UNIVERSITY OF CAPE COAST

UPSTREAM FISCAL REGIME REDESIGN FOR VALUE OPTIMISATION: A CASE STUDY OF THE JUBILEE FIELD IN GHANA

ASHIKWEI DESMOND ASHITEY

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BY

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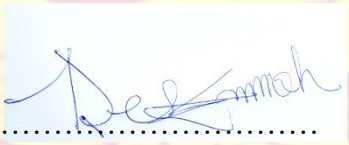
Thesis submitted to the Institute of Oil and Gas, Department of Social Science, College of Humanities and Legal Studies, University of Cape Coast in Partial Fulfilment of the Requirements for Award of Master of Philosophy Degree in Oil and Gas Resource Management.

DECEMBER 2022

DECLARATION

Candidate's Declaration

I hereby declare that this dissertation is the result of my own original work and that no part of it has been presented for another degree in this university or elsewhere.



Candidate's Signature: …… Date: ……..……..

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Supervisor's Declaration

I hereby declare that the preparation and presentation of the thesis were supervised in accordance with guidelines on supervision of dissertation laid down by the University of Cape Coast.

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ABSTRACT

Globally 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 many foreign investors. The current upstream fiscal regime that governs the development of petroleum resources in Ghana does not capture windfall profit and further does not enable value creation for development. The challenges for the loopholes in the existing fiscal regime of Ghana are the fixed regressive royalty and the non-profitable additional entitlement elements constituting fiscal regime. To ascertain the performance of the current upstream petroleum fiscal regime, it was compared to some Gulf of Guinea countries fiscal regime and was ranked. A proposed upstream fiscal regime to create value for the petroleum industry of Ghana was modelled using the discounted cash-flow framework. The new regime has a sliding scale royalty tied to the R-Factor of the project. The regime's value was then measured using petroleum economic profitability indicators. These indicators are Net present value (NPV), Internal rate of return (IRR), Present value ratio (PVR) and Profitability index (PI). The current fiscal regime of Ghana had an NPV of the government take (GT) to be $2.86 billion whilst that of the proposed regime had $ 3.02 billion when it was discounted. For the undiscounted, the current fiscal regime had GT NPV of $ 6.92 billion and the proposed made $ 7.29 billion. The proposed fiscal regime created a value of $ 160 million when the cash flow was discounted and $370 million when it was not discounted for the Government. The models successfully incorporated Monte-Carlo simulation using @RISK software to account for risk and uncertainty in decision making.

KEY WORDS

Additional oil entitlement

Corporate income tax

Deterministic analysis

Economics of exhaustible resources

Foreign direct investment

Pareto Optimality

Petroleum economic model

Petroleum upstream fiscal regime

Production sharing contract

Profitability indicators

Resource curse theory

R-Factor

Royalties

Royalty and tax regime

Sliding scale royalty

Stochastic analysis

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DEDICATION

This thesis is dedicated to My lovely Parents – Mr. Ebenezer Charles Amarh Ashikwei and Mrs. Abigail Asheley Ashikwei My dearest friend – Miss Jessica Akorfa Tamakloe My siblings – Lovelace, Yvette and Caleb.

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AOI –	Additional Oil Entitlement
CF –	Cash flow
CTake –	Contractor Take
DGT –	Discounted Government Take
DNCF –	Discounted Net Cash flow
EPT –	Excess Profit Tax
FLGT-	Front-end loading Government Take
GNPC-	Ghana National Petroleum Corporation
GoG –	Gulf of Guinea
GTake –	Government Take
IOCs –	International Oil Companies
IRR –	Internal Rate of Return
NCF-	Net Cash flow
NPV –	Net Present Value
PI –	Profitability Index
PSA –	Petroleum Sharing Agreement
PSC –	Petroleum Sharing Contract
PVR –	Present Value Ratio
R/T –	Royalty and Tax
RoR –	Rate of Return
$MM –	Million Dollars

CHAPTER ONE

INTRODUCTION

Background of the Study

Ghana, located on the Atlantic Ocean shares borders with three francophone countries: Togo, Cote d'lvoire, and Burkina Faso. Its population is estimated around 32 million in 2021. Ghana has been democratically disciplined under the multi-party system for over two decades, with an autonomous judiciary earning the trust of Ghanaians and the world at large. Ghana is consistently ranked among the top three African countries for freedom of expression and press freedom. The COVID-19 pandemic halted Ghana's rapid economic growth in March 2020, causing commodity exports to fall (Marques, 2021). Ghana's economy is expected to gradually recover in stability due to commodity price growth and strong domestic demand. From 2021 to 2023, annual growth is expected to average around 5.1 percent.

The discovery of petroleum resources in developing countries sparked hope for economic emancipation (Kemp, 1993). The discovery of petroleum resources in Ghana is significant because policies and measures are being put in place to ensure the nation's maximum benefit. Hydrocarbon exploration in Ghana began in the late nineteenth century. From 1896 to 1967, there was initial exploration. The second exploration phase lasted from 1968 to 1980. A total of 31 exploratory wells were drilled, yielding three discoveries (Ghana Gas, 2021). Ghana has four distinct sedimentary basins: western (Tano-Cape three points), central (saltpond), eastern (Accra-Keta), and inland voltaian (Ghana Gas, 2021). Petroleum production in Ghana began in December 2010, following the discovery of the Great Jubilee field in June 2007. Another discovery, the TEN

field, which included Tweneboah in March 2009, Enyenra in June 2010, and Ntomme in January 2011, began production in August 2016. Further exploration resulted in the September 2009 discovery of Sankofa Gye-Nyame (SGN) field. This is primarily a gas field that began production in May 2017. (Ghana Gas, 2021). The fiscal regimes that govern these petroleum discoveries in Ghana are capable of valuing them in monetary terms (Ashikwei, 2019). Fiscal terms define the extent to which the host government and prospective investor can share project risks and rewards (Ghana Gas, 2021). Petroleum fiscal regimes are classified into two broad categories: concessionary fiscal regimes (Royalty and Tax) and contractual fiscal regimes (Production sharing contract). Ghana's upstream petroleum sector is governed by a fiscal regime that includes royalties, carried and participatory interest, corporate income tax, addition oil entitlement, surface rentals, and other receipts (Ashikwei, 2019).

Problem Statement

Crude oil prices ensure that revenues from petroleum production taxation continue to support the national development and budgets of oil producing countries in Africa (Iledare, 2004). According to (Ghebremusse, 2014), petroleum rent extraction mechanisms have the potential to help oil-producing countries like Ghana fund infrastructure development in the medical and energy sector. The revenue generated has the potential to foster an enabling environment for greater economic growth and development in Ghana (Ackah & Kankam, 2014). Nwosi-Anele, Adeogun & Iledare (2018) and Mian (2010) stressed that fiscal regimes that give the host government substantial acess to petroleum revenue appear very favourable to the government but are unfavourable to the contractor and will not attract optimal investments.

Similarly, fiscal terms that are overly generous and favourable to investors will produce significant returns and may attract more investors, but might limit the host country's development objectives. Both extreme scenarios are not realistic and will ultimately not benefit neither the investors nor the host country (Mian, 2010). An analysis of the existing upstream fiscal regime of Ghana by Ackah and Kankum (2014), Ghebremusse (2014) and Ashikwei (2019) outlined some elements in the current upstream fiscal regime of Ghana which doesn't make the regime generate the optimum revenue. The elements are complex additional oil entitlement (AOE) and fixed royalty. According to Ackah and Kankum (2014), the AOE which is a major component of Ghana's existing fiscal regime has never generated any revenue since crude production started in November 2010. Ghebremusse (2014) and Ashikwei (2019) also stressed that the existing fiscal regime of the upstream petroleum industry of Ghana has a fixed royalty scheme that is incapable of capturing windfall profit. Such schemes also stiffen the development of small or marginal assets. These aforementioned challenges in the current upstream petroleum fiscal regime necessitated research to restructure, rebrand and redesign the upstream fiscal regimes in Ghana to expand value creation for petroleum resources development.

Purpose of the Study

The aim of this study is to evaluate the petroleum fiscal regime elements in Ghana to expand the economic value of petroleum resources development in Ghana. Specifically, the objectives of the study are:

- Assess the existing upstream petroleum fiscal regime underlying the oil and gas resource development in Ghana

- Develop and apply upstream petroleum regime economic modelling framework for optimal resources exploration and production that maximise value for stakeholders
- Quantify the risk and uncertainty inherent in petroleum business decision in Ghana using Monte-Carlo simulation technique

Research questions

- Does the existing upstream petroleum fiscal regime optimise government access to petroleum revenue ?
- Can there be a rebranded upstream fiscal regime that will maximise value creation for stakeholders ?
- What are the drivers of risk and uncertainty inherent in petroleum value creation in Ghana ?

Significance of the Study

Petroleum exploration and production have the potential to benefit the host country's economy and people if well managed, but they can also put undue economic pressure on the country if mismanaged. This study identifies the limitations in the existing upstream petroleum fiscal regimes in Ghana. The study proposes solutions to these limitations by restructuring and redesigning the upstream petroleum fiscal regime. The study applies a progressive royalty scheme rather than the fixed royalty rate and delay rent extraction mechanism. This research seeks also to quantify the various risks inherent in upstream petroleum industry. The study will assist the government in realigning the petroleum industry and providing a framework for policymakers, industry sector players, stakeholders, and legislators to use as a decision-making guide.

Delimitation

The scope of the research includes a review of Ghana's existing petroleum fiscal system and recommendations for improving it for value creation. Internal rate of return, net present value, profitability index and present value ratio are the variables considered when measuring the profitability of the petroleum business in terms of equity, efficiency, and effectiveness. The production profile that was used to construct the economic model is limited to the Great-jubilee field. Real- production data will provide us with an accurate picture of what is going on in the industry. To analyse the risk inherent in the business, a good risk analysis tool such as @Risk was used.

Limitations

The sample size for the research was a limitation of the study. The Jubilee field began production in November 2010, only 11 years ago, making it younger than the average production field in countries such as Nigeria and Angola, and thus not providing a broader scope for analysis. The availability of data was the second limitation. These are exclusive data that are not normally available on the GNPC website. As a result, it was very difficult to receive production profile data for the model development the field operator.

Organisation of the Study

The arrangement of this thesis are as follows; The first chapter provides a general introduction, which includes the background to the study, the problem statement, the purpose of the study, research questions, the significance of the study, the delimitation and limitation of the study, the organisation and definition of study terms.

The second chapter of the thesis is a review of relevant literature. These include petroleum resource development literature, theories, and concepts. The third chapter of the research focused on the study area, study design, and the development of petroleum economic models. The fourth chapter focused on the interpretation and discussion of the model results. The summary, conclusion, and recommendations are then covered in Chapter 5.

Definition of Relevant Terms

Oil and gas exploration-Is the searching of hydrocarbons by petroleum geologists and geophysics beneath the earth surface either on land or in the sea.

Foreign Direct Investment- It's an investment made by an investor or a company in another country of interest.

Petroleum Fiscal Regime - It's the extent to which the host government and the prospective investor apportion risks and share project reward (Mian, 2010).

Stakeholder - It's a person or a group of persons who have a common interest in a project or business venture.

Host Government Take - The portion of petroleum project reward and risks in a petroleum business that goes to the government or state.

Contractors Take - The share of petroleum project reward that goes to the investors or IOCs

Royalty - It's the part of the gross production of petroleum resources that the owner of the resource is entitled to. It is given either in cash or kind

Surface Rentals - It is the yearly rents payment done by IOCs to the state for leasing the surface of their land or sea for petroleum resource exploration

GNPC - Ghana National Petroleum Corporation

IOCs - International Oil Companies

NOCs - National Oil Companies

PSC- Production Sharing Contracts

ROR- Rate on Return

CHAPTER TWO

LITERATURE REVIEW

Introduction

A literature review searches for publications that are pertinent to the topic at hand, research area, theories, including books, dissertations, articles, conference proceedings, and other materials. This chapter's main objective is to emphasize the importance of the selected field of study while also pointing out fresh areas where contributions can be made. A theoretical overview or framework that examines the theories supporting the study's objectives is included in this chapter. An empirical review, which will look at research papers, theses and presentations made utilising a variety of approaches in keeping with the goals of the study, is also included in this chapter. The chapter will conclude with a conceptual framework that describes the methodology used in the research and extrapolates its implications for a wider field of study. In order to increase state revenue, the literature reviews research that has been done by others on the existing upstream fiscal structure and its effects on value creation in Ghana.

Theoretical Framework

There are many theories that cover the concept of value creation and the optimality of upstream petroleum investment for sustainable economic development. However, the Natural Resource Curse theory and Economics of Exhaustible Resources were used in this thesis because they best underpin the aim of the study. By focusing on these two theories, this study investigates how restructuring, rebranding, and redesigning upstream petroleum fiscal regimes

will improve value creation under different upstream petroleum arrangements (Smith 2004).

Natural Resource Curse theory

The phenomenon in which natural resource development has no positive economic growth impact is known as the "Natural Resource Curse" (Nashiru, 2019). The survival of human life is seen to depend critically on the conservation and preservation of natural resources (Guan et al, 2020). The world is experiencing constant uncertainty and change, particularly in terms of socioeconomic and geopolitical conditions (Samlafo, 2019). The ongoing exploration and extraction of resources negatively impacts more than simply the availability of natural resources in the future. However, it also degrades and harms the current ecosystems and environment (Amissah, 2019). Therefore, maintaining the earth's biological diversity is a topic that has been discussed over the past few decades by academics and decision-makers (Nashiru, 2019; Guan et al., 2020).

It is obvious that nations, both industrialised and developing, struggle to strike a balance between the consumption of natural resources and economic progress (Guan et al., 2020). Additionally, scientists concur that Green House Gases (GHG) and CO_2 emissions are to blame for the current unfavourable environmental scenario (Guan et al., 2020). However, the scenario is also negatively impacted by the overuse of natural resources without assuring their conservation, contributing to the imbalance in biodiversity (Amissah, 2019). However, such detrimental impacts on natural resources would lead to a lack of fundamental ecosystem resources and services, such as clean air, food, etc. This unfavourable circumstance compels the nations to concentrate on sustainable

resource extraction and harvesting (Guan et al., 2020; Nashiru, 2019). Countries all across the world have entered into numerous agreements and commitments in the same quest (Nashiru, 2019).

For instance, nations concurred to limit temperature increases to 1.5 °C or below by 2020 in a United Nations agreement on climate change (Guan et al., 2020). Similarly, in accordance with the United Nations Development Programme, the signatory countries agreed to put policies and practices into place that not only strengthen economic growth and development of their respective countries, but also play their role as stewards to encourage preservation. The preservation of natural resources promote a culture of stewardship for the resources for future generations to benefit from it (Guan et al., 2020).

