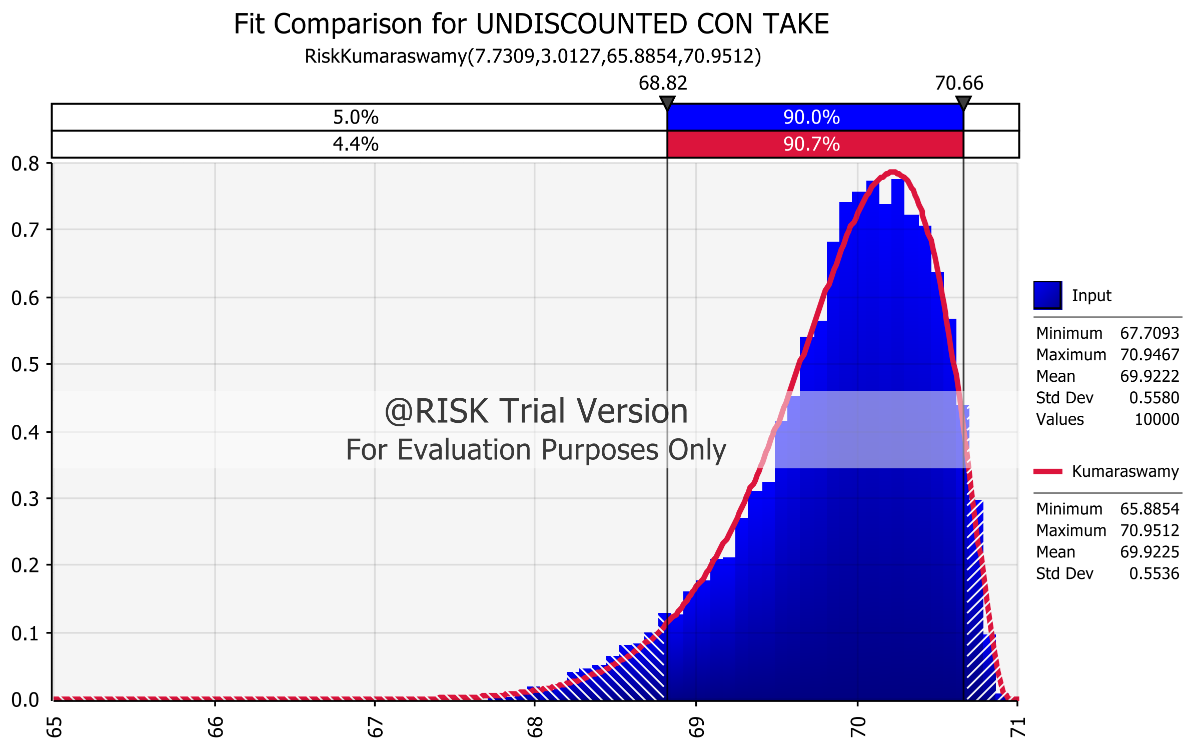


Figure 5.6 Stochastic result for undiscounted CTake

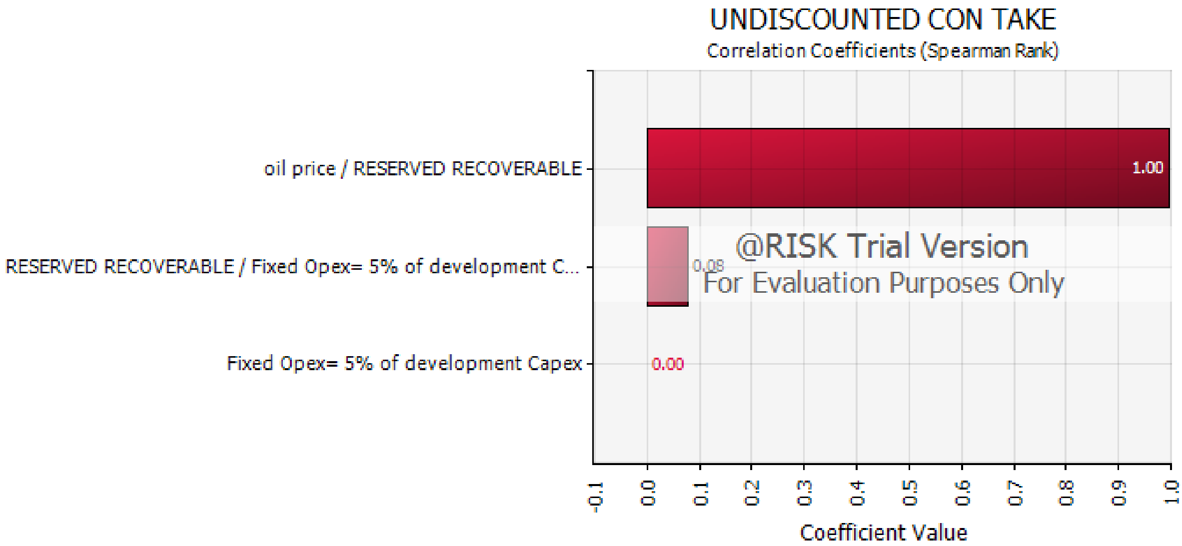


Figure 5.7 Stochastic Input variables that affects undiscounted CTake output

Figure 5.8 and figure 5.9 shows the stochastic modelling of undiscounted net present value and the input effects on it respectively for the contractor's share. The values generated from the stochastic analysis are all positive, which means values are added to the investment. It can be observed from fig 5.8 that, there is a 5% chance that, the NPV will be less than $MM 1,121 and 95 % chance that, the NPV will be less than or equal to $MM 6,271. Fig 5.9 shows that, oil price and reserved recoverable are affecting the NPV of the contractor's share positively meaning increasing them will increase the NPV. Discount rate input variable is different which means increase will decrease the NPV.

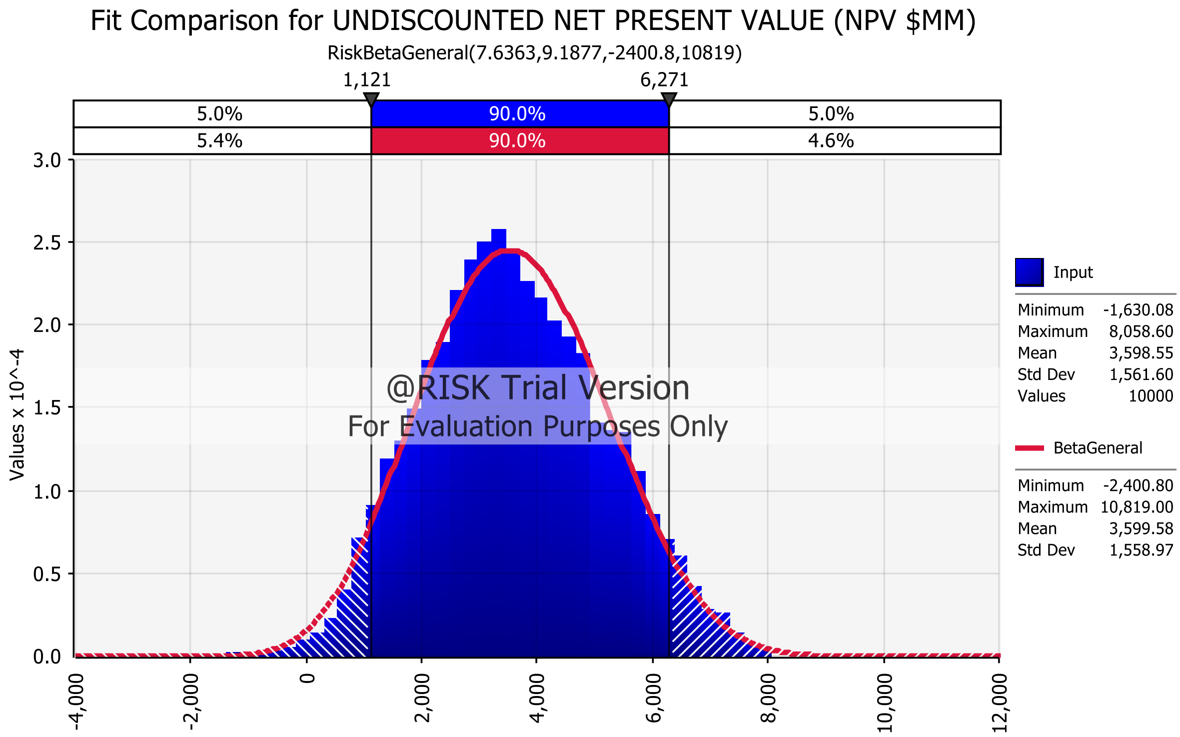


Figure 5.8 Stochastic result for undiscounted NPV

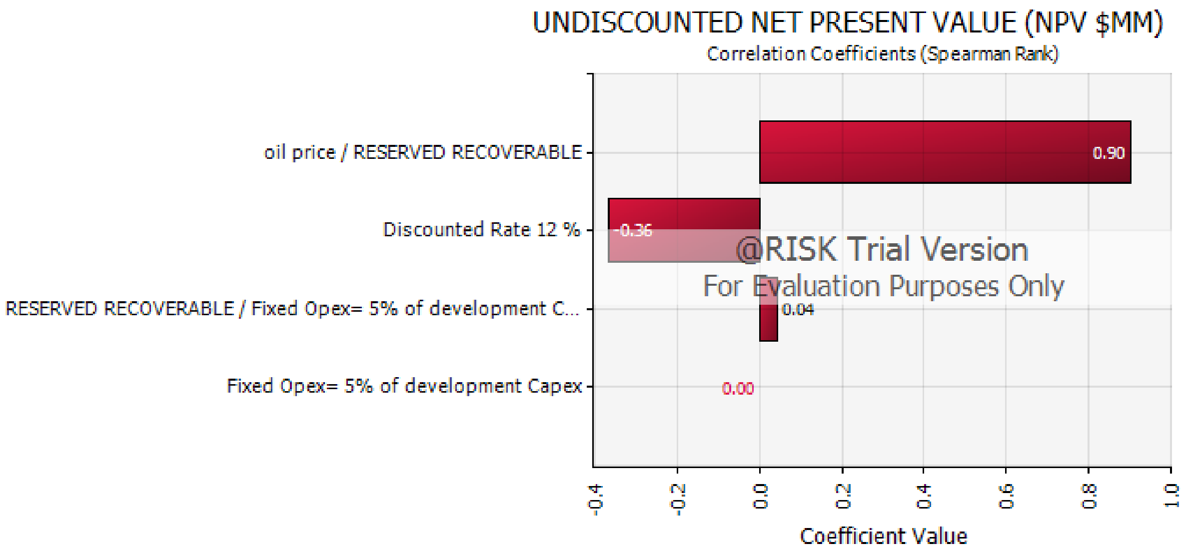


Figure 5.9 Stochastic Input variables that affects undiscounted NPV output

Figure 5.10 and figure 5.11 shows the stochastic results of fixed royalty model for Internal Rate of Return (IRR) and the stochastic input variable effect on the IRR output. The values from the stochastic results are higher than the assumed discount rate which shows profit will emerge from the investment. From fig 5.10, it can be observed that, there is 5 % chance that, the IRR will be less than 16.74 % and there is 95 % chance that the IRR will be less than or equal to 25.60 %. Fig 5.11, it can be observed that, oil price and reserved recoverable are showing positive value meaning increasing those input will increase the IRR of the fiscal regime.

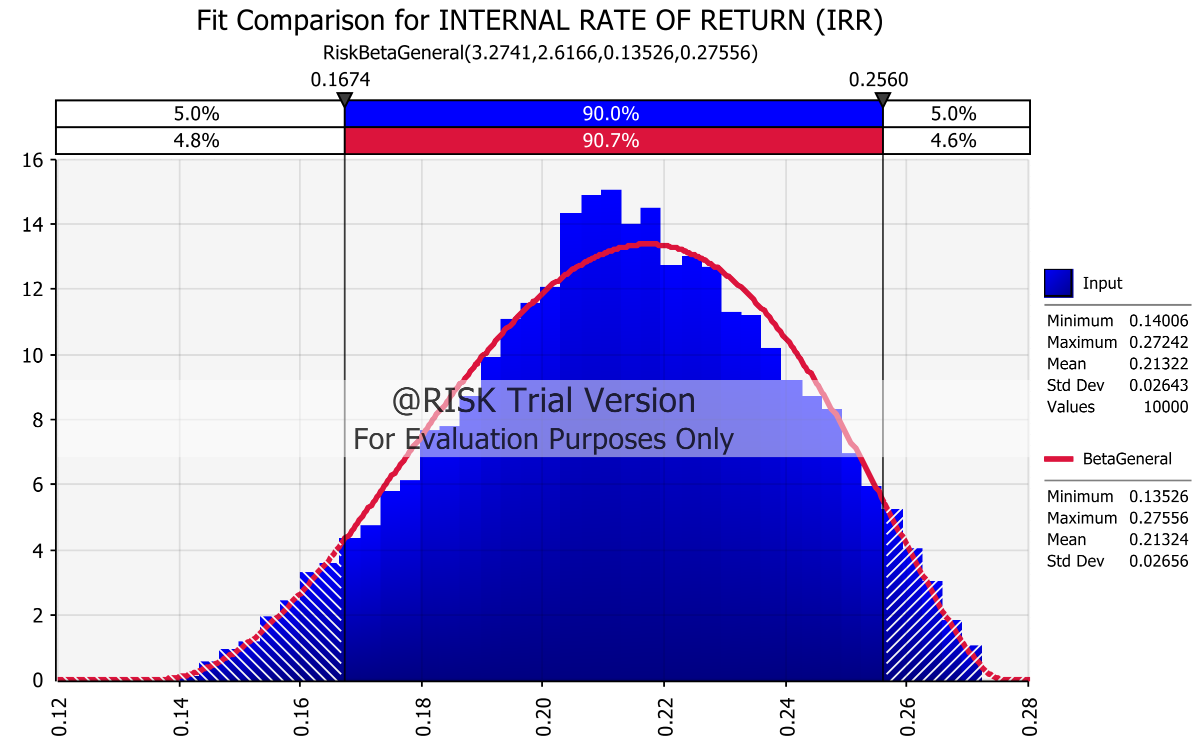


Figure 5.10 Stochastic result for IRR

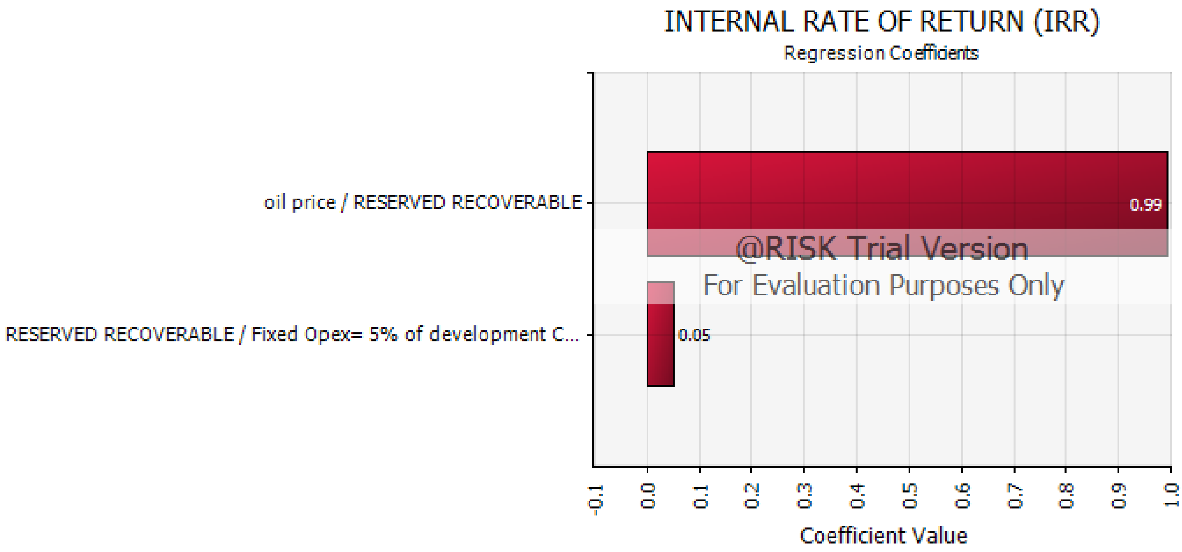


Figure 5.11 Stochastic Input variables that affects IRR output

5.1.3 MONTE CARLO SIMULATION ANALYSIS OF SLIDING SCALE ROYALTY MODEL

Figure 5.12 and figure 5.13 shows the stochastic results for undiscounted Host government take and the input variables that affects it output respectively. At a confidence level of 5%, the government take will be less than 44.48 %. Also at a 95 % confidence level, the government take will be less than or equal to 46.35%. From figure 5.3.2, which shows the input variable and their effects, you can observe that, oil price and reserve recoverable are negatively affecting the government take. So increase in those input variables will decrease it. The same for the 5% fixed opex.