Rents from natural resources are not a negative factor. We are able to benefit from natural resources in different ways, which have helped nations like Botswana and Norway overcome the resource curse. By strengthening economic and management systems, it will be possible to minimise any negative effects and generate enough rental income (Nashiru, 2019). Thus, one strategy for accelerating economic growth and avoiding the resource rent curse is to use the developed financial institutions (Guan et al., 2020). It is already understood that there is a negative correlation between the richness of natural resources and financial development, however other studies provide conflicting evidence (Guan et al., 2020).

According to the resource curse idea, the state's institutions and economy suffer as a result of petroleum exploration and its effects (Amiesa et al., 2018). The hypothesis, also referred to as the paradox of abundance,

contends that nations with a lot of natural resources experience slower economic growth, less democracy, and less successful development than nations with little or no natural resources. The research is most compatible with this argument since Ghanaians are aware of the country's exploration and petroleum production, but they feel that it does not benefit them, and the government continues to complain about poor revenue creation, leading to increased taxation of the populace. As a result, this research offers an essential policy directive on how to utilise natural resources effectively for the financial development of the nation while also imparting a priceless lesson from a global viewpoint.

The Economics of Exhaustible Resources

The demand for regulation of exploitable mineral resources arose as a result of the realisation that these natural resources are finite. Humans have the selfish belief that because natural resources are abundant and inexpensive for future generations, they should exploit them as soon as possible (Hotelling, 1931). As a result of this, excessive cheapness has resulted in the conservation method being used to control the wholesale devastation of these irreplaceable natural resources. Assume a global tax on fossil fuels was enacted, and governments all around the world agreed to a future schedule of levies thought necessary to balance the negative and positive effects of oil use. In light of climate change, would this development be beneficial?

It might not, according to one theoretical advancement. According to the "green paradox," dynamic factors may undermine the tax's goals by encouraging firms to move production to the present (Marques et al., 2014). As a result, damages would rise both immediately and over the next few months. The supply of oil is limited by using Hotelling's rule, the economics of finite resources. The

rule, which can be expressed in its most basic form, states that, in an equilibrium, the net price that is, the price less marginal costs and marginal taxes increases at the rate of interest.

According to Mohr (2016); Cairs (2013) and Hotellings (1931), the justification for the "green conundrum" is a straightforward application of the "exhaustible resource extraction and use rule," which specifies the ideal timing for resource extraction and usage. The tax may cause producers to "tilt" their production in favour of the present by altering the relative net worth of a unit of oil at various future times (as opposed to the initial equilibrium without the tax). Greater emissions could be induced now and over the next few years. The earth's supply of fossil fuels is fixed, thus today's higher emissions come at the expense of emissions in the years to come (in the most basic models, production shifts by a factor of one). Other ways to combat the climate problem may be available by then. Ironically, the tax, which was designed to address the issue of climatic change in the short and medium terms, may make it worse and offer only modest relief in the long term.

Petroleum resources that fall under these exhaustible resources must be managed or exploited with caution, because a barrel of crude produced today does not guarantee a barrel of crude tomorrow.

This theory emphasizes the importance of prudent management of Ghana's petroleum resources over the last ten years. The significance of this theory to this research is that it informs the researcher that because petroleum resources are non-renewable, their production must be managed carefully in order to benefit future generations. Effective management also includes maximising Ghana's benefit from the petroleum business. There has been public

outrage over the fixed royalty of 5 %, which Ghanaians consider to be extremely low. A 5% flat royalty provides an easy cash flow to the host government, but will these early generation leaders sacrifice the maximum revenue that will benefit future generations in order to enjoy their selfish early cash flow that is cheap and easy to obtain? Again, the theory will aid in raising awareness and ensuring that the host government achieves pareto optimality.

Conceptual Framework

Global fiscal regimes

Every country has a tax framework that is appropriate for extracting rent from businesses and individuals. Any company is likely to pay taxes to its country of residence in the form of corporate tax, VAT, and possibly withholding tax. The rate mechanisms and details are entirely at the discretion of the country, but they should not differ from standard business rates. The mobilisation of rent-seeking mechanisms put in place for petroleum taxation is known as a fiscal regime or fiscal system. Most countries have their own method of designing their fiscal regime, which they frequently update. Some countries have a single system for all resources, whereas others have separate systems for each region.

Regime Types

Royalty/tax regimes, production sharing contracts (PSC regimes), and service contracts are the three types of fiscal regimes (SC regimes). Within each group, they are further subdivided into subregions. Most regime categorisation names are more likely to be determined by the contract in the regime than by its broad name. If you choose a license, you will be required to sign a contract that will see you through the exploration, development, and abandonment phases.

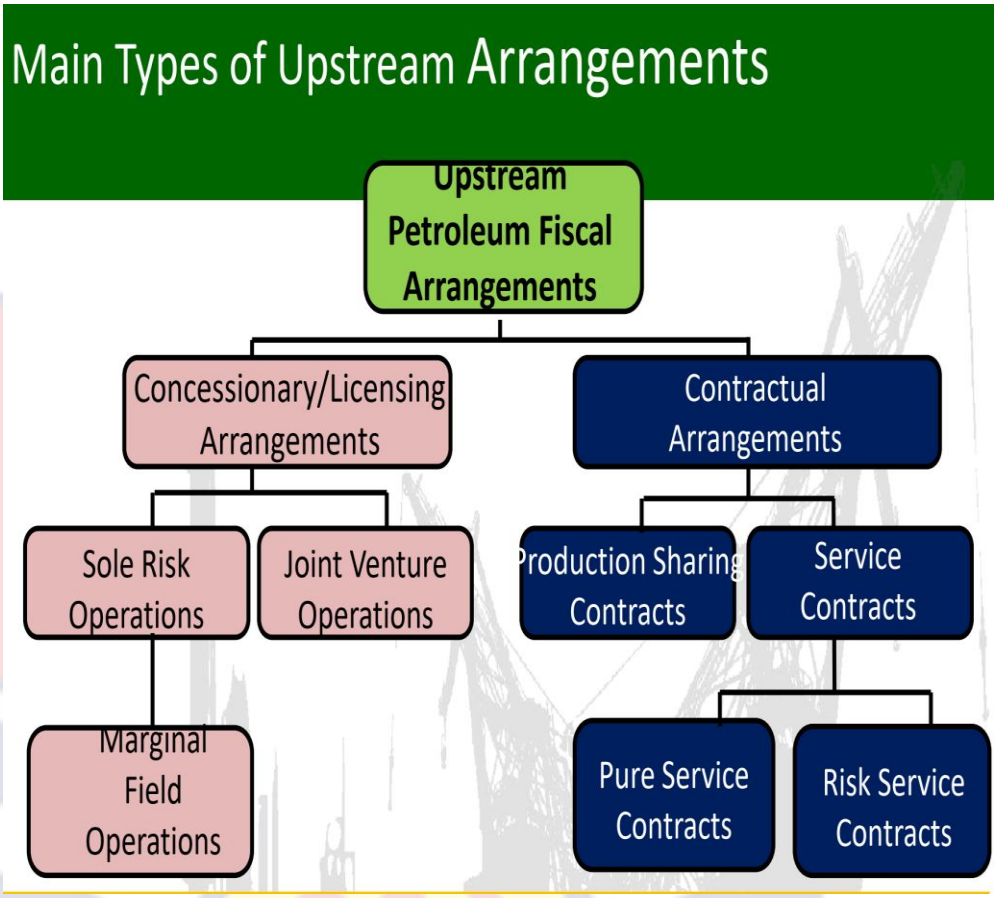


Figure 1: Fiscal system framework

Source: Iledare (2011)

There are two types of upstream fiscal arrangements: concessionary and contractual. The concessionary allows for private ownership of resources through right transfer with payments to the host country in the form of bonuses, royalties, and taxes. Companies assume all risks and funds for operations under this arrangement (Iledare, 2011). It also includes several fiscal devices such as layers of taxation methods and flexible levy systems, as well as a relinquishment clause that holds investors liable for abandonment and restoration.

The host government retains ownership of the petroleum resources under the contractual systems. This system is further classified into two broad groups. Service contracts (Pure or Risk) and production sharing contracts (Psc) or PSA are the two types. A sound fiscal framework, consisting of laws,

regulations, and tax agreements that control the revenues of extractive industry operations, is required to ensure that the government receives fair and appropriate revenues from the sector and to attract investors. Petroleum Fiscal Systems (PFS) are the legislative, tax, contractual, and fiscal elements that support exploration and production operations in a petroleum province, region, or country (Iledare, 2004).

The goal of the PFS is to assess how investments are recovered and earnings are distributed equitably among companies and host governments. It is also in charge of allocating the rights to establish and operate specific businesses within a country (Campbell et al., 2001). Mineral rights can be owned by individuals or states, but in the Gulf of Guinea (GOG), they are almost entirely controlled by the national government (state). The federal petroleum law governs all petroleum operations. Such laws frequently grant significant discretionary powers to federal administrative or legislative entities (Mian, 2002).

According to Iledare (2004) the most common provisions and regulations in PFS have to do with the following:

i. Type of permit, contract, or concession;
ii. Size, shape, and geographic limits of area to be explored and developed;
iii. Initial or primary term and extensions. If exploration efforts are successful, typical contract terms are for 20 to 30 years;
iv. Fees and bonuses;
v. Relinquishment or surrender;
vi. Selection and convertibility of acreage;

vii. Assignment or transfer of acreage, lease, or concession;

viii. Royalty payments, sharing profits, and cost recovery;

ix. Tax obligations;

x. Obligation to supply domestic markets first and building local refineries;

xi. Employment and training of nationals; and

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

Basic forms of fiscal agreement

The two primary and comprehensive mechanisms for providing rights to oil investors are the concessionary system and the contractual scheme. The concessionary system is thought to have begun in the mid-1800s and is mostly used in OECD countries, whereas the contractual system began in the mid-1950s and is mostly used by developing countries (Nakhle, 2010). Higgins (2013) point out that when looking at current fiscal regimes in some oil-rich countries, concerns such as the type of fiscal regime that should be in place and the tax rates that should be imposed can be considered. It's worth noting that under concessionary regimes like Norway's, where the host government keeps 78 percent of the revenue, highly onerous fiscal terms can be imposed. Similarly, in the 1980s, the British government received roughly 90% of the proceeds from oil sales. According to Nakhle (2010), among the countries that operate a concessionary framework in which companies are entitled to ownership of the oil extracted are Canada, the United States, Brazil, and Norway. Countries such as Algeria, Angola, Nigeria, and Azerbaijan, on the other hand, have a contractual framework in which the government retains

ownership of the petroleum produced through production sharing contracts (PSCs) or production sharing agreements (PSAs).

Concessionary Systems

A concession is an agreement between a government and a company where the company gets exclusive right to explore, develop, produce, transport, and market petroleum resources for a set length of time, at its own risk and expense, within a defined area (Marques, 2021). The characteristics of the concessionary system according to Nakhle (2010) are that:

- The petroleum resources in the ground or under the seabed are the property of the state
- The oil company has the right or title to produce oil at the wellhead and has to pay the appropriate taxes and royalties to the state. Royalties are the payment for the extraction of natural resources.

Contractual system

The contracting approach gives the host government more control over both petroleum operations and ownership of production. Production sharing contracts (PSCs) and risk service are two types of contractual regimes used by some petroleum-producing countries. Contractual systems emerged as a result of efforts to change the nature of international oil companies' relationships with host governments. Above all, it was to replace the concessionary system, which was discovered to be incompatible with government sovereignty as a result of global political changes in the second half of the twentieth century (Echendu, 2011).

Components of Ghana's Upstream Fiscal System

1. Royalty

   The state that owns the resource is entitled to a portion of the gross production before any deductions are made. This entitlement can be paid in cash or in kind (oil), though the state has always received it in kind. The royalty rates on gross production for Ghana's three producing fields, namely the Great Jubilee, TEN, and SGN, are 5%, 5%, and 7.5%, respectively.

2. Carried Interest

   In the sense that the state does not pay or contribute any money during exploration or development activities, the state is 'carried' by international oil companies (IOCs) or petroleum investors. However, once the IOCs reach a commercial quantity and production begins, Ghana must pay her share of the cost, which must be at least 15%.

3. Participating Interest

   In the event of commerciality, Ghana can increase her stake in participation in the declaration of discovery within a specific time frame. If the state decides to increase its interest, it pays for costs inquired from that stage upwards, including development and production costs. Normally, additional interest cannot exceed 25% under current petroleum agreements.

4. Corporate Income tax

   This is a tax placed on the profits of oil and gas companies in Ghana. The tax is valued at 25%.

5. Surface Rentals

   Surface Rentals are yearly rent payments made by IOCs to the state in exchange for the right to explore for petroleum resources on the surface of

the land or sea. They are paid in dollars per square kilometre of land operated by the area's licensees. In Ghana, the surface rental payment ranges between $30 and $100 per square kilometre.

6. Additional Oil Entitlement

   In this instance, the state becomes entitled to an additional percentage of the IOCs share of crude oil on each separate producing field once profitability passes certain agreed rate of return thresholds. For Ghana's case, it has been a maximum of 30% government take.

International oil firms operate their petroleum activities in line with the terms of their contract with the host government, operating at their own risk and expense under the host government's authority despite offering the necessary money and technology, claims Iledare (2011). The contractor is paid a share of the profits or a cash fee for its services if production is successful after the exploration and development costs have been covered.

Empirical Review

The state of the Ghana's economy

Ghana is an independent country located in western Africa. It borders Togo on the east, Cote d'Ivoire on the west, and Burkina Faso on the north, and it sits on the Atlantic Ocean. In 1957, it became the first Sub-Saharan country to gain independence from the British. It has a population of 32 million people and is ranked 47th in terms of population in 2021 (Marques, 2021).

For the past 20 years, Ghana has made great strides toward democracy under a multiparty system. Following the rebase of Ghana's economy in November 2010 with a change in the base year from 1993 to 2006, Ghana is now declared

a lower middle income earning country, with a debt to GDP ratio of 63% (Terkper, 2013).

Ghana was ranked among the fastest growing economies in 2019 with a growth rate of 6.3% to 7.1%. This was achieved through macroeconomic instability, which has been a long-standing cause of inflation (Terkper, 2013). In terms of macroeconomic performance, Ghana's overall real GDP (Gross Domestic Product) increased by 7.0% in 2019 compared to 6.3% the previous year. The overall growth rate in Sub-Saharan Africa (SSA) was 3.8%, implying that GDP growth in 2019 was higher than the overall rate. In the first quarter and second quarter of 2019, real GDP growth from oil was 6.7% (Terkper, 2013).

Crude Oil Contribution to the Economy of Ghana

Crude oil can be used as a lure to attract investment and development in the country. Foreign Direct Investment (FDI) is a long-term investment that operates outside of the investor's economy (Amissah, 2019). Foreign direct investment (FDI) is critical to the development of most developing economies. From 2002 to 2008, FDI inflows into developing-country economies increased, reaching $114.30 per head in 2008, while developed-country economies received $944.89 per head. In the same year, Africa received an ever-increasing share of $87.65 billion (Terkper, 2013). African countries with abundant natural resources attract more foreign direct investment than countries with limited resources.