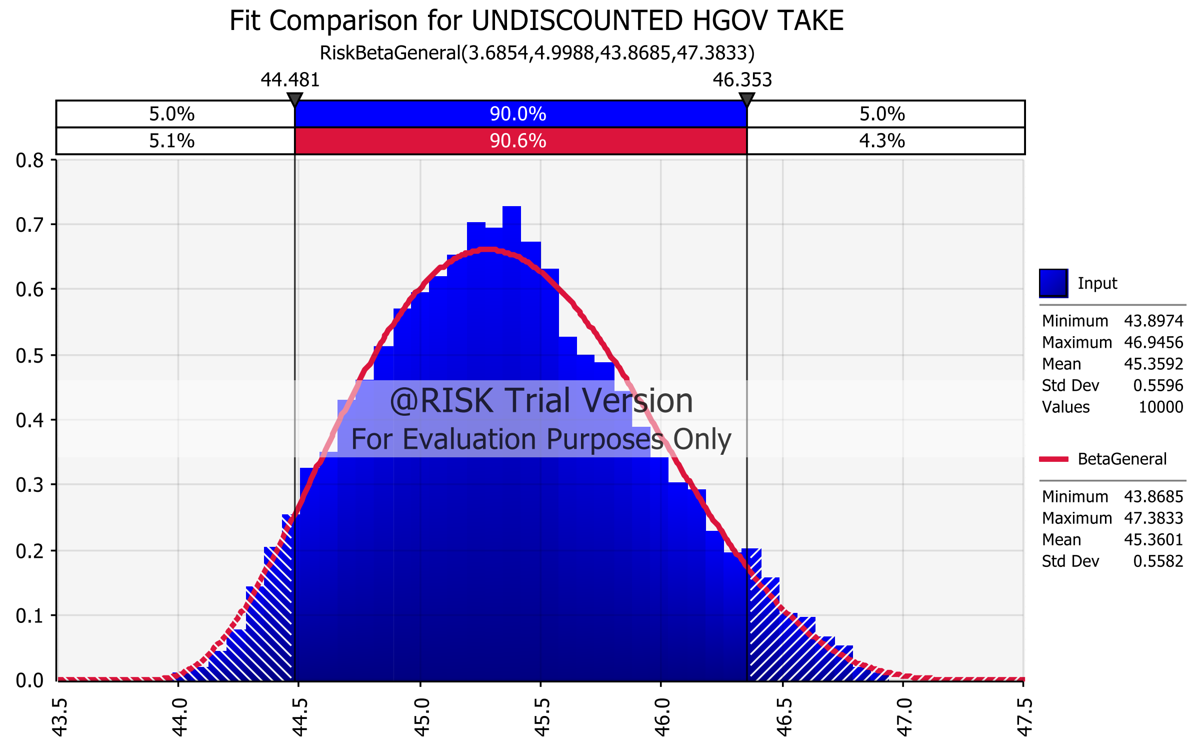


Figure 5.12 Stochastic result for undiscounted GTake

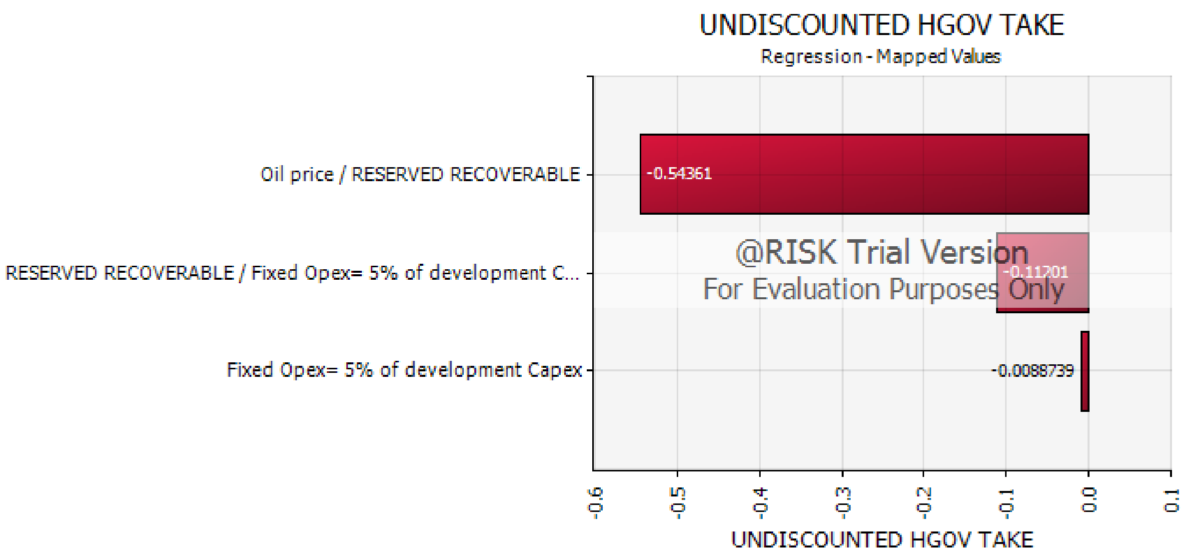


Figure 5.13 Stochastic Input variables that affects undiscounted GTake output

Figure 5.14 and figure 5.15 shows the simulation results on NPV for Government portion of the profit. At 90 % confidence level, both values are positive meaning value will be added to such a project. From fig 5.3.3, there is 5% chance that the NPV will be less than $MM 7,017 and there is 95 % chance that, it will be less than or equal to $MM 7,966.

Fig 5.3.4 on the same NPV for the government shows the input variable that affects the NPV more. Oil reserves and oil price and 5% development capex is affecting it positively whilst discount rate is affecting it negatively. Meaning increasing the positive input parameters will increase the NPV for government take and the negative input parameters (Discount rate) will affect the NPV negatively if its increased.