Ghana has a wealth of natural resources that attract foreign investment. Over the last decade, US oil companies alone invested more than $40 billion in African oil producing countries. Crude oil investments now account for more

than half of all FDI inflows to the continent (World-Bank, 2009). As discoveries and explorations increase in Ghana, FDI in the oil and gas industry and other sectors of the economy are expected to increase. Ghana's oil reserves are estimated to be between 1.8 and 5 billion barrels, according to economic analysts. The reserve is expected to attract foreign investors, resulting in an FDI and economic development of 3.6 billion barrels on average (Ugbomeh, 2008). Foreign investments in firms, building and construction, hospitals, food and beverage, and other industries will provide services to these multinational oil companies, and the dormant local energy industry is expected to be revitalised. For government revenue, the World Bank estimated a potential revenue of US$ 1 billion per year between 2011 and 2029 at a price cap of $75 per barrel (Ugbomeh, 2008).

The Upstream Oil and Gas Industry Revenue Management

Ghana's parliament passed an important governance reform to manage revenue from the upstream industry in 2011. This resulted in the Petroleum Revenue Management Act, 2011 (ACT 815), which was enacted to manage petroleum revenues. The primary purpose of the act is to establish a framework for accounting for the receipts and expenses of oil and gas revenues. Also outlines investment and savings guidelines in accordance with industry practices. The act was then amended in 2015 to address some omissions and deficiencies ("Driving socio-economic development through diversification of gas utilisation" 2021**)**. This act gives journalists, civil society organisations, and politicians the authority to conduct forensic investigations into how the government manages revenue from crude oil sales. Although it has its own operational challenges, industry stakeholders have described the Petroleum

Revenue Management Act as one of the outstanding progressive petroleum management policies. The act is also intended to increase transparency and accountability in order to provide citizens with more information about the management of petroleum revenues.

The laws and policies that govern the upstream petroleum activities in Ghana

The legal and regulatory framework for the upstream petroleum development in Ghana is governed primarily by:

1. The 1992 constitution of Ghana
2. The Ghana National Petroleum Corporation Act, 1983(PNDC law 64)
3. The petroleum Income Tax Act, 1987(PNDC law 188)
4. The Environmental Protection Agency Act 1

Sources of the Petroleum Revenues

Oil and Gas revenue mobilisation by the government is obtained from a number of sources. Some are collected due to petroleum extraction activities whilst others are levies on corporations.

The following are some of the major revenue sources:

1. Royalties
2. Carried Interest
3. Additional Interest
4. Corporate Income Tax
5. Additional oil Entitlement
6. Surface Rentals
7. Other receipts

Following the mobilisation of petroleum revenue, it is deposited in the Petroleum Holding Fund account at the Bank of Ghana. The petroleum holding fund is a fund at the Bank of Ghana that receives all of the state's petroleum payments. The petroleum holding fund is used for all allocations and disbursements ("Driving socio-economic development through diversification of gas utilisation" 2021**)**.

Revenues collected and accessed by the Ghana Revenue Authority (GRA) are paid into the Petroleum Holding Fund (PHF) by the 15th of each month; failure to pay will result in a penalty of 5% of the original amount. In some cases, the government receives petroleum revenues in kind rather than cash. The "kind" in question is crude oil. In such cases, the GRA obtains the actual date the crude is received in order to keep track of the fluctuating oil price. The proceeds from the sale of petroleum are then deposited into the PHF within 60 calendar days; the money in the PHF is not kept indefinitely, but is disbursed in accordance with established rules and procedures.

To begin, the Petroleum Revenue Management Act (PRMA) guarantees payment to the national oil company, Ghana National Petroleum Corporation (GNPC). This money is to cover their operating costs and the interests they hold in petroleum agreements. After deducting equity financing costs, the amount transferred to GNPC cannot exceed 55% of the revenue received from carried and participatory interest.

The same amount is also transferred to the Annual Budget Funding Amount (ABFA), which is one of the primary channels through which the nation's budget is supported. The PRMA requires the ABFA to give priority to government programs in 12 areas. However, the government is not supposed

to address more than four areas when submitting activities that will require the use of petroleum revenue. The parliament is required to approve any funds allocated to the ABFA as part of the national budget and spending allocations, which it does every three years. The government prioritised loan expenditure and amortisation for oil and gas infrastructure, road infrastructure, agriculture modernisation, and capacity building (including oil and gas) over the last six years, from 2011 to 2013 and 2014 to 2016 (Terkper, 2013).

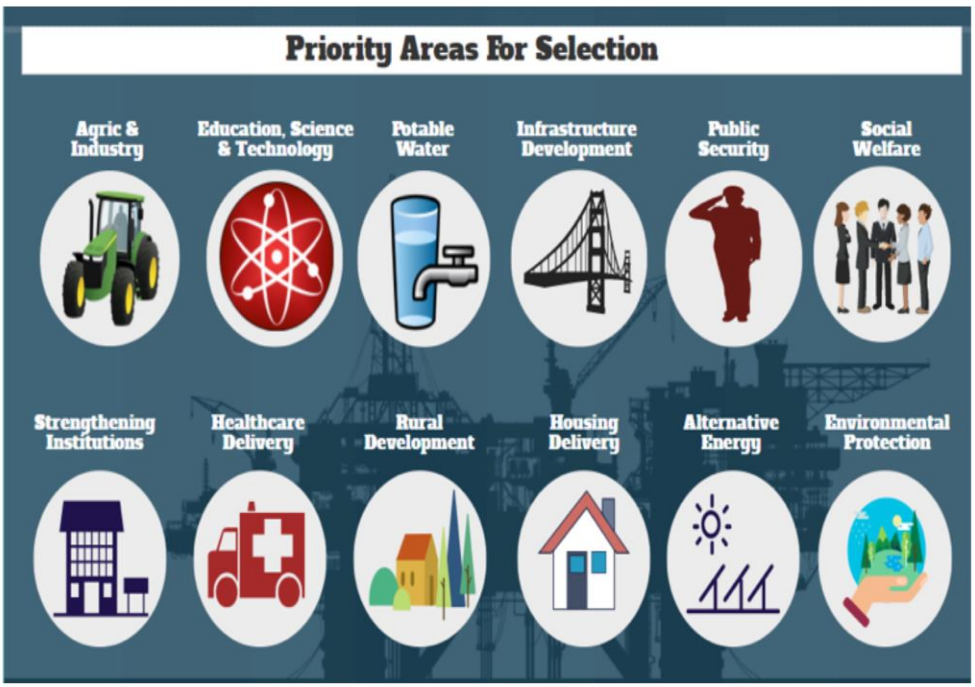


Figure 2: Priority areas

Source: Piac report (2022)

Agriculture, physical infrastructure and delivery in health, roads, rail and education have also been chosen for 2017 to 2019. The ABFA is only allowed to receive 70% of petroleum revenue. A maximum of 25% of the ABFA is allocated to the Ghana Infrastructure Investment Fund (GIIF); additionally, the law provides that the ABFA can be used to settle government collateral for debt and liabilities for a period of no more than 10 years from the start of the PRMA.There are also the Ghana petroleum funds, which consist of the Ghana

Stabilisation Fund (GSF) and the Ghana Heritage Fund (GHF), which serve as channels through which savings and investments are made when excess petroleum revenues accrued to the Ghana Petroleum Fund (minimum of 30% as mandated by the PRMA) are sent to the Ghana Heritage Fund to serve as inheritance for unborn generations for their development when petroleum reserves deplete.

The funds are invested outside of Ghana in a favourable investment environment, and the transfer restrictions will be reviewed by parliament every fifteen years. The remaining balance in the Ghana petroleum funds after the transfer to the GHF is then set up to support the government's budget in times of shock and unexpected shortfalls. The stabilisation fund receives no more than 70% of funds from Ghana's petroleum funds. The Ghana Petroleum Wealth Fund is another option (GPWF). This is the consolidation of the Ghana Heritage Fund and the Ghana Stabilisation Fund into a single fund after the country's petroleum reserves are depleted within a year; both funds will cease to exist once the consolidation is completed (Sam-Okyere 2010).

The State of the Upstream Petroleum Industry of Ghana

Petroleum exploration can be traced back to the nineteenth century. The first exploration took place between 1896 and 1967. Then came the second exploration phase, which lasted from 1968 to 1980. The second exploration phase was intense, taking place offshore, with 31 wells drilled, leading to the discovery of sedimentary of three basins. These basins are located on Cape Three Points (Salt pond, the North and South Tano). The third exploration phase took place between 1981 and 2000. This third phase saw the creation of a new regulatory and legal framework. The industry is now in its fourth and most

recent exploration period, which began in 2001. Deepwater is the focus of the current phases.

Upstream Development and Production in Ghana

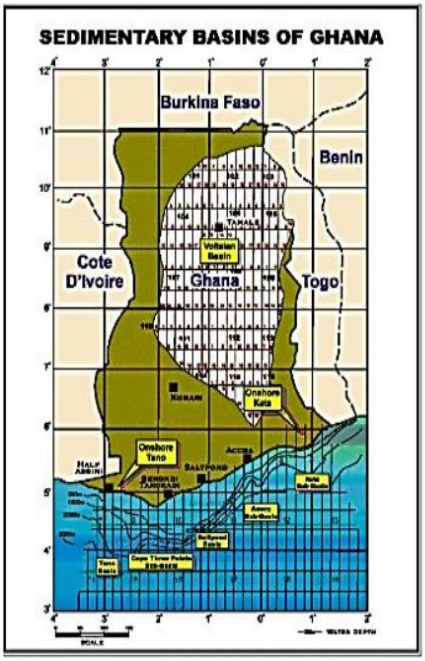
After the various exploration phases, Ghana now has four (4) distinct sedimentary basins. They are:

i) Tano-Cape three points.

ii) Salt pond

iii) Accra- Keta

iv)Voltaian basin



Basin	Status
Tano-Cape Three Points	Shallow/Deepwater well explored; Ultra deepwater unexplored
Saltpond	Shallow water moderately explored
Accra-Keta	Shallow water moderately Explored; Deepwater poorly explored
Voltaian	Huge Potential Untested; Barely Explored

F*igure 3*: Sedimentary basins in Ghana

Source: Ghana Gas (2021)

Petroleum production started in December 2010 after the discovery of the Jubilee field in June 2007. It followed with the discovery of the Tweneboa Enyenra Ntomme (TEN) field in 2000, which achieve first production in August 2016. Again in 2009, another discovery was made and that was Sankofa Gye-

Nyame (SGN) which is also known as the offshore Cape three points (OCTP) which started production in May 2017.

Table 1: Hydrocarbon Production by field

Field	Year	Volume (Barrels)
G. Jubilee	2010-2020	312,462,457.00
TEN	2016-2020	89, 447,751.00
SGN	2017-2020	52,111,984.40
		454,022,192.40

Source : Ghana Gas (2021)

General Elements of Petroleum Fiscal Regimes

Royalties, resource rent taxes, auctions, and income taxes, which include equity participation, service agreements, and production sharing agreements, are important elements of petroleum fiscal regimes (Blake & Roberts, 2006).

Royalties

African governments hope to receive a portion of the extra money generated by oil companies after accounting for capital and labor expenditures. Royalties are one method of accomplishing this. As the resource owner, royalties allow national oil companies to keep a portion of resource rents. The royalty rate can be determined by the value of the extracted resource, the company's profits, or the weight of each unit of the resource. The unit-based method establishes royalty at a fixed rate. The unit-based method may be appealing to states because it reduces the impact of fluctuating oil prices on the money collected. The value-based and profit-based systems, on the other hand, use a variable rate that is linked to the value of the resource and the profitability

of the extractive operation, influencing the amount of money generated by the state (Blake & Roberts, 2006). Royalties, according to Ashikwei (2019), are a desirable fiscal mechanism for governments because they guarantee a portion of revenue as soon as extraction begins. Royalties are also advantageous when oil prices are high, but they expose the host government to significant risk if the price falls dramatically.

Furthermore, the government's share of revenue is conditional on full disclosure from oil companies, which does not always happen. Companies may purposefully falsify revenue figures in order to avoid paying higher royalties. According to (Blake & Roberts, 2006), royalties may influence a company's investment decision due to their impact on profitability. This effect is influenced by the royalty rate charged, particularly if the future level is lower than the current value, as it makes extracting tomorrow more appealing than starting production today. Royalties can also influence a company's decision to continue operations, particularly when oil prices are insufficient to cover both extraction costs and the royalty.

Resource rent taxes

A resource rent tax is another revenue tool that a government could use to get its fair share of economic rent. This instrument has the added benefit of being less distortive in the oil and gas industry. In countries such as Australia and Papua New Guinea, only projects with positive accumulated cash flows are subject to this tax (Ashikwei, 2019). Typically, the tax is "back-loaded," which means that revenue from this instrument is generated later in the project. If the project is profitable, the government is likely to profit from it. As a result, governments should use this revenue tool in addition to other revenue tools like

royalties and standard profit tax. Having an appropriate ring-fencing regime in place will ensure that governments get the most out of this revenue tool.

Today, there are several types of resource rent taxes in use. The majority of the distinguishing features vary depending on the tax base used as the computation unit and the possibility of distortionary effects. The R-based cash flow tax, also known as the Brown tax, is levied on a producer's cash flow, which is defined as "all real (rather than financial) cash transactions." As a result, the tax's base is defined as "all revenue from output sales less all cash outlays for all input purchases, capital and current." Interest and other financial expenditures are not deducted because they are already accounted for in the tax system (Iledare, 2011).

Auctions

Unlike royalties and resource rent taxes, auctions provide governments with a source of revenue that is not contingent on the success of an extractive project. Auctions serve two purposes for oil-producing countries. They do this by first assigning extraction rights to potential investors, allowing national governments to determine the best royalty or taxation structure during the process, and then by allowing states to collect cash. Auctions can be conducted in a variety of ways. Only a few examples include open or closed bids (which require businesses to submit technical applications) and "simple rationing schemes." Other important auction design considerations include clearly defining the physical rights being auctioned as well as the length of time the rights are available (Blake & Roberts, 2006).

Auctions are praised for leveling the playing field between national governments and extractive companies. According to Mian (2010), extractive firms and governments have "asymmetric information." With their extensive experience in oil production around the world, multinational corporations are likely to be more knowledgeable about the value of resources and the cost of production than less well-informed national governments. As a result, a government may be convinced to accept a lower price for extraction rights. Auctions can prevent this from happening because competition among sellers reveals the true value of the rights and the costs of production.