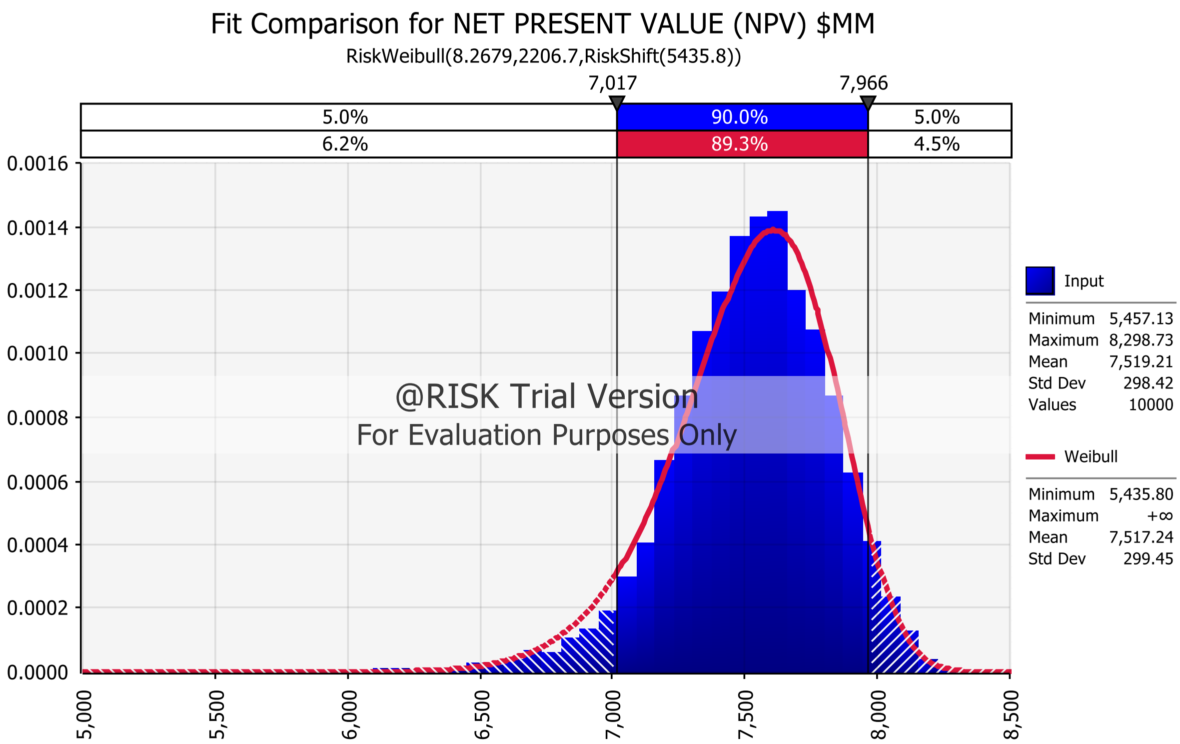


Figure 5.14 Stochastic result for undiscounted NPV

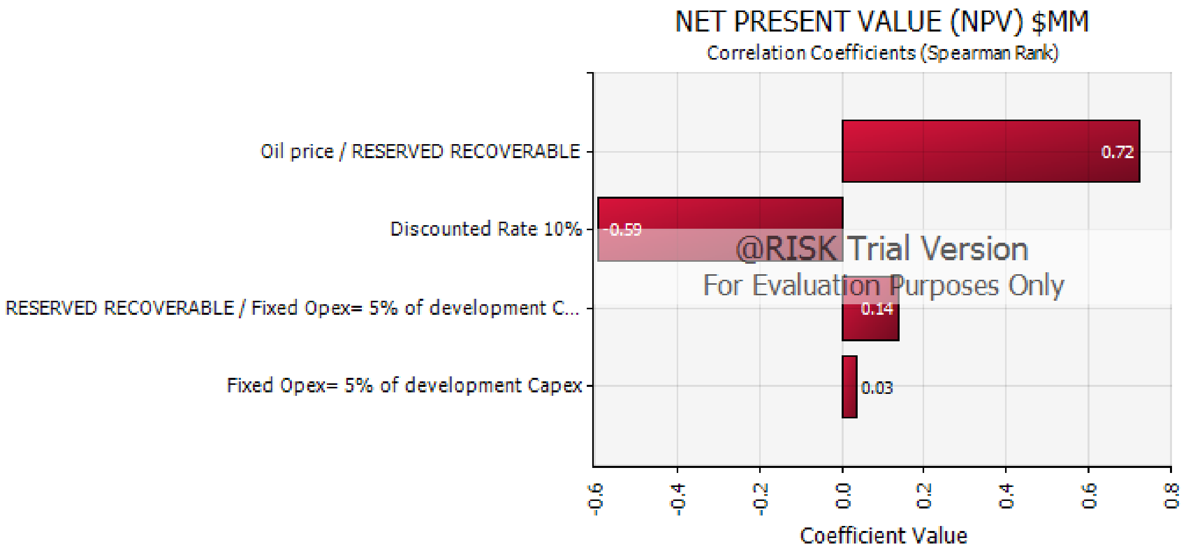


Figure 5.15 Stochastic Input variables that affects undiscounted NPV output

Figure 5.16 and figure 5.17 shows the stochastic results of how front-end loading the fiscal regime is and the input variables that affects it output respectively. At a confidence level of 5%, the FLI will be less than 0.84 %. Also at a 95 % confidence level, the FLI will be less than or equal to 1.103 %. Figure 5.17 shows the stochastic result of how the various input variables affect the front-end loading index of the sliding scale royalty model. The discounting rate variables affecting the FLI output much positively. This infers that, should incase the discount rate be increased, it will increase the FLI and thereby favouring the Government. On the other hand, oil price, recoverable reserve and 5% fixed development capex are affecting it negatively and should it be increased, it will decrease the FLI.

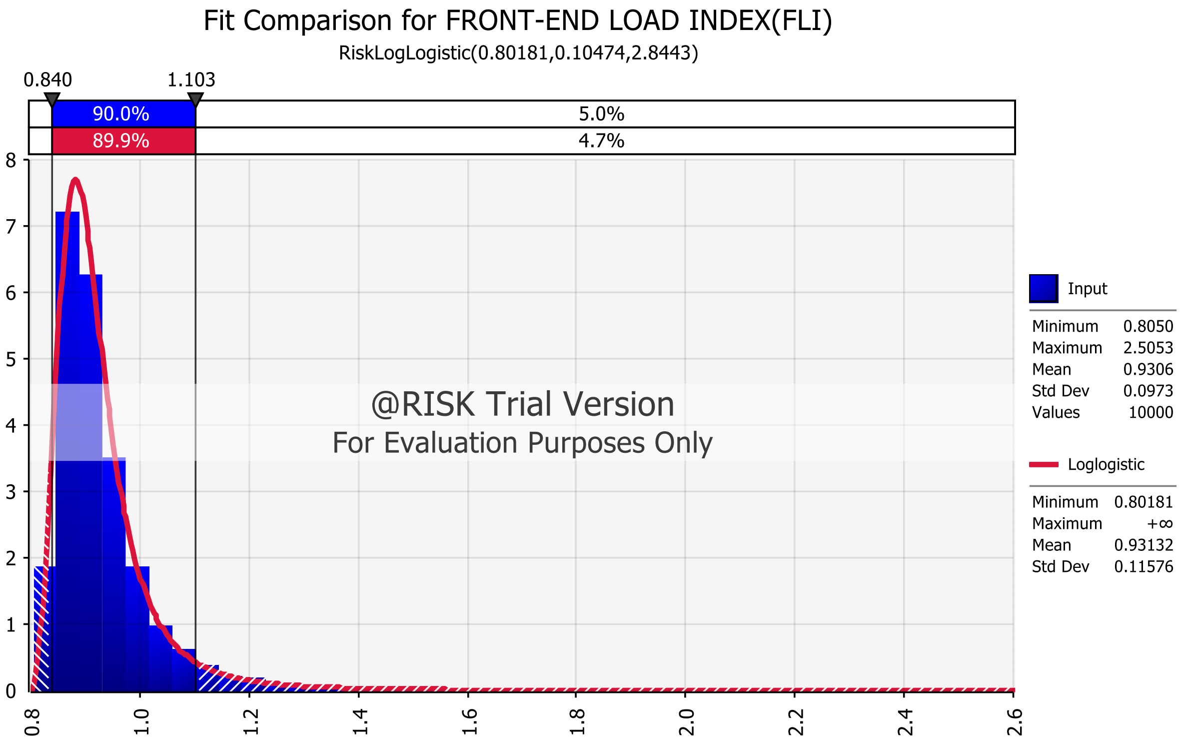


Figure 5.16 Stochastic result for FLI

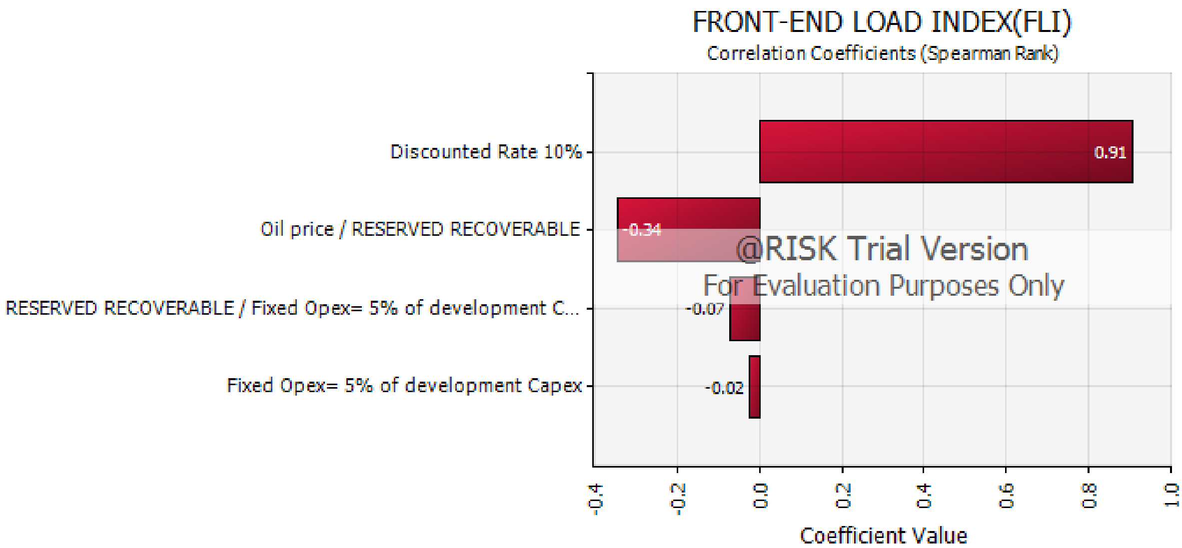


Figure 5.17 Stochastic Input variables that affects FLI output

Figure 5.18 shows the stochastic results for undiscounted contractor take. At a confidence level of 5%, the contractor take will be less than 53.64 %. Also at a 95 % confidence level, the contractor take will be less than or equal to 55.51%.

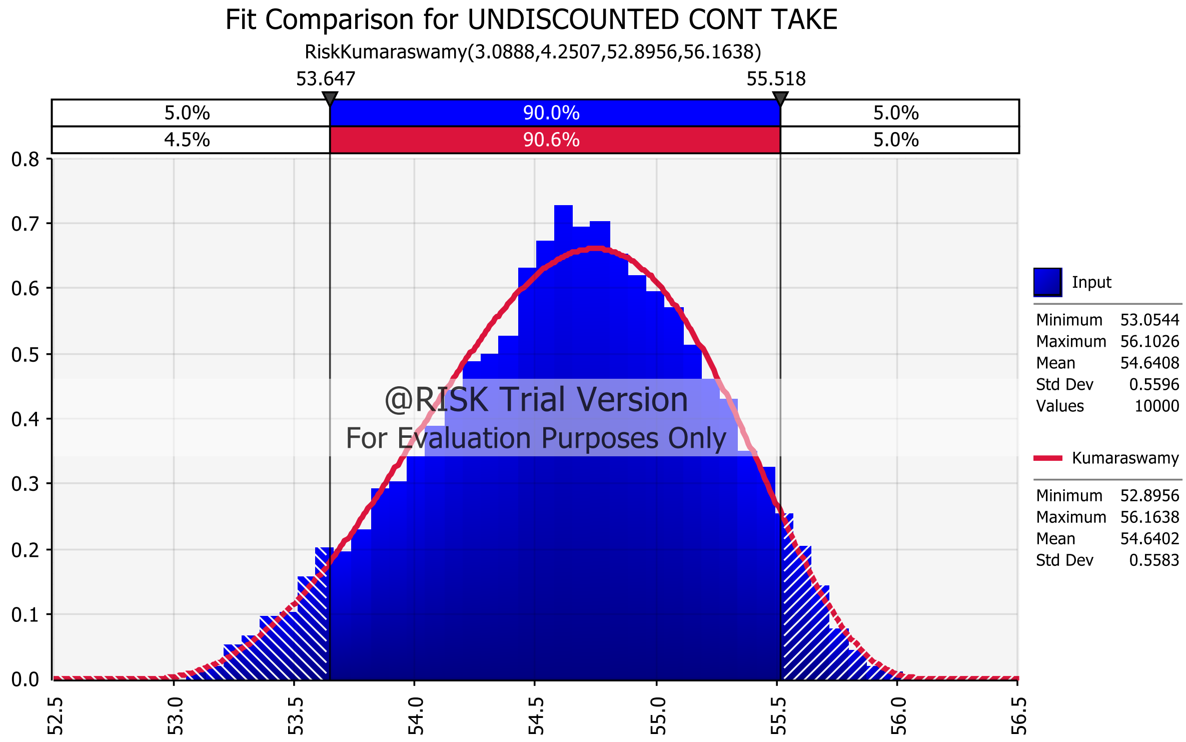


Figure 5.18 Stochastic result for undiscounted CTake

Figure 5.19 and figure 5.20 shows the stochastic modelling of undiscounted net present value and the input effects on it respectively for the contractor's share. The values generated from the stochastic analysis are all positive, which means values are added to the investment. It can be observed from fig 5.19 that, there is a 5 % chance that, the NPV will be less than $MM 308 and 95 % chance that, the NPV will be less than or equal to $MM 1,709. Fig 5.9 shows that, oil price and reserved recoverable are affecting the NPV of the contractor's share positively meaning increasing them will increase the NPV. Discount rate input variable is different which means increase will decrease the NPV.