The government's ability to maximise revenue through an auction is dependent on factors such as bidder preferences and the characteristics of the rights being auctioned. This system has the potential to limit the amount of revenue that national governments can receive, which could be in the form of a one-time payment or a combination of one-time payments and royalties. The existence of asymmetrical knowledge among bidders has an impact on maximising the amount of income from an auction. According to Boadway and Keen (2010), bidders may have conflicting information about the value of the resource, which may lead to cautious bidding if the true value is unknown.

Income Tax

In most countries, companies in the oil and gas industry pay a higher rate of income tax than companies in other sectors of the economy (Blake & Roberts, 2006). According to Nakhle (2010), the general level of corporate income tax rate varies significantly across countries. The tax rate, on the other hand, ranges from 25% to 35%. Oil and gas companies in Ghana pay a corporate tax rate of 35%, which is higher than the 25% charged in other industries. As a

result, Ghana's corporation tax rate in the oil and gas sector, at 35%, falls within the range, albeit near the top.

When adjusting corporate taxes for oil companies, national governments may take into account a number of factors. First, states may decide to levy a separate corporate income tax on oil corporations, with a different rate than the tax imposed on other corporate entities. This method may benefit national governments because it allows them to levy higher fees, to the detriment of oil companies. Second, governments may choose to levy the corporation tax at the project level rather than the business level. This technique, according to Baunsgaard et al. (2010), should be used with caution because it may cause distortions in investment levels. As a result, firms may be discouraged from expanding their exploration and production activities because the measure limits a company's ability to offset losses, which are common in the early stages of oil production (Tadjoeddin, 2007).

Mian (2010) conducted research on the topic "Designing Efficient Fiscal Systems." Mian's paper focused on fiscal system design issues for hydrocarbon exploration and production. The study discussed how an ideal fiscal system has variables that influence the outcome. According to the sudy, fiscal agreements are typically reached between the host government and 1. an international oil company (IOC), 2. an international national oil company (INOC), or a consortium of IOCs and INOCs. He emphasized that there are three major types of agreements.

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)

The research also analysed and compared two fiscal systems to demonstrate how Government Take (GT) and the contract's ROR vary with changing boundary conditions (field size and product prices). For fiscal system A, which is a slightly modified version of Kazakhstan fiscal terms, progressive royalty, economic rent tax (ERT), corporate tax, and excessive profit tax are all included. Fiscal system B is an alternative to fiscal system A that includes a progressive royalty of 5% if the ROR is less than 5% and 20% if the ROR is greater than 12%. If ROR is 10%, corporate tax is 30%. Also, if the contractor's pre-EPT ROR is 15%, the EPT rate is 6%.

To calculate GT, the researcher typically used undiscounted net cash-flow (Mian, 2010). The GT rises as the reserve rises. This makes sense because the Host Government should recover a higher percentage of the incremental benefits as the project's profitability grows (Mian, 2010).

The comparison was good, but it would have been better if the researcher did sensitivity analysis on the various indicators to assist various parties in making decisions (Mian, 2010).

Samanhyia (2016) investigated the fiscal regime of Ghana's oil and gas industry: a precommercial production review.

The fiscal regime of a country is a critical deterministic for prospective investors 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 hybrid fiscal system, which combines elements of concession, production sharing agreement (PSA), and state participation. The amount of revenue Ghana receives from upstream petroleum operations is largely determined by the effectiveness of the fiscal regime that governs her oil and gas industry.

There is currently no well-defined fiscal system for the deep offshore jubilee field. Furthermore, due to the nature of investment packages, as well as weak laws and insufficient administrative capacity in the industry, Ghana currently earns a relatively smaller share of petroleum revenue. As a result, the researcher's goal is to amend the current petroleum tax laws in order to protect state revenue from all petroleum operations in Ghana. The researcher conducted research on the Jubilee oil field in Ghana and dubbed it the world's fastest well-tracked development because it took three years and four months from discovery to production, whereas the global average was six to seven years. The study considered the Petroleum Income Tax Act of 1987 (PNDC law 188), the Internal Revenue Act of 2000 (Act 592), the Value Added Tax Act of 1998 (Acts 546), and the Customs Excise and Preventive Service (Management) Act of 1993. (PNDCL 330).

Royalty/tax systems and production sharing contracts are the two main types of fiscal systems. Ghana uses the Royalty/Tax systems, which generates little revenue for the government because the laws are very old. Finally, some changes and amendments are to be made to the laws in order to give the state a little more than she was collecting in order to boost her economy.

Iledare (2004) investigated "Analysing the impact of petroleum fiscal arrangements and contract terms on petroleum exploration and production economics and the Host Government Take". The study investigated the effects of fiscal terms and system parameters on the performance profile of exploration and production ventures and the associated government take under various fiscal arrangements. The researcher stated that over the last three decades, nearly 200 percent of Nigeria's produced reserves have been replaced by new

reserves, which compares favourably to the global reserves replacement rate of 183% during the same period. The study stated once more that for E&P to grow and positively impact the Nigerian economy, the manner in which an E&P activity is funded and the petroleum fiscal regime is specified and negotiated is critical. As a result, oil has become the engine that has driven the Nigerian economy over the last 30 years, accounting for nearly 80% of government revenue and 90-95% of foreign exchange earnings, assisting in GDP growth.

The researcher incorporated the fiscal system and terms that drive the E & P ventures and operations into a discounted cash flow model for the production sharing and joint venture agreement in his paper. Under technical uncertainty conditions, he used the model to investigate the effects of the selected fiscal system metrics on the E & P profile performance and the corresponding government actions. The study examined the discounted cash-flow modelling framework with product prices and reserves as technical parameters.

Finally, he investigated the effects of selected fiscal terms and their corresponding government take under the PSC or JVA using the discounted cashflow model.

In base case scenarios, the researcher empirical results show that the contractor would prefer the PSC arrangement to the JVA under the defined terms. He also discovered that certain fiscal parameters in the cashflow model have asymmetric responses while others do not. For example, at lower prices than the baseline oil price, responsiveness is more inelastic than at higher prices. The researcher did not conduct any sensitivity analysis to support his conclusion that PSC is superior to JVA.

Back (2003) performed research in preparation for a discussion on the influence of international fiscal regimes on portfolio selection in the petroleum industry. His study concentrated on the problem corporate planners in a multinational oil company faced when assessing potential investment opportunities across diverse regional and fiscal regimes. The researcher noted that dealing with economics in various global fiscal regimes, such as production sharing contracts (PSC), should necessitate the use of advanced modelling skills, iterative computations, and consolidated economics at a field or block level. Moreover, he turned to investigate what would occur if the effects of various widespread international fiscal regimes were contrasted with both traditional project ranking and cutting-edge portfolio management techniques used in the capital investment process for exploration and production. The researcher also examined the effects of standalone versus integrated project economics at the PSC level.

For the researcher's investigation, he employed detailed economic modeling together with discounted cash flow (DCF) analysis to assess petroleum assets under alternative fiscal regimes. Along with the discounted cash flow, he used traditional discounted and undiscounted economics. Examples of indicators used for evaluation include net present value (NPV), payout, profit investment ratio (PIR), and rate of return (ROR).

These economic measurements or indicators, together with the government and contractor approach, provided a strong forecast of the profitability and risk of a certain profit venture. In the end, he determined that, in contrast to stand-alone economics, the viability and composition of the portfolio were not greatly impacted by the integrated area of economics. Furthermore, he discovered that

the after-tax cash flow profiles of the portfolios created using stand-alone economics were more favourable to Malaysia's fiscal regime and less favourable to Australia's fiscal regime. Discounted cash flow modeling, the method he employed, would be helpful in my research because I will be evaluating Ghana's current fiscal structure as well as that of several other African countries. The researcher's selection of profitability indicators (such as NPV, ROR, etc.) will also help me because it will be possible for me to evaluate the profitability of each fiscal policy and investment opportunity included in my study. It was highlighted that he did not include sensitivity analysis and decision-making processes to estimate risk and uncertainty in his evaluation of the fiscal regimes he examined.

Dharmadji and Parlindungan (2002) researched on fiscal regimes competitiveness comparison of oil and gas producing countries in the Asia Pacific region: Australia, China, India, Indonesia and Malaysia. The researchers in this study compared and studied the fiscal regimes of the countries mentioned above in order to assess the advantages and disadvantages of each fiscal regime. They applied the same hypothetical fields to each fiscal system before discussing the results. For the most accurate assessment of the various fiscal regimes of the countries, they used complex economic modeling and cash flow analyses. They used the same production estimate, pricing projection, operating cost, and capital cost to calculate typical indicators such as Net Present Value, Rate of Return, Payout Time, Profit Investment Ratio and Contractor Take. They utilised NPV to compare the competitiveness of the fiscal regimes because it is the most popular measure. Australia's government take is assessed as having a very favourable system by its economic criteria, followed by China, India,

Malaysia, and Indonesia. They also came to the conclusion that the terms of each fiscal regime affect the contractor's take, NPV, and cash flow. This thesis will be contrasting Ghana's current fiscal structure with that of other African countries in order to give a clear assessment to the existing fiscal regime so their method deployed in this paper will utilised cash flow modelling will be helpful. They came to the conclusion that a contractor must possess a thorough understanding of financial concepts in order to make wise investment decisions, but in my opinion, the inclusion of Monte Carlo simulation into the work to quantify risk and uncertainty would have been great so they provide clear investment decision for investors and government officials.

The framework for modeling the fiscal system was studied by Coddou et al. in 2012. According to their research, an important aspect of project economic analysis is the fiscal systems used by various governments in the oil and gas industry. A thorough economic model that supports decision-making ought to take fiscal systems' terms into account. The development of a modeling framework that addressed royalties and tax regimes was the main goal of their effort. These are the terms that they incorporated: resource location (onshore, offshore, or deepwater), resource type (gas, oil, conventional, and unconventional), and resource location. In designing their model framework, they had five (5) objectives in mind: i. model time reduction ii. model clarity improvement iii. Establish an audible setting iv. Demonstrate adaptability. v. Demonstrate accessibility. In their conclusion, they found that they had created and described a framework for modeling oil and gas fiscal systems that split up its multiple components into building blocks, which reduced the complexity that modelers had to cope with. Their framework made it easy to understand and

represent the concept of the financial system. The model assumptions they made, especially the one about the cost and price included in the model, make their research essential to my work. Furthermore, the models in their research are not assessed using economic profitability metrics like NPV, IRR, etc., even though these are the metrics that foreign investors are most interested in.

Ferro et al (2017) studied Uruguayan petroleum fiscal regime. The government take, effective royalty rate, savings index, lifting entitlement, and progressivity were among the most commonly utilised profitability measures used to build the Uruguayan petroleum fiscal system and compare it to worldwide standards. Another important goal is to make Uruguay's fiscal framework for oil and gas more appealing. On their research, they used discounted cash flow analysis. This paper presents a systematic method to quantitative accounts for the necessary components in the oil and gas industry in order to appropriately examine the economics of upstream investments. They used a hypothetical field development of an offshore possibility that was discovered for the study. The formulation of economic models and the advancement of technology used a hypothetical field development. The IOC's entitlement, the effective royalty rate, and the government take all added up to an average of 52%, 9%, and roughly 70%, respectively, in their calculations. They concluded that Uruguay's fiscal structure demonstrated cutting-edge fiscal architecture and was progressive. They also came to the opinion that Uruguay's fiscal structure is unfair to investors given the geological risk connected to the country's basins. The essence of their study to this thesis is the building of the economic model of the Uruguayan fiscal system using discounted cash flow analysis and R-Factor. They didn’t undertake enough risk and uncertainty

analysis, which would aid in the better understanding of the Uruguayan petroleum fiscal system by investors and policymakers.

Ghebremusse (2014) looked at how Nigeria, Ghana, and Cameroon handled the trade-off between luring foreign oil businesses and increasing petroleum tax collection. The researcher evaluated the effectiveness of the nations' upstream petroleum fiscal regimes using a four-point approach. Important factors to take into account include how heavily the host nation depends on oil revenue, how far along the oil business is in development, how financially secure the government is, and how heavily involved the host nation is in the oil industry. He came to the conclusion that even though Ghana is not fiscally dependent on oil money, the upstream petroleum fiscal design needs to be changed to provide long-term revenue generation. The author also claimed that because Ghana's petroleum sector is still developing, the mechanics of the existing fiscal system aim to entice investors by offering them a sizable share of the nation's income in the form of incentives. The intricacy of the AOE calculation and the 100% incentives given to contractors in order to draw investors are also discussed by the author. These incentives are given at no cost to the host government. The aforementioned challenges confronting Ghana's current upstream petroleum fiscal regime necessitate research to restructure, rebrand, and redesign Ghana's upstream fiscal regimes in order to expand value creation for Ghana's petroleum resource development.

Researchers Nwosi-Anele, Adeogun, and Iledare (2018) examined government and contractor take figures in the budget bill for the petroleum industry under consideration. Their research indicates that the fiscal system forms the basis for calculating the take statistics ratio between the government

and contractor. The modifications that Nigeria is recommending for 2017 to the current fiscal code for the petroleum industry will result in the expansion of the midstream and downstream sectors. A deterministic and stochastic cashflow model was constructed and used to assess the fiscal provisions of the current royalty and tax system, as well as the production sharing contracts. Findings from the research offer a beneficial royalty and tax deductions strategy in the proposed bill, which incentivizes investors to reinvest in both midstream and downstream. For my research to be successful, both deterministic and stochastic cashflow models must be used. They implemented the sliding scale royalty for both gas and oil fields, which was based on the topography and the rate of production. Their study lacked sensitivity analysis to determine how sensitive their input variable affects profitability indicators like NPV and IRR.

Ghana's upstream petroleum fiscal regime was evaluated by Ackah and Kankam (2014) to ascertain the state take and investor take. The fiscal systems of Ghana, Uganda, Nigeria, Cote d'Ivoire, Cameroon, Equatorial Guinea, and Congo were then compared by the writers. As a result of their investigation, they learned that the government of Ghana receives an average of 37.18% when the cashflow is discounted and 39.96% when it isn't. The authors also found that Ghana's government is sixth in terms of state take, which indicates that more money goes to investors than to the owners of the resources. They came to the conclusion that the amount of money the investor gave the host government was insufficient because a larger portion of the money Ghana's petroleum resources produced went to the contractor. The authors suggested that the current upstream fiscal system needs to be overhauled as they also recognise the

problem of fixed regressive royalty as the cause of the host government's poor petroleum income.

The table below is a summary of relevant literature that supports my research work. The table is categorised in five compartments. The first one describes the authors and date of the research paper, the second describes the topic, the third talks about the relevance of the research paper to this thesis, the fourth elaborates on the gaps found in the researcher's work and the last describes major conclusions in the research work.