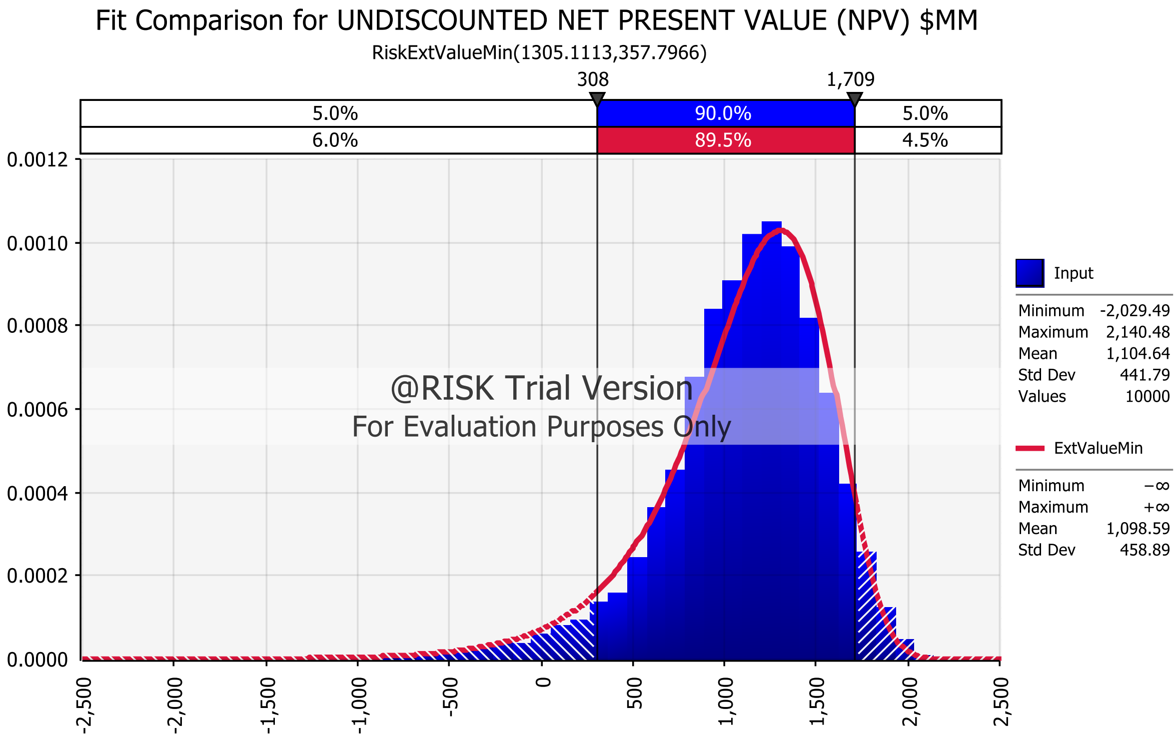


Figure 5.19 Stochastic result for undiscounted NPV

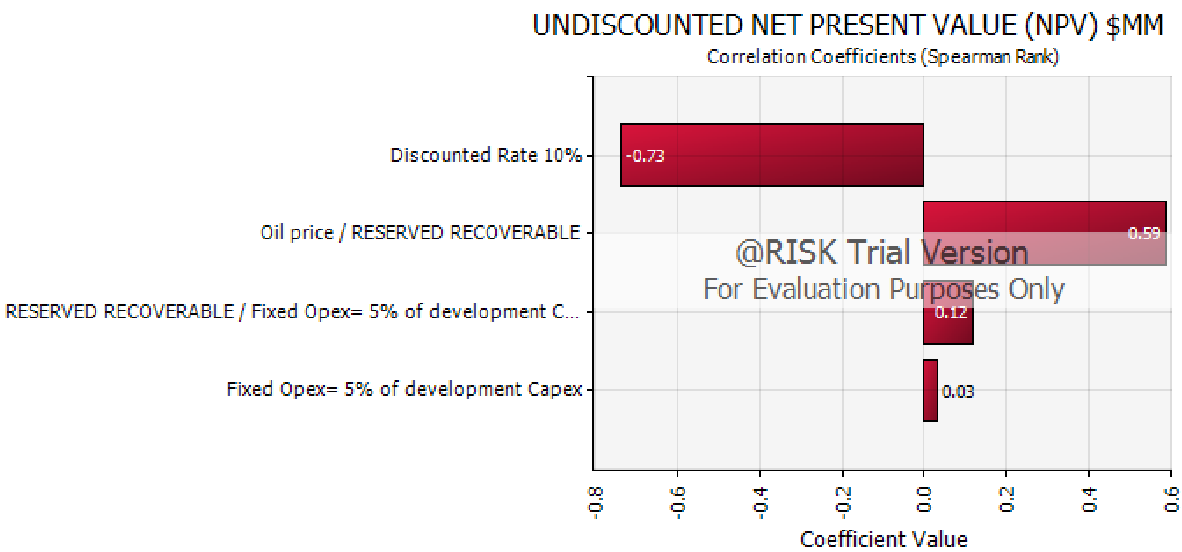


Figure 5.20 Stochastic Input variables that affects NPV output

Figure 5.21 and figure 5.22 shows the stochastic results of sliding scale royalty model for Internal Rate of Return (IRR) and the stochastic input variable effect on the IRR output. The values from the stochastic results are higher than the assumed discount rate which shows profit will emerge from the investment. From fig 5.21, it can be observed that, there is 5 % chance that, the IRR will be less than 15.46 % and there is 95 % chance that the IRR will be less than or equal to 17.79 %. Fig 5.11, it can be observed that, oil price and reserved recoverable are showing positive value meaning increasing those input will increase the IRR of the fiscal regime.

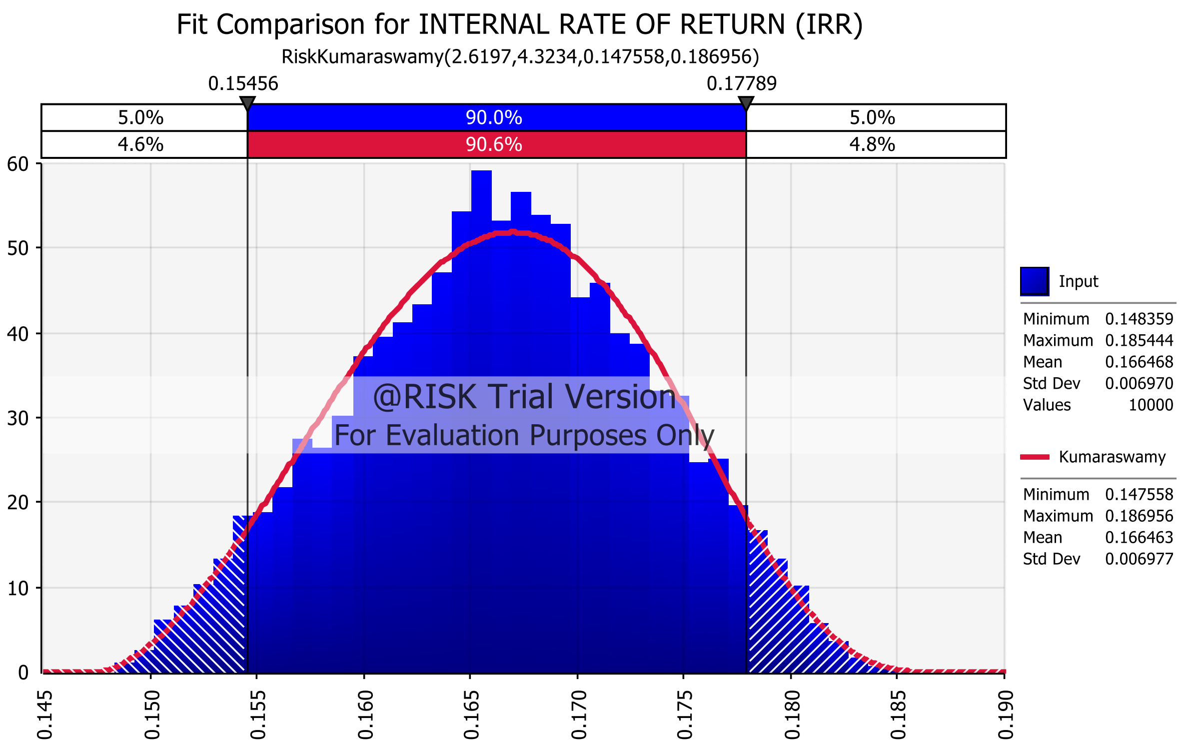


Figure 5.21 Stochastic result for IRR

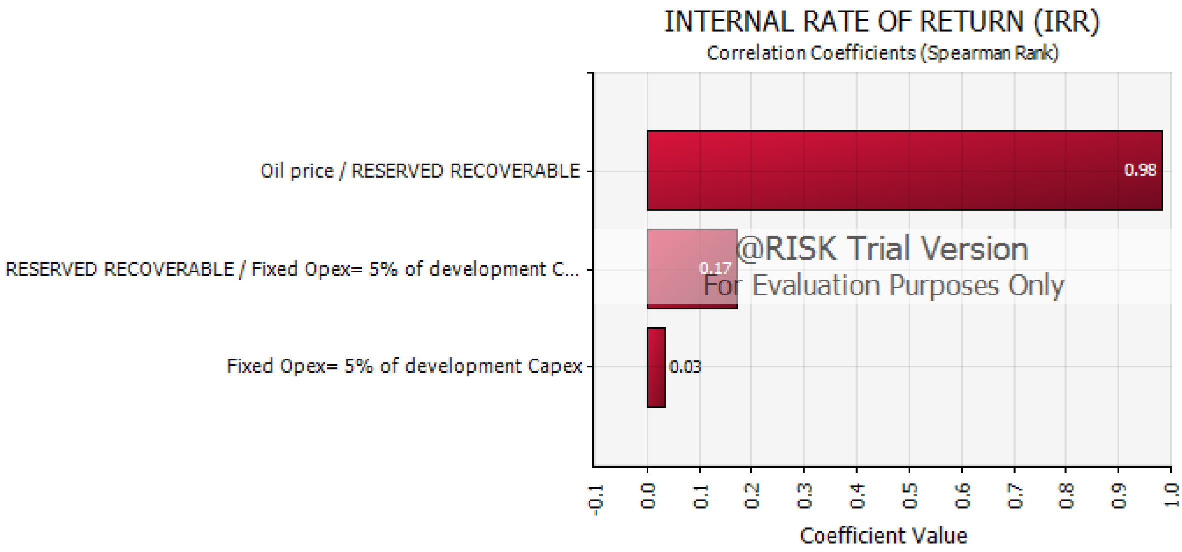


Figure 5.22 Stochastic Input variables that affects IRR

CHAPTER SIX

CONCLUSION AND RECOMMENDATION

6.1 Summary

In this thesis, the comparative study of the current PFS in Ghana and the proposed PFS was discussed. An overview of the current Ghana's fiscal regime and how the GTake can be increased in the proposed PFS is highlighted. Evaluating and analysing fiscal regimes serves to define the possibility of investing in a hydrocarbon producing nation. The key challenge for harnessing oil and gas resources is making the right economic choices and synchronizing their implementation in a context that supports fiscal prudence and minimizes macroeconomic distortion (Chukwuemeka, 2011) This study is therefore imperative for Ghana petroleum resources because it affects investments interest. The aim of this study is to design a fiscal regime for petroleum resource development in Ghana in terms of efficiency, effectiveness and equity. The economic model for both fixed royalty and sliding scale royalty accounts for risks and uncertainties using @RISK for its stochastic simulation for appropriate decision making at the outset of an E&P venture in Ghana.

6.2 Conclusion

- A field development plan for the jubilee oil field was successfully built
- The current fiscal regime underlying the oil and gas industry in Ghana was successfully review and evaluated.
- A new fiscal regime which is efficient, effective and equitable was successfully built.
- The new fiscal regime with sliding scale royalty, achieved its pareto optimality purpose by increasing the government take from 30.15 % to 69.85 %.
- The NPV of the government increased from $MM 3,976.02 to $MM 7,724.72.

- The effectiveness of the fiscal regime for the fixed royalty was achieved with a FLI of 0.38 and the proposed regime with a FLI of 0.84. All within the acceptable FLI of 0-1.
- The Profitability index (PI) of both fixed royalty and sliding scale model for the PFS is 2 which is greater than 1, meaning value is added to the investment.
- Stochastic simulation to determine uncertainties and risks was incorporated successful in the economic model which made it unique.
- Stochastic analysis shows clearly the input variables which affect the various profitability instrument.

6.3 Recommendation

- Further studies can design a model for production sharing agreement fiscal regime for Ghana resource development.
- The royalty rates can be tied to R-factor and also observe it impact on the fiscal regime.
- Other profitability indexes like the Rate of Return (ROR), Growth Rate of Return (GRR) and Adjusted Net Present value (ANPV) can be also be tested on further studies.
- The payback period can be determined in further studies so the contract will know when he can breakeven in the project.

NOMENCLATURE

ATAX – After Income Tax

BBL – Barrel

BC – Boundary conditions

BOPD – Barrels of Oil Per Day

BTAX – Before Income Tax

CAPEX – Capital Expenditure

CF – Cash flow

CITA – Corporate Income Tax

CTake – Contractor Take

CUM. PROD. – Cumulative Production

DEVT – Development Costs

E&P – Exploration and Production

ETAX – Education Tax

EXPL. – Exploration Costs

FLGT – Front Loaded Government Take

G & G – Geological and Geophysical Costs

GOG – Gulf of Guinea

GRR – Growth Rate of Returns

GTake – Government Take

IOC – International Oil Companies

IRR – Internal Rate of Returns

Mb/d – Thousand Barrels Per Day

$MM – Million Dollars

MMBBL – Million Barrels

NCF – Net Cash Flow

NPV – Net Present Value

OPEC – Organization of Petroleum Exporting Countries

OPEX – Operating Expenditure

PFS – Petroleum Fiscal System

PI – Profitability Index

PIB – Petroleum Industry Bill

POP – Payout Period

PROD. RATE – Production Rate

PSC – Production Sharing Contract

PVR – Present Value Ratio

R/T – Royalty and Tax

STOIIP – Stock Tank Oil Initially in Place

STB – Stock Tank Barrel

STB/D – Stock Tank Barrel Per Day

TC – Technical Cost

UR – Ultimate Recovery

APPENDIX A: FIELD DEVELOPMENT PLAN FOR JUBILEE FIELD

Year end	2010	year
A.Recovery (UR)	538,000,000	bbls
Economic Life	26.00	years

No of Days 365

q = qi * exp(-Dt)

Np = (qi - q)*365/D

Profile 1			Profile 2		
Qi1 =	24000	bbl/day	Qi2 =	76000	bbl/day
Qf1 =	76000	bbl/day	Qf2 =	76000	bbl/day
t1 =	7	years	t2 =	8	years
D1 =	-0.16	/year	D2 =	0	/year
Np1 =	115,261,874	bbls	Np2 =	221,920,000	bbls
	2017			2025	

Year	Rate (BOPD)	Annual Prod. (bbl)	Cum. Prod (bbl)
2009	-	-	-
2010	24,000	-	-
2011	28,296	9,522,522	9,522,522
2012	33,361	11,227,074	20,749,596
2013	39,333	13,236,746	33,986,342
2014	46,373	15,606,152	49,592,495
2015	54,674	18,399,688	67,992,183
2016	64,461	21,693,273	89,685,456
2017	76,000	25,576,417	115,261,874
2018	76,000	27,740,000	143,001,874
2019	76,000	27,740,000	170,741,874
2020	76,000	27,740,000	198,481,874
2021	76,000	27,740,000	226,221,874
2022	76,000	27,740,000	253,961,874
2023	76,000	27,740,000	281,701,874
2024	76,000	27,740,000	309,441,874
2025	76,000	27,740,000	337,181,874
2026	69,777	26,588,178	363,770,052
2027	64,064	24,411,178	388,181,229
2028	58,819	22,412,427	410,593,656
2029	54,003	20,577,331	431,170,987
2030	49,581	18,892,489	450,063,476
2031	45,521	17,345,601	467,409,077
2032	41,794	15,925,369	483,334,445
2033	38,372	14,621,423	497,955,869
2034	35,230	13,424,243	511,380,111
2035	32,346	12,325,086	523,705,197
2036	29,697	11,315,926	535,021,123

APPENDIX B FIXED ROYALTY ECONOMIC MODEL (OVERVIEW OF GHANA'S FISCAL SYSTEM)