Table 2: Summary of review of Relevant Literature

Authors/Year	Topic	Relevance to my study	Comments/ Gap	Major Conclusions
1. Nwosi-Anele, Adeogun and Iledare (2018)	Analysis of Government and Contractor take statistics in the proposed petroleum industry fiscal bill	• The use of the deterministic and stochastic cashflow models. • The use of sliding scale royalty tied to terrain and production rate for gas and oil fields	• They didn't add sensitivity analysis to their stochastic input variables to observe the effects on NPV and IRR	• Friendly royalty and tax deductions strategy in the proposed bill provides incentives to investors to reinvest
2. Ferro et al (2017)	Uruguayan petroleum fiscal regime	• Used discounted cashflow to build the economic model of the Uruguayan fiscal regime. Inculcated R-Factor to evaluate the fiscal regime of Uruguay	• Their work lacked risk and uncertainty analysis to further give good insight to understanding the Uruguayan fiscal regime	• The Uruguayan fiscal regime proved to be progressive, revealing state-of -the -art fiscal design.
3. Coddou et al (2012)	Fiscal system modeling framework	• The several model assumptions they made on the price of crude and cost involve in the project	Their work lacked economic profitability measurements like NPV, IRR etc to evaluate the models	Their work presented and described a modeling framework for oil and gas fiscal systems. Also provided a convenient structuring of the fiscal system

Table 2: Cont.

4. Dharmadji and Parlindungan (2002)	Fiscal regimes competitiveness comparison of oil and gas producing countries in the Asia pacific region: Australia, China, India, Indonesia and Malaysia	The method they deployed was the cash-flow modeling which he used for the evaluation of the various fiscal regimes.	They didn't inculcate monte-Carlo simulation to quantify risk and uncertainty in the various fiscal regime of the countries.	From their economic indicators, the Australian regime is ranked very favorable compared to the others. Contractor cash-flow, NPV and contractor take were all affected by every fiscal regime terms.
5. Back (2003)	A discussion on the effect of international fiscal regimes on portfolio selection in the petroleum industry	The discounted cash-flow model he used to evaluate the project. The choice of profitability measurements (NPV, IRR, ROR, etc)	He didn't incorporate sensitivity analysis and decision- making techniques to quantify risk and uncertainty	Observed that the consolidated field versus the standalone economics did not have a measurable impact on the portfolio composition and viability
6. Iledare (2004)	Analyzing the impact of petroleum fiscal arrangements and contractor terms on petroleum E&P economics and the host Government take	The use of discounted cashflow models to evaluate NPV, IRR and ROR on investment	He didn't perform sensitivity analysis to investigate his claim on petroleum sharing contracts (PSC) and Joint ventures.	Selected the fiscal terms and their corresponding government take under PSC or JVA effect can better be analysed using discounted cash-flow

Source: Ashikwei 2022

CHAPTER THREE

RESEARCH METHODS

Introduction

The theoretical analysis and systematic methods used in research are applied to a field of study. It includes a theoretical analysis of the body under study, as well as all methods and principles related to that body of studies. It usually includes concepts like quantitative techniques, paradigms, theoretical models and phases. This research aims to assess and improve Ghana's upstream fiscal system in order to increase value creation for Ghana's petroleum resource development. This chapter focuses on the research design, the study area, the construction of the economic model and its procedure, model analyses, and the chapter summary.

Research Design

Every research requires a meticulous study designed to address the researcher's specific problem (Nashiru, 2019). The study design can be thought of as a framework or set of guidelines for how the researcher should conduct his or her research. A researcher can use two main methods, according to (Nashiru 2019), and they are quantitative and qualitative. A qualitative study is one in which the researcher's decisions and actions determine the design or scope of the research. In a quantitative study, the design influences the researcher's decisions and actions. The quantitative approach would be used primarily in this study because the majority of the analyses would be quantitative. Furthermore, the descriptive research design would be selected because it includes a cross-sectional design in terms of how data collected is used to build an economic model (Iledare, 2007). When the @risk software is used, it also provides

evidence about the risks and uncertainties in the petroleum industry. Furthermore, the study takes a positivist rather than an interpretivist approach. This is because the positivist approach to studying phenomena is scientific, employs objective analyses, and encourages the use of quantitative techniques (Nashiru, 2019).

Research Philosophy

The positivist school of thought is the research philosophy employed. Positivism, as a philosophy, adheres to the idea that only knowledge obtained via observation, including measurement, can be trusted. This is according to (Nashiru, 2019). According to Amissah (2019), the researcher's involvement in positivist studies is restricted to gathering data and objectively interpreting it. It must be noted that it is challenging to accurately and succinctly describe positivist research philosophy. This is thus because the contexts in which positivism is applied by researchers vary greatly. There may be as many different explanations of positivism as there were people who wrote on research philosophy. However, positivism's fundamental tenet is that science is the only route to discover the reality. The positivist philosophy aids this research by making all conclusions factual and supported by scientifically valid procedures.

The Study Area

This section of the study describes the study area's location, physical characteristics, and economic activities. The Great Jubilee field, Ghana's first oil field, is being studied.

The Great Jubilee field is located in the deep water Tano (DT) and West Cape Three Points (WCTP) blocks, approximately 60 km offshore Ghana. The water

depth in the Jubilee field ranges from 1000 to 1,700 m. It covers approximately 110 km^2, which is the size of 155 football fields (Higgins, 2013).

In the last three days of November 2010, the Great Jubilee field began commercial production at an average of 24,395 barrels per day. Production increased to 37,932 barrels per day in December. According to Tullow Ghana, the Great Jubilee field was supposed to produce about 120,000 barrels of oil per day by June 2011, but due to production challenges, they did lesser (Higgins, 2013).

Over the course of the phase 1 development, over 278 million barrels of oil are expected to be recovered. The Great Jubilee field has a recoverable reserve of more than 600 million barrels, with a potential upside of 1.8 billion barrels (Higgins, 2013). The countries whose fiscal regimes are to be compared to that of Ghana are Nigeria, Cameroon, Guinea, Congo, Uganda and Ivory Coast.

Data Set

The Ghana National Petroleum Corporation (GNPC) provided secondary data for this study. They provided the Great Jubilee field's production profile, which the researchers used to build petroleum economic models. Petroleum economic models provide tools for quantifying financial risks associated with field exploration, appraisal, and development, as well as a basis for comparing alternative investments (Iledare, 2007). The cash flow model is the most commonly used model for gaining access to petroleum projects.

Cash Flow Model

According to Dharmadjo & Parlindungan (2002), cash flow (CF) model depicts the inflows and outflows of cash in an investment over time. 1. Cash receipts generated in a petroleum business at the end of the year are shown in the cash

flow. 2. Annual cash disbursements for various costs required for operations. 3. The total amount invested over the course of the year. Cash flow diagrams show that a capital investment is an amount paid to receive expected net cash flows over the investment's economic life (Mian, 2002 ; Ackah & Kankam 2014).

From Iledare (2007), cash flow model is the most commonly used and efficient model for petroleum economic analysis because it provides net cash flow and more accurately places the timing of funds to and from petroleum projects. As a result, it is preferred over the financial profit model and the tax profit model. According to Mian (2010), the revenue (cash received) less expenses (cash spent) over a yearly economic project life is simply known as the Net Cash Flow (NCF).

Net Cash Flow (NCF) is calculated as Receipts - Disbursements. In this study, a petroleum economic model for Ghana and a few other African countries is developed.

Cash Flow Items

1. Gross Revenue: This is the crude production stream multiplied by projected price of the product.

   GR = Price × Marketed volume of hydrocarbon.

2. Royalty: It is a fraction or part of the gross profit. It is also known as paying homage to the resource owners.

   Royalty = Royalty rate × GR

3. State and local taxes: These are taxes other than the income taxes levied on oil and gas production. These are paid whether IOCs makes profit or not. Some examples of local taxes are training fees, social welfare fund, education taxes, COVID 19 recovery taxes etc.

4. Technical costs: These are (CAPEX and OPEX)
    a. Capital expenditures (APEX): It is also known as the front-end costs. They are investments or monies paid for assets that will generate benefits for more than a year.
        - Tangible costs were capitalised and depreciated for after tax calculation purposes.
        - Intangible costs were expensed through amortisation for tax calculation purposes.
    b. Operating expenses (OPEX): It is also known lease operating expenditure (LOE). These are normally cost associated with production or injection.
5. Additional field (OPEX): these costs are also known as overheads. They represent a significant component of OPEX and its hidden costs of being in business.
6. Income taxes: They are some fractions of taxable income on annual or total life basis.
    - Taxable income is net revenue less fiscally permitted cost deductions.

      Taxable Income = Revenue – Royalties – Fiscal costs.

Front-end Loading Index (FLI)

The purpose of FLI is to show how costs are covered and earnings are distributed fairly among businesses and the host government. The host government often employs royalties, bonuses, surface rentals, crypto taxes, and taxes to collect as much economic rent as feasible (lledare 2007). The government's initial take primarily consists of economic rents that are collected

through taxes on cryptocurrencies, royalties, and bonuses. Levies, tariffs, and other indirect taxation methods, such as cryptocurrency taxes, are used by the government to raise money (lledare, 2007). The sorts of extraction that take place during the transfer of rights include royalties and bonuses, which are not often based on profitability. There are other kinds of bonuses, such as production bonuses, signature bonuses, and discovery bonuses. A signature bonus is given when an IOC signs a lease. Typically, this bonus takes the form of a one-time flat sum payment (Echendu, 2011). It can be decided through bidding, negotiations, or legislation, among other methods. It can be necessary for a production bonus when development begins or production starts.

There are three kinds of royalties.

They are,

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

IOCs who use the term "fixed percentage" pay a certain percentage of gross revenue in cash or in-kind. The GOG nations have the highest likelihood of doing this. Without accounting for the highs and lows of the oil price, the percentage is computed based on gross revenue. Examples of nations that practice this type include Sierra Leone, Ghana, Chad, Niger, and Mali. Fixed pay enables a predetermined sum of money to be paid regardless of whether a profit is reported.

The drawbacks of high fixed royalty rates are offset by the usage of sliding scale royalties (Echendu, 2011). Sliding scale royalties, according to Ferro et al. (2017), are used to offset risk and uncertainty related to, among other things,

field size, oil price, average daily output, geology, economics, or engineering. The R-factor, average daily production, cumulative production, the price of oil, and project cost-recovery metrics can all be used to link the sliding scale royalty rates. Scales that slide can be either gradual or jumpy. The tranche (level) indicated determines the value or sum to be paid for the jumping. In incremental scale royalties, an effective value or percentage was computed based on the tranche attained. Echendu (2011) created an incremental sliding scale that can be either linear or logarithmic. The table that follows shows how a deep-water field's sliding scale royalty is based on average daily oil output.

Table 3: Sliding Scale Royalty tied to Daily Crude Production

Average daily production qd (BOPD)	Royalty rate (%)
0 – 50M	5
50 – 100M	12.5
>100M	25

Source: Iledare (2007)

Before and After Income Tax Cash Flow

Economic analyses that take tax effects into account are incredibly deceptive. Cash flow actually consists of interest on debt, depreciation, depletion, and amortisation costs multiplied by the amount and timing of taxable income. These are commonly known as tax-deductible items. Corporate taxes might not affect every project in the same way (Iledare 2004 & Echendu 2011). The majority of decision criteria are built on the after-tax cash flow model, which was applied in this study. When modeling Ghana's current fiscal system as well as the fiscal systems of six other African nations, including Nigeria, Côte

d'Ivoire, Congo, Cameroon, Guinea, and Uganda, it was taken into account. The after-tax success of Ghana's fiscal regime helped the fiscal regime's overall performance (Iledare 2004).

Petroleum Economics and Profitability Measures

In Ghana's upstream fiscal regimes, profitability indicators were modelled to aid in deterministic choice, analysis, and objective functions in stochastic analysis for investments, decisions, purposes, and capital investments (Coddou et al., 2012 & Back 2003).

The following measures of profitability were imposed,

- Government take (G Take)
- Contractors take (C Take)
- Internal Rate of Return (IRR)
- Net Present Value (NPV)
- Return on Investment (ROI)
- Profit Investment Ratio (PIR)
- Present Value Ratio (PVR)
- Discounted Net Cash Flow

Discounted Take Statistics: According to the fiscal regime, the investor and the resource owner's net cash flow is divided into contractor take and government take (Ackah & Kankum , 2014 ; Iledare, 2004). These "takes" vary with time and the producing life of the field, and are best calculated on a discounted cumulative basis. In year x, x=1, the contractor and government take can be computed on a cumulative discounted basis...

$$PVx(\%) = \frac{PVx}{PVx(CT)+PVx(GT)} \quad 1$$

Net Present Value: According to (Back, 2003; Coddou et al., 2012) The net present value (NPV) measures how much money would have been earned had a dollar been invested today at a given interest rate. The net present value of a project, which ensures end-of-year cash receipts, is often just the sum of the present values of all of the project's annual net cash flows.

$$NPV(f,F) = \sum_{t=1}^{K} \frac{NCF_t}{(1+D)^t} \quad 2$$

IRR (Internal Rate of Return): It is defined as the discount rate at which the net present value (NPV) of a series of cash receipts and disbursements equals zero. It is a profitability metric that is unaffected by the size of cash flows (Nwosi-Anele et al., 2018).

$$NPV = \sum_{t=1}^{k} \frac{NCF}{(1+IRR)^t} = 0 \quad 3$$

Profitability Index (PI): According to Iledare (2004) a PI or investment efficiency ratio normalizes the value of project relative to the total investment and it's computed as

$$PI(f,F) = 1 + \frac{PV(f,F)}{PV(TC)} \quad 4$$

The PI is dimensionless ratio of the PV of future operating project cash flow to PV of investment.

ROI (Return on Investment): It is equivalent to the profitability investment ratio (PIR). It is simply a measure of net cash flow attributable to the total project investment. It reflects total profit or return relative to investment value and does not reflect cash flow time pattern (Dharmadji & Parlindungan, 2002).

$$ROI = \frac{\sum NCF}{\sum(INVESTMENT)} \quad 5$$

Simulation and Sensitivity Analysis

The @RISK software was used for simulation and sensitivity analysis on profitability measures in the economic model. With the aid of simulation analysis, analysts can present risk and uncertainty as distributions for each potential value of any random variable. Simulation can be employed in investment projects due to the low cost of analysis (Echendu, 2012).

The process of calculating the degree of forecast uncertainty brought on by model uncertainties and assumptions. The analysis includes a graph that displays the impact of each assumption on a certain forecasted result.

Monte Carlo Simulation

Complex models with empirical answers are created using the Monte Carlo approach. A numerical method called the Monte Carlo process uses uniformly dispersed random behavior across a large number of sums to produce a sequence of deterministic calculations that serve as the solution to a probability model. Numerically, stochastic models are reduced to a series of deterministic computations. Using a Monte Carlo simulation in this study, the general algorithm mostly used according to Echendu (2012) was as follows÷

1. General a random number uniformly distributed on the interval 0 to 1.
2. Compute a value of one of the stochastic variables in the model.
3. Repeat step 1 and 2 until values have been obtained for all stochastic variables'
4. Perform the model calculation, retaining the results for statistical analysis.
5. Do step 1 through 4 until a predetermined statistical requirement has been satisfied.