Year	Annual Prod (MMB/Y)	Explo/Ap CAPEX (MM$)	DEVE CAPEX (MM$)	FIXED OPEX (MM$)	VAR OPEX CALC (MM$)	VARIABLE OPEX (MM$)	TOTAL COST (MM$)	OIL PRICE ($/Stb)	GROSS REVENUI (MM$)	5.00% ROYALTY (MM$)	NET REVENUI (MM$)	TAXABLE INCOME (MM$)	% TAXABL INCOME (MM$)	NET CASH FLOW Contractor;s (MM$)	HG take (MM$)	DISCOUNTED Contractor;s (MM$)	DISCOUNTED HG take (MM$)
2007		113.33	1601.67				1715.00	-	0.00	0	0			-1715	-	-1715	-
2008		100	1601.67				1701.67	-	0.00	0	0			-1701.67	-	-1519.35	-
2009		126.66					126.66	-	0.00	0	0			-126.66	-	-100.97	-
2010	-	-		12.31	11.651	12.31	24.62	-	0.00	0	0			-24.62	-	-17.52	-
2011	9.52	-		12.31	11.651	123.23	135.54	80	761.60	38.08	723.52	587.98	205.79	626.06	243.87	397.87	154.99
2012	11.23	-		12.31	11.651	143.15	155.46	80	898.40	44.92	853.48	698.02	244.31	742.94	289.23	421.56	164.11
2013	13.24	-		12.31	11.651	166.57	178.88	80	1059.20	52.96	1006.24	827.36	289.58	880.32	342.54	446.00	173.54
2014	15.61	-		12.31	11.651	194.19	206.50	80	1248.80	62.44	1186.36	979.86	342.95	1042.30	405.39	471.49	183.38
2015	18.40	-		12.31	11.651	226.69	239.00	80	1472.00	73.60	1398.4	1159.40	405.79	1233.00	479.39	497.99	193.62
2016	21.69	-		12.31	11.651	265.03	277.34	80	1735.20	86.76	1648.44	1371.10	479.89	1457.86	566.65	525.72	204.34
2017	25.58	-		12.31	11.651	310.35	322.66	80	2046.40	102.32	1944.08	1621.42	567.50	1723.74	669.82	555.00	215.66
2018	27.74	-		12.31	11.651	335.52	347.83	80	2219.20	110.96	2108.24	1760.41	616.15	1871.37	727.11	537.98	209.03
2019	27.74	-		12.31	11.651	335.52	347.83	80	2219.20	110.96	2108.24	1760.41	616.15	1871.37	727.11	480.34	186.63
2020	27.74	-		12.31	11.651	335.52	347.83	80	2219.20	110.96	2108.24	1760.41	616.15	1871.37	727.11	428.87	166.63
2021	27.74	-		12.31	11.651	335.52	347.83	80	2219.20	110.96	2108.24	1760.41	616.15	1871.37	727.11	382.92	148.78
2022	27.74	-		12.31	11.651	335.52	347.83	80	2219.20	110.96	2108.24	1760.41	616.15	1871.37	727.11	341.89	132.84
2023	27.74	-		12.31	11.651	335.52	347.83	80	2219.20	110.96	2108.24	1760.41	616.15	1871.37	727.11	305.26	118.61
2024	27.74	-		12.31	11.651	335.52	347.83	80	2219.20	110.96	2108.24	1760.41	616.15	1871.37	727.11	272.56	105.90
2025	27.74	-		12.31	11.651	335.52	347.83	80	2219.20	110.96	2108.24	1760.41	616.15	1871.37	727.11	243.35	94.55
2026	26.59	-		12.31	11.651	322.12	334.43	80	2127.20	106.36	2020.84	1686.41	590.24	1792.77	696.60	208.15	80.88
2027	24.41	-		12.31	11.651	296.72	309.03	80	1952.80	97.64	1855.16	1546.13	541.15	1643.77	638.79	170.40	66.22
2028	22.41	-		12.31	11.651	273.41	285.72	80	1792.80	89.64	1703.16	1417.44	496.10	1507.08	585.74	139.49	54.22
2029	20.58	-		12.31	11.651	252.09	264.40	80	1646.40	82.32	1564.08	1299.68	454.89	1382.00	537.21	114.21	44.40
2030	18.89	-		12.31	11.651	232.40	244.71	80	1511.20	75.56	1435.64	1190.93	416.82	1266.49	492.38	93.45	36.33
2031	17.35	-		12.31	11.651	214.46	226.77	80	1388.00	69.40	1318.6	1091.83	382.14	1161.23	451.54	76.50	29.75
2032	15.92	-		12.31	11.651	197.80	210.11	80	1273.60	63.68	1209.92	999.81	349.93	1063.49	413.61	62.56	24.33
2033	14.62	-		12.31	11.651	182.65	194.96	80	1169.60	58.48	1111.12	916.16	320.66	974.64	379.14	51.19	19.91
2034	13.42	-		12.31	11.651	168.67	180.98	80	1073.60	53.68	1019.92	838.94	293.63	892.62	347.31	41.86	16.29
2035	12.33	-		12.31	11.651	155.97	168.28	80	986.40	49.32	937.08	768.80	269.08	818.12	318.40	34.25	13.33
2036	11.32	-		12.31	11.651	144.20	156.51	80	905.60	45.28	860.32	703.81	246.33	749.09	291.61	28.00	10.90
	535.03													32360.57	13966.06	3976.02	2849.16

APPENDIX C SLIDING SCALE ROYALTY TIED TO PRODUCTION ECONOMIC MODEL (OVERVIEW OF PROPOSED FISCAL SYSTEM)

Year	Prod (MMB/Y)	Explo/Ap CAPEX (MM$)	DEVE CAPEX (MM$)	FIXED OPEX (MM$)	VAR OPEX CALC (MM$)	VARIABLE OPEX (MM$)	TOTAL COST (MM$)	OIL PRICE ($/Stb)	GROSS REVENUE (MM$)	Sliding scale Royalty Calc. (MM$)		NET REVENUE (MM$)	TAXABLE INCOME (MM$)	35% TAXABLE INCOME (MM$)	NET CASH FLOW Contractor; (MM$)	HG take (MM$)	DIS Contractor;s (MM$)	DIS HG take (MM$)
2007		113.33	1601.67				1715	-							-1715		-1715	
2008		100	1601.67				1701.67	-		BUILD-UP					-1701.67		-1519.35	
2009		126.66					126.66	-		30	1.5				-126.66		-100.97	
2010	0			12.31	11.05	12.31	12.31	-		60	4.5				-12.31		-8.76	
2011	9.52			12.31	11.05	117.53	129.84	80	761.60	25.27	3.15875	1567.52	1437.68	503.19	934.49	4117.49	593.89	4117.49
2012	11.23			12.31	11.05	136.43	148.74	80	898.40	115.27	9.15875	1567.52	1418.78	496.57	922.21	496.57	523.29	443.37
2013	13.24			12.31	11.05	158.65	170.96	80	1059.20	ROY AMT	732.7	1567.52	1396.57	488.80	907.77	488.80	459.90	389.67
2014	15.61			12.31	11.05	184.84	197.15	80	1248.80			1567.52	1370.37	479.63	890.74	479.63	402.93	341.39
2015	18.4			12.31	11.05	215.68	227.99	80	1472.00	PLAUTEAU		1567.52	1339.53	468.84	870.70	468.84	351.66	297.95
2016	21.69			12.31	11.05	252.04	264.35	80	1735.20	30	1.5	1567.52	1303.17	456.11	847.06	456.11	305.46	258.81
2017	25.58			12.31	11.05	295.04	307.35	80	2046.40	60	4.5	1567.52	1260.18	441.06	819.11	441.06	263.73	223.46
2018	27.74			12.31	11.05	318.91	331.22	80	2219.20	90	9	1567.52	1236.30	432.71	803.60	432.71	231.01	195.73
2019	27.74			12.31	11.05	318.91	331.22	80	2219.20	41.92	5.24	1567.52	1236.30	432.71	803.60	432.71	206.26	174.76
2020	27.74			12.31	11.05	318.91	331.22	80	2219.20	221.92	20.24	1567.52	1236.30	432.71	803.60	432.71	184.16	156.04
2021	27.74			12.31	11.05	318.91	331.22	80	2219.20	ROY AMT	1619.2	1567.52	1236.30	432.71	803.60	432.71	164.43	139.32
2022	27.74			12.31	11.05	318.91	331.22	80	2219.20			1567.52	1236.30	432.71	803.60	432.71	146.81	124.39
2023	27.74			12.31	11.05	318.91	331.22	80	2219.20	DECLINE		1567.52	1236.30	432.71	803.60	432.71	131.08	111.06
2024	27.74			12.31	11.05	318.91	331.22	80	2219.20	30	0.05	1567.52	1236.30	432.71	803.60	432.71	117.04	99.16
2025	27.74			12.31	11.05	318.91	331.22	80	2219.20	60	4.5	1567.52	1236.30	432.71	803.60	432.71	104.50	88.54
2026	26.59			12.31	11.05	306.20	318.51	80	2127.20	90	9	1567.52	1249.01	437.15	811.86	437.15	94.26	79.87
2027	24.41			12.31	11.05	282.11	294.42	80	1952.80	17.84	2.23	1567.52	1273.11	445.59	827.52	445.59	85.79	72.69
2028	22.41			12.31	11.05	260.00	272.31	80	1792.80	197.84	15.78	1567.52	1295.21	453.32	841.89	453.32	77.92	66.02
2029	20.58			12.31	11.05	239.77	252.08	80	1646.40	ROY AMT	1262.4	1567.52	1315.44	460.40	855.04	460.40	70.66	59.87
2030	18.89			12.31	11.05	221.10	233.41	80	1511.20	ROY AMT t	3614.3	1567.52	1334.12	466.94	867.18	466.94	63.99	54.22
2031	17.35			12.31	11.05	204.07	216.38	80	1388.00			1567.52	1351.14	472.90	878.24	472.90	57.86	49.02
2032	15.92			12.31	11.05	188.27	200.58	80	1273.60			1567.52	1366.95	478.43	888.51	478.43	52.27	44.28
2033	14.62			12.31	11.05	173.90	186.21	80	1169.60			1567.52	1381.31	483.46	897.85	483.46	47.16	39.95
2034	13.42			12.31	11.05	160.64	172.95	80	1073.60			1567.52	1394.58	488.10	906.47	488.10	42.51	36.02
2035	12.33			12.31	11.05	148.59	160.90	80	986.40			1567.52	1406.62	492.32	914.31	492.32	38.28	32.43
2036	11.32			12.31	11.05	137.43	149.74	80	905.60			1567.52	1417.79	496.23	921.56	496.23	34.451	29.19
									42802.40						18675.65	15585	1507.23	7724.72

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