6. Summarise the solution obtained in step 4 using conventional statistical requisites- that is the series be both uniformly distributed and random.

A ten thousand (10, 000) iterations in a simulation were performed on four (4) basic input variable and applies to five (5) profitability indicators that have both time-value of money or not, serving as the objective functions. Triangular distribution was imposed on all costs including crude oil price and development costs. The objective functions of interest were NPV, IRR, GTAKE, CTAKE, PVR and PI.

Sensitivity analysis

According to Nwosi-Anele et al,. (2018) & Echendu (2012) using the @RISK software, sensitivity analysis was carried out on each of the relevant variables. Keeping all other model components constant while modifying each other parameter to see how these changes affect the best choice is the conventional methodology for any sensitivity study. This illustrates what could occur if forecasting assumptions were steadily raised. The objective is to evaluate how variable variation affects profitability at its core.

CHAPTER FOUR

RESULTS AND DISCUSSION

Introduction

It is impossible to overstate the significance of oil and gas for global economic growth because their discovery draws multinational firms and boosts foreign direct investment, among other things (Nashiru, 2019). Revenue generated from taxes on oil and gas production will continue to significantly contribute to the goals of national budgets and the development of oil-rich African states as the price of crude oil and natural gas rises and new fields are found (Ghebremusse, 2014).

Estimated Deterministic Results

This chapter gives the deterministic outcomes for Ghana and six other countries in the Gulf of Guinea region for the economic model created in the previous chapter. The following decision metrics were used in the study to evaluate the upstream fiscal policies for petroleum in each nation (Echendu 2012 & Coddou et al. 2012) :

1. Governments take (GTake) /Contractors take (CTake)
2. Internal rate of return
3. Net present value (NPV)
4. Discounted net cash flow
5. Present value ratio (PVR)
6. Profitability index (PI)

According to Iledare (2004) and Echendu (2012), The aforementioned parameters for measuring petroleum projects help different petroleum industry players make choices based on relevant criteria while also being aware of the

risk and uncertainty associated with Ghana's upstream petroleum business. It is crucial to understand that the discussion below does not aim to disparage Ghana's upstream petroleum fiscal regime in comparison to other nations, but rather to make necessary adjustments to the fiscal regime in order to achieve its pareto optimality between investors and mineral resource owners (Mian, 2010).

Model assumptions

1. An assumed production profile from the Great Jubilee field from 2010 to 2020 was used for all the countries
2. An assumed exploration, development and operation cost was also imposed in all the regimes of the other countries
3. An assumed oil price of $75/bbl was imposed on all the countries.

Decision analysis guide of fiscal systems

In analyzing the economic viability of a petroleum project, common indicators often used are in the industry according to (Coddou et al., 2012; Back, 2003; Ashikwei, 2019) are Net Present Value (NPV), Internal Rate of Return (IRR), Contractor and Government take together with decision rules. The table below shows their acceptability and rejection when evaluating a project. The profitability measurement are used to evaluate a project. NPV >0 means for a project to be accepted, the NPV should be greater than zero, otherwise, it should be rejected. IRR greater than r^* means for a project to be viable, the IRR should be greater than the assumed discount rate (r^*). PVR which is another profitability means must also be greater than zero (0) for a project to be accepted and otherwise, it should be rejected. The last profitability measurement is the PI which is also used to determine the evaluation of a project. PI greater than one (1) means the project is acceptable and otherwise should be rejected.

Table 4: Capital Budgeting Decision rules

Profitability measure	Accept If @r	Reject If @r
NPV	>O	<0
IRR	$>r^*$	$<r^*$
PVR	>0	<0
PI	>1	<1

Where r^* =discount rate

Source: Iledare (2011)

Table 5: Performance of various African countries and their Fiscal regime

COUNTRIES	NPV (C Take) $ MM	NPV (HG Take) $ MM	IRR %
GHANA	934.41	2,863.63	14.3
GHANA *	778.59	3,019.45	13.7
NIGERIA	-874.02	5,262.57	4.8
CONGO	672.71	3,466.92	13.3
UGANDA	1,012.09	3,127.54	14.7
CAMEROON	-733.82	4,873.44	4.6
IVORY COAST	826.30	2,101.78	13.9
GUINEA	660.06	3,479.57	13.2

NB GHANA * is The proposed fiscal regime of Ghana

Source: Petroleum Economic Model (2022)

Performance of Ghana's Fiscal Regime R/T (1997)

The existing upstream petroleum fiscal regime of Ghana has been in place for well over 25 years. The regime has been the petroleum sharing guide between the investors and the resource owners. From the petroleum economic model built using the existing fiscal elements, the contractor's Net Present Value (NPV) from the petroleum project was $MM 934.4. This means that at the value of dollars invested in a petroleum project which is guided by the upstream fiscal regime of Ghana, at the end of the project the contractor will receive this value on his investment. According to (Echendu, 2012, Iledare, 2004, Back, 2003), the positive NPV means that, it will add value to any investment made in such projects. The calculated Internal Rate of Return (IRR) which describes the earning power on every dollar invested was calculated. From the existing fiscal regime, the IRR was higher than the assumed discount rate of 10 %. The IRR of the project is 14.3% higher than the assumed rate (r). This means that the investment is efficient and profitable under the fiscal regime because the interest earned from the petroleum business is high. Such a fiscal regime is described as friendly to investors and will attract more investors to that regimes petroleum industry.

The existing elements also provided the opportunity for the portion of the resource rent that goes to the state called the government take to be modeled. Government take is used to measure the profitability of the revenue from the resources that goes to the state. According to Ackah and kankam (2014), the government take is also called state take. The government's Net Present Value was $MM 2,863.63. The positive value indicates that the host government will benefit if this fiscal regime is implemented according to (Nwosi-Anele et al.,

2018). This regime can be also be described as equitable according to Ashikwei (2019), providing a win-win situation for both contractor and the host government.

Performance of Nigeria's Fiscal Regime R/T (2000)

Nigeria's R/T (2000) upstream petroleum fiscal regime was used until it was changed. Using the fiscal elements to create a model for the country, the fiscal regime produced a Net Present Value for the investor's portion of the resource rent of $MM -874.02 using the same production profile as Ghana's Jubilee field. This negative value indicates that using the Nigeria regime components on the same Jubilee field will not result in a profit for the investor (Iledare, 2004). No investor will march towards such regime since it adds no value to their investment. The calculated Internal Rate of Return (IRR) was 4.8%, which is less than the 10% discount rate. This means that no profit will be made on any dollar invested in such a project. This value further emphasis on the unprofitability of such upstream fiscal regime if imposed on the annual production profile of Ghana's Jubilee field. Such will scare investors away.

However, the Net Present Value (NPV) of the host government's Net Cash Flow is $MM 5,262.57. This value is greater than zero, indicating that the government will benefit significantly from the venture. Using Nigeria's fiscal regime components, the host government will receive a net present value of $5.26 billion from the field. This signifies that, fiscal elements like royalty, income tax, signature and production bonus of Nigeria's fiscal regime all directed increase the revenue of the host government. This upstream fiscal regime is very hostile to investors but more friendly to the host government who is the resource owner.

Performance of Congo Fiscal Regime R/T (1997)

Congo's upstream fiscal regime (1997) has been in existence till date. Using the fiscal elements that form the fiscal regime to build economic model for the country, the contractor's net present value was $MM 672.71 using the same annual production profile as Ghana's Jubilee field. This value is greater than zero and positive, implying that any investment made in such a fiscal environment will add value and generate profit. The calculated internal rate of return (IRR) is 13.3 % greater than the assumed discount rate of (10%) used for the project. This implies that every dollar invested in such a petroleum business will yield a profit for the investor. Such an upstream petroleum fiscal regime is described as very investor friendly and will attract more investors. Moreover, in terms of the efficiency, fiscal regime is termed efficient since it will efficiently maximise profit for investors in such petroleum project (Iledare, 2011).

The project's net present value (NPV) for the host government is $3.4 billion. A positive value indicates that the host government will profit from such a fiscal regime should the fiscal elements be implemented. Such an upstream petroleum fiscal regime is described as equitable which means it achieved pareto optimality between the host government who is the petroleum resource owner and the contractor who is the investor.

Performance of Uganda's Fiscal Regime R/T (2010)

Building a petroleum economic model using the Upstream fiscal elements of Uganda's R/T (2010). The upstream petroleum fiscal regime of Uganda has been in existence for the past 12 years. After building the economic model, the contractor's Net Present Value was $MM 1,012.09 based on the performance of Uganda's fiscal regime on the same production profile as

Ghana's jubilee field. This value is greater than zero, indicating that when an investor invests in such a business, value will be generated on his/ her investments and will make a lot of profit. The internal rate of return (IRR) which defines the earning power of the investor was calculated at 14.7%. This value exceeds the assumed 10% discount rate. This means that every dollar invested in such a project will be profitable. According to Echendu (2012), having this kind of returns on your investment makes investors happy and describe such upstream fiscal regime as friendly and will attract more investors.

The Host government portion of the petroleum business was also calculated. The net present value was $MM 3,127.54. This means that the host government will profit if he negotiates for such a fiscal regime regime to be implemented. Such upstream petroleum fiscal regime is described as efficient, effective and equitable meaning investing in such petroleum environment will yield a win-win situation for both resource owner and investor.

Performance of Cameroon Fiscal Regime R/T (1995)

The Cameroon upstream fiscal regime has been in existence over 27 years. Building a petroleum economic model using the fiscal terms provided a net present value of -$MM 733.82 with the same production profile as the great Jubilee field. A negative net present value (NPV) indicates that the project should be rejected because it will not generate any profit for the investor. This means that investing in such environment will depreciate the value on your investment at the end of the petroleum project. Also using the same fiscal terms had the internal rate of return (IRR) to be 4.6%. This value is less than the assumed 10% discount rate, highlighting yet another reason why an investor

should decline such a project. Such upstream fiscal environment is described as an hostile environment for investors so they tend to run away from such.

The share of the petroleum project for the Host government was also calculated from the model. The host government's net present value was $ MM4,878.44. This positive value indicates that such a project will benefit only the host government. This type of upstream petroleum regime is regarded as bias and one sided which is not healthy for investment.

Performance of Ivory Coast Fiscal Regime R/T (1996)

Using the same annual production profile of the Great Jubilee Field, the Ivory Coast R/T (1996) fiscal regime was also modeled. It had a net present value (NPV) of $MM 826.30. A positive value indicates that such a project will generate profit if an investor invests in such a petroleum environment. The Internal Rate of Return (IRR) is also 13.9%. The value is greater than the 10% assumed discount rate. This means that every dollar invested in such a project will generate returns. Investors are delighted for such upstream petroleum fiscal regime since it creates such a healthy environment for investment. The host government's net present value is $MM 2,101.78. This positive value indicates that the project will benefit the host government as well. The upstream petroleum fiscal regime for Ivory Coast is efficient, effective and equitable in performance.

Performance of Guinea Fiscal Regime R/T (2006)

Guinea's fiscal regime's performance with the Great Jubilee field's production profile had a Net present value of $MM 660.06. A positive value which indicates that such project is viable for an investor who invest in it. Again, the Internal Rate of Return (IRR) is 13.2%, slightly higher than the 10%

assumed discount rate. That is, value will be generated for every dollar invested in such project. Such an upstream petroleum fiscal regime is okay for investors since they are going to reap returns on their investment. The project also generated a net present value of $MM 3,479.57 to the host government. This means that such a project will benefit the host government, who is the owner of the petroleum resource.

Comparing other Fiscal Regimes to Ghana's Fiscal Regime

Table 6: Fiscal Regime of Ghana vs Nigeria

GHANA		NIGERIA	
Fiscal Regime Elements		Fiscal Regime Elements	
1. Royalty rate	5%	1. Royalty rate	8%
2. Income Tax	35%	2. Income Tax	65.8%
		3. Signature bonus	25m$
		4. Production bonus	0.10%
Profitability Results		Profitability Results	
3. IRR	14.3%	5. IRR	4.8%
4. NPV Contractor	$MM 934.41	6. NPV Contractor	- $MM 874.02
5. NPV Government	$MM 2863.63	7. NPV Government	$MM 5262.57

Source: Petroleum Economic Model (2022)

Ghana Vs Nigeria

The table 5 shows the performance of the upstream petroleum fiscal regime of both Ghana and Nigeria. The fiscal elements that make up the Ghana's regime are royalty of 5% and income tax of 35%. The ones that make up Nigeria's fiscal regime are royalty of 8%, income tax of 65.8%, a signature and production bonus. Comparing these two to find out the performance of the fiscal regime of Ghana, the GTake which is the petroleum share portion for both governments. Ghana had $ 2.86 billion and Nigeria had $ 5.26 billion from the same project using their unique fiscal elements. GTake is a profitability measurement which describes the share of the resource rent that goes to the resource owner. Nigerian's portion is more than twice that of Ghana and its because they have certain fiscal elements which goes in favour of their government. Firstly, their royalty is 8% whilst Ghana is 5%. Royalty is the portion of the gross revenue from a petroleum venture that is deducted before tax. A higher value of royalty will definitely increase the government revenue. Secondly, the fiscal element of Nigeria has a corporate income tax of 65.5% whilst Ghana has 35%. Corporate tax is another mechanism which gives more revenue to the government. This will definitely increase government revenue base when the numbers are high. Nigerian's corporate tax fiscal element is almost twice that of Ghana which clearly shows that the government of Nigeria will receive more than that of Ghana. The third element that increased the portion of Nigerian GTake was a mechanism called signature bonus. Signature bonus is a fiscal element which gives an amount of money or crude to the host government when an international oil company signs a petroleum agreement (Iledare, 2004). Nigeria has this element which gives the government $ 25

million but Ghana has no fiscal element like that. The last fiscal element which further increased the GTake of Nigeria's fiscal regime is called production bonus. Production bonus is an amount of money or crude which is allocated to the host government when production of crude starts (Ashikwei, 2019). Nigeria's fiscal regime has 0.1% production bonus which means 0.1 % of the gross revenue is given to the host government which further increases the GTake. These findings further confirm the conclusions of Ackan and Kankam (2014) which says that Ghana's fiscal element are too friendly to the contractor and not optimising revenue for the government.

The IRR of Ghana is 14.3% and that of Nigeria is 4.8%. IRR is a profitability measurement use to evaluate projects to find out whether that project is worthy of investment. IRR acceptability according to Iledare (2011) says internal rate of return (IRR) should be greater than the discount rate of a project. For this petroleum project the discount rate was 10% so any IRR less than it will be rejected. Ghana's IRR of 14.3% means any contractor can venture into such project and make profit since it also means there will be profit on any dollar invested in such project. Nigeria's IRR of 4.8% is less than the assumed discount rate of 10% which means any petroleum project that uses Nigeria's fiscal regime will not yield profit. Also the contractor net present value (NPV) for Ghana (CTake) was $934.41 and that of Nigeria was $-874.20. NPV shows the value of today invested today, at a specific interest rate what will be the future returns. According to Echendu (2012), a negative value means the project is not viable and a positive NPV means the investment is worth it. The contractor's NPV for Ghana's fiscal regime is positive which means the contractor made a profit on the investment. Nigeria's portion means such project

will not benefit the contractor. Overall performance comparison of both regime depicts that Ghana's upstream fiscal regime needs an adjustment to incorporate some of the fiscal elements of Nigeria to increase Government's NPV of the resource rent.

Table 7: Fiscal Regime of Ghana vs Cameroon

GHANA		CAMEROON	
Fiscal Regime Elements		Fiscal Regime Elements	
1. Royalty rate	5%	1. Royalty rate	12.5%
2. Income Tax	35%	2. Income Tax	57.50%
Profitability Measures		Profitability measures	
3. IRR	14.3%	5. IRR	4.6%
4. NPV Contractor	$MM 934.41	6. NPV Contractor	-$MM 733.82
5. NPV Government	$MM 2863.63	7. NPV Government	$MM 4873.44

Source: Petroleum Economic Model (2022)

Ghana Vs Cameroon

The table above depicts the performance of the upstream fiscal regime of Ghana's fiscal regime and that of Cameroon. The fiscal elements that constitute the fiscal regime of Cameroon are 12.5% royalty rate and income tax of 57.5%. The fiscal elements that make up the upstream fiscal regime are

royalty of 5% and income tax of 35%. Both countries have the same fiscal elements make up but their results are different. The NPV of the government portion for the resource rent of Cameroon is $ 4.87 billion whilst Ghana is $ 2.86 billion. The two figures are positive which means there is value for both government but the different in value is the fiscal elements. Ghana has a fixed royalty of 5% whilst Cameroon has a fixed royalty of 12.5%. Cameroon's royalty is more than twice that of Ghana which means that, the resource revenue that the government of Cameroon is receiving from the project is equally on royalty rate is more than twice that of Ghana. This is one reason the NPV of both goverments are not the same. The second element is income tax mechanism. The income tax of ghana's fiscal regime is 35% and that of Cameroon is 57.5%. This mechanism also gives revenue to the resource owner so higher income tax will equally affect the portion of the revenue. These are the two elements that affected the NPVs of the two countries.

The IRR of Ghana is 14.3% and that of Cameroon is 4.6%. This clearly shows that in asmuch as the Cameroonian fiscal regime gives much to the host government, it is not friendly to investors since 4.6% returns on investment where discount rate is 10% is very bad. Ghana's fiscal regime is more friendly to investors with a return on investment of 14.3%. Further confirmation of the unfriendly regime of the Cameroonian fiscal regime is the negative NPV for the contractor. The contractor's NPV is -$ 733.82 million which will prevent investors but Ghana's NPV of the contractor is $ 934 million which is very welcoming to investors. Ghana's performance in terms of the government's revenue is poor as compared to Cameroon which again means for them to get more, they must adjust their royalty and income tax.

Table 8: Fiscal Regime of Ghana vs Uganda

GHANA		UGANDA	
Fiscal Regime Elements		Fiscal Regime Elements	
		1. Royalty	
1. Royalty rate	5%	rate	12.5%
2. Income Tax	35%	2. Income Tax	30.0%
		3. Signature	
		bonus	0.5m$
Profitability Measures		Profitability measures	
3. IRR	14.3%	5. IRR	14.7%
4. NPV		6. NPV	
Contractor	$MM 934.41	Contractor	$MM 1012.09
5. NPV		7. NPV	
Government	$MM 2863.63	Government	$MM 3127.54

Source: Petroleum Economic Model (2022)

Fiscal Regime of Ghana vs Uganda

Table 7 shows the comparison performance analysis for the upstream fiscal regime of Ghana and that of Uganda. The fiscal elements that make up the upstream fiscal regime of Uganda are royalty rate of 12.5%, income tax of 30% and a signature bonus of $ 0.5 million whilst Ghana is made up of royalty of 5% and income tax of 35%. The government NPV of Uganda is $ 3.13 billion dollars whilst that of Ghana is $ 2.86 billion. The reason for the vast difference in what both governments receive how they have arranged their fiscal elements in their regime. Uganda has a royalty of 12.5% and Ghana has 5%, which is

more than twice less that of Uganda. Royalty has a direct effect on the NPV of the government so having a higher royalty will definitely increase the revenue. However, when it comes to income tax, Ghana's income tax that he charges on petroleum projects is 35% whilst that of Uganda is 30%. This implies that for income tax mechanism, Ghana is supposed to receive more than that of Uganda. The last fiscal element mechanism in Uganda's upstream fiscal regime is signature bonus. Signature bonus is triggered when a petroleum agreement is signed for exploration of petroleum to begin. Uganda has a signature bonus of $ 0.5 million which adds to the total NPV revenue of the state but Ghana has no signature bonus mechanism. These fiscal elements mechanisms make Ghana trail behind Uganda in terms of Government take NPV. The upstream fiscal regime of Ghana had an IRR of 14.3% whilst that of Uganda had 14.7%. The fiscal regimes had IRR which are greater than the discount rate of the project, meaning both petroleum project will yield profit for investors who will invest in such petroleum projects. The contractors' NPV for both Ghana and Uganda are positive values which means both upstream fiscal regimes are friendly to investors. Assessing the existing upstream fiscal regime of Ghana by measuring her performance with that of Uganda, in terms of government revenue Ghana trails Uganda.

Table 9: Fiscal Regime of Ghana vs Guinea

GHANA		GUINEA	
Fiscal Regime Elements		Fiscal Regime Elements	
1. Royalty rate	5%	1. Royalty rate	13%
2. Income Tax	35%	2. Income Tax	35.00%
		3. Signature bonus	1.5m$
		4. Production bonus	5m$
Profitability Measures		Profitability measures	
3. IRR	14.3%	5. IRR	13.2%
4. NPV Contractor	$MM 934.41	6. NPV Contractor	660.06MM$
5. NPV Government	$MM 2863.63	7. NPV Government	3479.57MM$

Source: Petroleum Economic Model (2022)

The table 9 shows the performance comparison of the upstream petroleum fiscal regime of both Ghana and Guinea. The fiscal elements that make up the Ghana's regime are royalty of 5% and income tax of 35%. The ones that make up Guinea's fiscal regime are royalty of 13%, income tax of 35%, a signature bonus of $1.5 million and production bonus of $ 5 million. Comparing these two fiscal elements to find out the performance of both fiscal regimes, the NPV GTake of Ghana was $ 2.86 billion and Guinea was $ 3.48 billion. Guinea's portion is almost twice that of Ghana and it's because they have certain fiscal elements which goes in favour of their government. First is

a royalty of 13% whilst Ghana is 5%. Royalty is the portion of the gross revenue from a petroleum venture that is deducted before tax. A higher value of royalty will definitely increase the government revenue. Second is a component called corporate income tax, which Guinea's upstream fiscal regime is 35%, the same as Ghana. The third element that increased the portion of Guinea GTake was a mechanism called signature bonus. Signature bonus is a fiscal element which gives an amount of money or crude to the host government when an international oil company signs a petroleum agreement (Iledare, 2004). Guinea's fiscal regime has this element which gives the government $ 1.5 million but Ghana has no fiscal element like that. The last fiscal element which further increased the GTake of Guinea's fiscal regime is called production bonus. Production bonus is an amount of money or crude which is allocated to the host government when production of crude starts (Ashikwei, 2019). Guinea's fiscal regime has $ 5million production bonus which goes to the host government which further increases the GTake NPV. These findings again further confirm the conclusions of Ackan and Kankam (2014) which says that Ghana's fiscal regime lacks some mechanisms which will optimise revenue for the government.

The upstream fiscal regime of Ghana had an IRR of 14.3% whilst that of Guinea is 13.2%. The fiscal regimes had IRR which are greater than the discount rate of the project (10%), meaning both petroleum project will yield profit for investors who will invest in such petroleum projects. The contractors' NPV for both Ghana and Guinea are positive values which means both upstream fiscal regimes are friendly to investors. The NPV for the contractor take of Guinea is $ 660.06 million and that of Ghana is $ 934.41 million. The NPVs on

the contractor's perspective makes Ghana's fiscal regime more friendly to the contractor than Guinea. However, for the NPVs of the government portion of the resource rent, Ghana trailed Guinea because of the production and signature bonuses imbedded in their regime compared to Ghana.

Table 10: Fiscal Regime of Ghana vs Ivory Coast

GHANA		IVORY COAST	
Fiscal Regime Elements		Fiscal Regime Elements	
1. Royalty rate	5%	1. Royalty rate	12.5%
2. Income Tax	35%	2. Income Tax	35.00%
		3. Signature bonus	$M 12
		Production bonus	$M 12
Profitability Measures		Profitability measures	
3. IRR	14.3%	5. IRR	13.9%
		6. NPV	$MM
4. NPV Contractor	$MM 934.41	Contractor	826.30MM$
5. NPV Government	$MM 2863.63	7. NPV Government	$MM 2101.78

Source: Petroleum Economic Model (2022)

Ghana vs Ivory Coast

Table 9 shows the comparison performance analysis for the upstream fiscal regime of Ghana and that of Ivory Coast. The fiscal elements that make up the upstream fiscal regime of Ivory Coast are royalty rate of 5%, income tax

of 30% , a signature bonus of $ 2 million and production bonus of $ 2 million whilst Ghana is made up of royalty of 5 % and income tax of 35 %. The government NPV of Ivory Coast is $ 2.10 billion dollars whilst that of Ghana is $ 2.86 billion. The reason for the vast difference in what both governments receive is based on the arrangement of their fiscal elements in their regime. Ivory Coast has a royalty of 12.5 % and Ghana has 5 %, this implies both governments receive the same revenue in terms of royalty. However, when it comes to income tax, Ghana's income tax that he charges on petroleum projects is 35% whilst that of Ivory Coast is 30%. This implies that for income tax mechanism, Ghana is supposed to receive more than that of Ivory Coast. The last two fiscal element mechanism in Ivory Coast upstream fiscal regime is signature bonus of $ 2 million and production bonus of $ 2 million. Signature bonus is triggered when a petroleum agreement is signed for exploration of petroleum to begin whilst production bonus is triggered when production of petroleum starts. These two mechanisms add to the total NPV revenue of Ivory Coast but Ghana has no signature bonus mechanism. Although Ghana upstream fiscal regime has no signature and production bonuses, Ivory Coast upstream fiscal regime still trail behind Ghana in terms of Government take NPV. The upstream fiscal regime of Ghana had an IRR of 14.3% whilst that of Ivory Coast was 13.9%. The fiscal regimes had IRR which are greater than the discount rate of the project, meaning both petroleum project will yield profit for investors who will invest in such petroleum projects. The contractors' NPV for both Ghana and Ivory Coast are positive values which means both upstream fiscal regimes are friendly to investors. Assessing the existing upstream fiscal regime

of Ghana by measuring her performance with that of Ivory Coast, in terms of government revenue, Ghana is superior to Ivory Coast.

Discounted Government Take Graph of Various countries

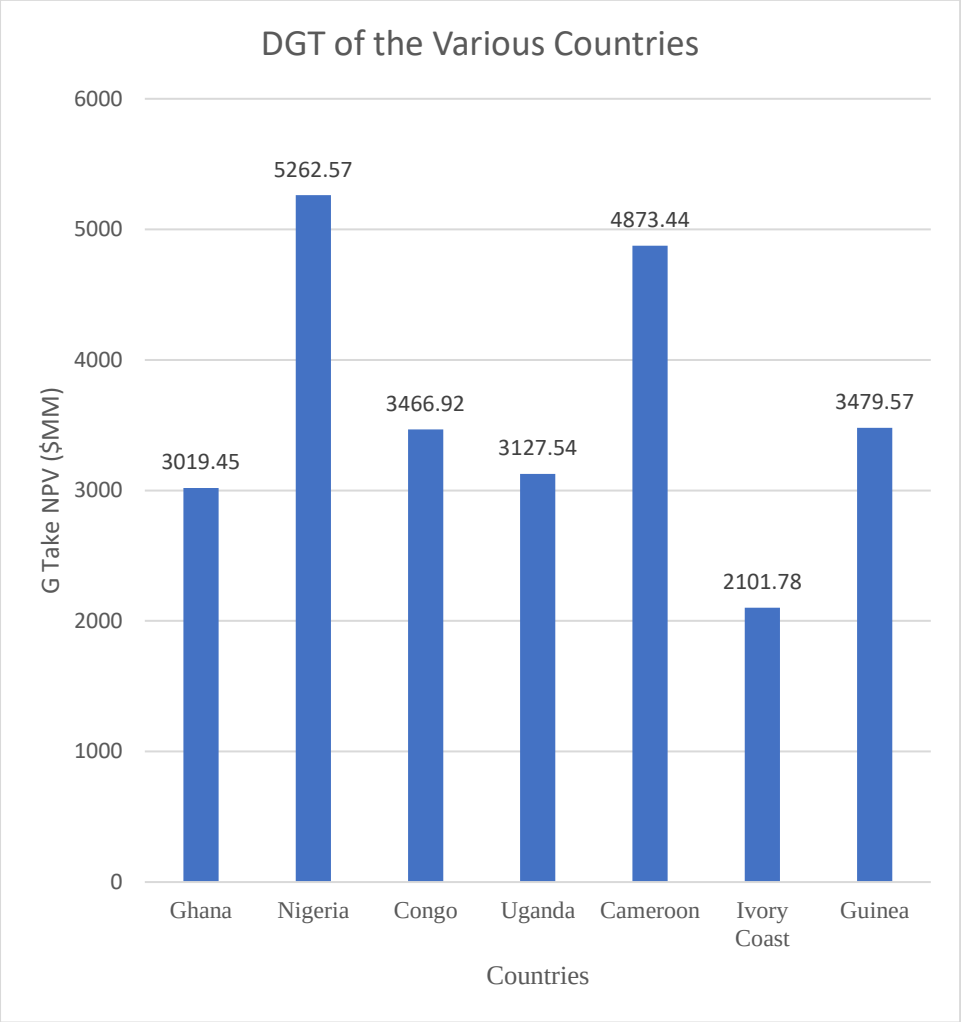


Figure 4: A Graph of DGT ranking of Ghana and other countries upstream fiscal regime

Source: Ashikwei (2022)

Comparing the Discounted Government Take Net present values (NPVs) of the various countries Government take. The above graph indicates the performance of the existing upstream fiscal regime of Ghana with the other countries. Prior to the first objective of assessing the existing upstream petroleum fiscal regime of Ghana, the performance assessment is very poor

compared to the other Africa countries. The upstream petroleum fiscal regime of Ghana is ranked 6th, compared to the others. The same annual production profile used for all the countries shows that the fiscal terms imbedded in Ghana's upstream fiscal regime is not affecting the Host government take positively enough. This finding confirms Ackah & Kankam (2014) result which analysed Ghana's current upstream fiscal regime using hypothetical data and concluded that Ghana's upstream fiscal regime is ranked 6th in-terms of the Government take, comparing Ghana's fiscal regime with the same selected countries. One particular fiscal element that cut across all the fiscal regimes is the royalty rate of the countries. All the countries have their royalty rate above Ghana's 5 % of gross revenue of the petroleum project. Ghana's royalty is fixed too, which doesn't capture windfall profit from any petroleum project.

Proposed Royalty tied to R-factor fiscal Regime

Table 11: R-Factor linked to Royalty

R- Factor	Royalty (%)
< 1.00	1.5
1.00 – 1.50	3.5
1.50– 2.00	5
>2.00	7.5

Source: Mian (2010)

The assessment of the performance of the existing upstream petroleum fiscal regime (R/T 1997) not being optimal in terms of Government's petroleum revenue and not capturing windfall profit, led to redesigning of a proposed fiscal regime with a sliding scale royalty. Royalty adjustment is one way that the revenue base of the host government can be increased. For this fiscal regime,

the host government's royalty was linked to the project's R-factor. The R-factor is the revenue-to-cost ratio and it is used to evaluate the performance of a project (Ferro et al., 2017). In the comparative analysis of the fiscal regime of Ghana and that of the other Africa countries, Ghana's fiscal regime trailed so many countries in terms of the revenue accrued to the government and one of the reasons was the fixed royalty rate of Ghana. This justifies the research conducted by Ghebremusse (2014); Ackah & Kankam (2014) that the existing fiscal regime of Ghana needs a readjustment especially with the royalty rate if Ghana wants to optimised host government revenue. This necessitated the redesigning of Ghana's upstream petroleum fiscal regime's royalty rate to sliding-scale sliding on the R-Factor of the project. The royalty of 1.5% is charged on the gross revenue of the petroleum business when the R-factor of the project is less than one. The royalty is 3.5% when it was between 1-1.5. If the R-factor is between 1.5 and 2.00 and the royalty rate is 5%, a royalty of 7.5% is generated if the R-Factor is above 2.00. Nwosi-Anele et al (2018) and Ferro et al (2017) both used the R-Factor regime mechanism tied to sliding scale royalty in their research when they wanted to increase government take. The proposed upstream fiscal regime designed generated a Net Present Value (NPV) of $MM 778.59 on the contractor investment. This value is greater than zero (0) which indicates that the investor has generated profit for the investor. The IRR (internal rate of return) was 14%. The value is also higher than the 10% assumed discount rate. This means that the project will generate returns on every dollar invested in it. Further profitability measurements were generated. The Profitability Index (PI) which is one of them was 1.17 is greater than one (PI>1), indicating that more money is generated in such a project. The present value

ratio (PVR) is 0.17, higher than zero (PVR>0). This confirms how profitable the project will be for the investor and create a friendly environment for investors to invest more. The revenue for the government of Ghana which was the main focus for the proposed fiscal regime was also measured. The project's Net Present Value (NPV) for the host government was $MM 3,019.45. Positive value for (NPV>0), indicating that the project benefits the host government of Ghana even more without jeopardizing the investment of the IOCs. This means that upon the adjustment made on the upstream petroleum fiscal regime of Ghana, the regime didn't destroy the investment of the contractor but rather created a win-win situation for the two parties.

Table 12: Ghana's Fiscal Regime vs The Proposed Fiscal Regime

GHANA		PROPOSED	
Fiscal Regime Elements		Fiscal Regime Elements	
		1. Sliding Royalty	
1. Royalty rate	5%	rate	R-Factor
2. Income Tax	35%	2. Income Tax	35%
Profitability Measures		Profitability measures	
3. IRR	14.3%	5. IRR	13.7%
4. NPV Contractor	$MM 934.41	6. NPV Contractor	$MM 778.59
5. NPV Government	$MM 2863.63	7. NPV Government	$MM 3019.45

Source: Petroleum Economic Model (2022)

According to the table above, Ghana's existing upstream fiscal regime has a government take net present value of $ 2.86 billion, while the proposed upstream fiscal regime has a take net present value of $ 3.02 billion. Furthermore, the current fiscal regime yielded an undiscounted government take of $ 6.92 billion, whereas the proposed upstream fiscal regime yielded an undiscounted government take of $7.29 billion. These values indicated that when the proposed fiscal regime's royalty rate was tied to the R-factor, more revenue was generated for the Government of Ghana. The government's Net present value rose by $160 million. If the proposed upstream fiscal regime is used, the undiscounted government take will be increased by $ 370 million. The current upstream fiscal regime has IRR of 14.3% whilst the newly proposed fiscal regime has 13.7%. Both investments had an internal rate of return greater than the assumed discount rate when the contractor's investment was considered. This means that both projects will generate a profit for every dollar invested. The current fiscal regime has a contractor NPV of $934.41 million, while the proposed fiscal regime has an NPV of 778.59 million. These values show that sliding the royalty in the proposed fiscal regime increased the Government portion of the resource without jeopardizing the portion of the contractor.

Model simulation and analysis

Stochastic Simulation

A stochastic simulation is run on the deterministic results obtained from the various countries' upstream petroleum fiscal regimes to analyze the pertinent issue of high-level risk and uncertainty associated with the extractive capital-intensive industry, which could result in a relatively low success rate (Echendu,

2012; Nwosi-Anele et al. 2018). This simulation analysis provides investors with the ability to describe risk and uncertainty in the form of distributions for the most likely value of any random variable in the fiscal regime component. The use of probabilistic models in risk and decisive analysis will help provide a better estimate of the expected value in decision making (Echendu, 2012). @RISK is used in the stochastic simulation of this economic model. @RISK risk analysis is a quantitative method for determining the outcomes of a decision situation as a probability distribution (Ashikwei, 2019). Ten thousand (10,000) iterations on four (4) basic input variables were performed in one simulation and applied to five (5) measures of profitability indicator on the current upstream petroleum fiscal regime, the proposed fiscal regime and the upstream fiscal regime of the other countries.

Table 13: Parameters distribution for stochastic analysis

Input Variables	Stochastic Distribution	Min	Mean	Max
Development Cost ($MM)	Triangle	1401.67	1601.67	1801.67
Exploration and Appraisal Cost ($MM)	Triangle	206.66	226.66	246.68
Crude Oil Price ($/BBL)	Triangle	45	75	105
Discount factor (%)	Lognormal	8	10	12

Source: @Risk software (2022)

Using the result from @RISK Monte Carlo Simulation, the stochastic analysis was done with following objective functions with 5%, 10%, 50% and 90% confidence levels consideration on the current and proposed upstream fiscal regime of Ghana on the following output variables:

- NPV of Government take
- NPV of C Take
- IRR
- PVR
- PI

Stochastic analysis performance on Ghana's R/T (1997)

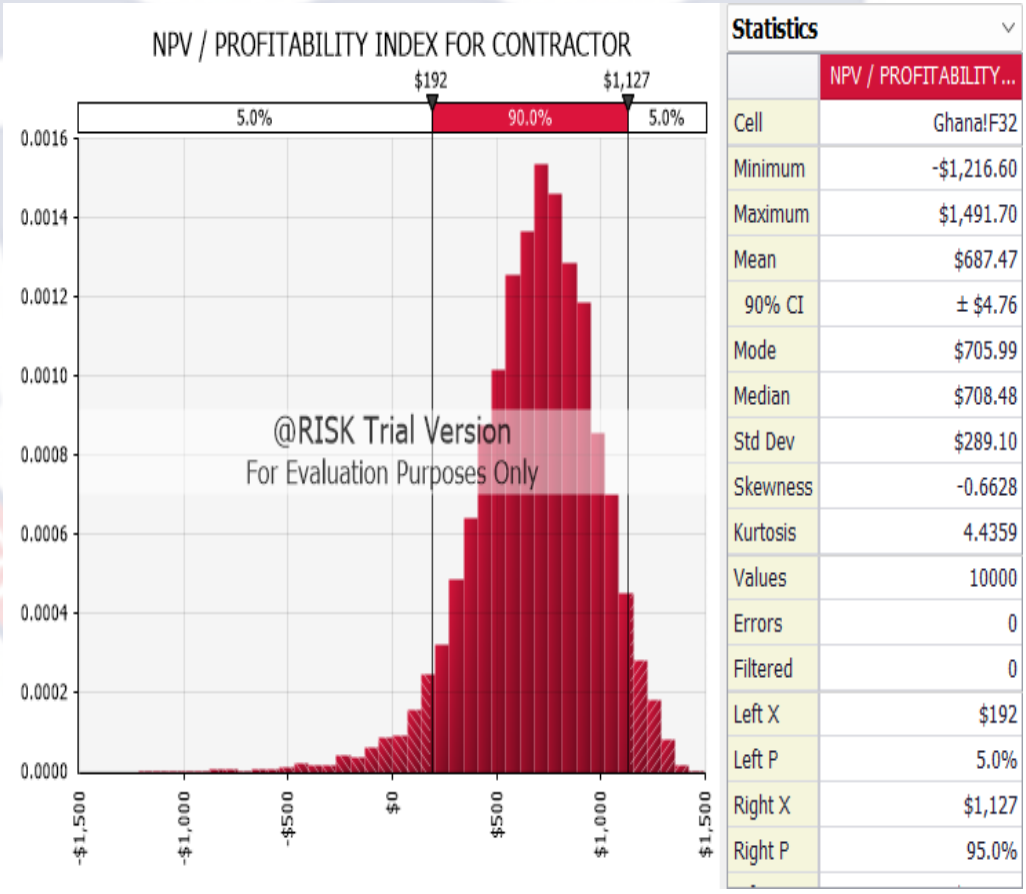


Figure 5 : Ghana RT 1997 Contractor's Stochastic NPV

Source: Stochastic model (2022)

Figure 5 depicts the range of possible average values that can occur instead of a single deterministic value as a result of stochastic modelling on profitability indicators. Risk and uncertainty management is very crucial in upstream petroleum business because of the high capital involved in the industry. The @RISk software is created to show both investors and stakeholders risk involve in such a venture. The result from @risk software for modeling presents the range of safety the business and provides statistics needed to make a solid decision. The result from the @RISK software ware has three graduations and they are the 5 percentile, 90 percentile and 95 percentiles. According to the results, the 5 percentile depicts that there is a 5% chance that the NPV will be greater than $1.127 billion dollars. So, the chance that your NPV of $ 1.127 increasing in this project is only 5%. There is another 5% chance that the contractor's NPV in the fiscal regime will be less than $192 million dollars. This also means that there is only 5% chance that the NPV of the contractor in the existing fiscal regime of Ghana will fall below $ 192 million. In the existing fiscal regime, there is a 90% chance that the contractor's NPV will fall between $192 million and $1.127 billion. This is the information the investor needs to take decision concerning risk management involve in the venture.

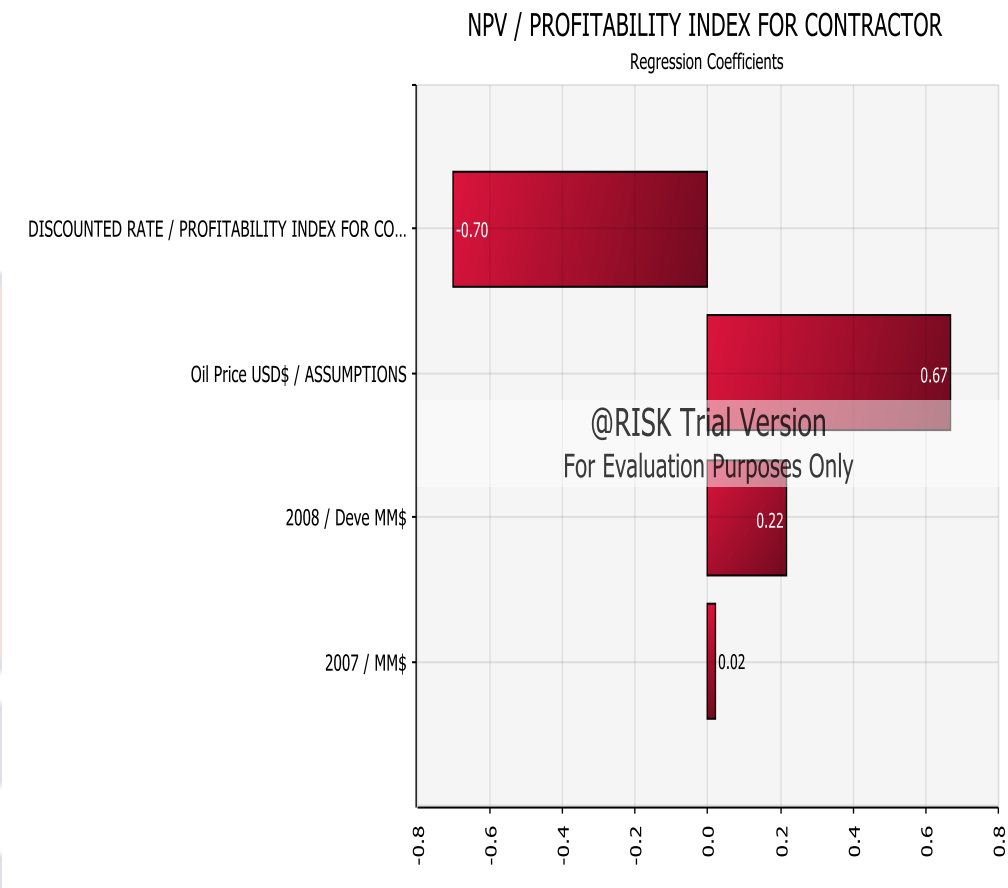


Figure 6: Ghana RT 1997 Contractor's Stochastic NPV Sensitivity Input

Source: Stochastic model (2022)

Figure 6 depicts the factors that contributed to the contractor's NPV and how sensitive they are. Sensitivity analysis is conducted to observe the input factors and how they affect the Contractors NPV. The negative value shows the negative effect on the profitability measurement whilst the positive numbers shows the positive effect. The discount factor input variable reduced the NPV by 70%. This means that increasing the discount rate further reduces the contractor's NPV. The oil price input variable raises the NPV by 67%. This means that as oil prices rise, so will the NPV. Furthermore, the development and exploration costs raise the NPV by 22% and 2%, respectively. So with these values, an investor will have an explicit view of the petroleum project and will will decide to negotiate some input factor. Since the investor knows that the

discount rate is negatively affecting his/her NPV, the investor can negotiate a reduction of the discount rate for the project.

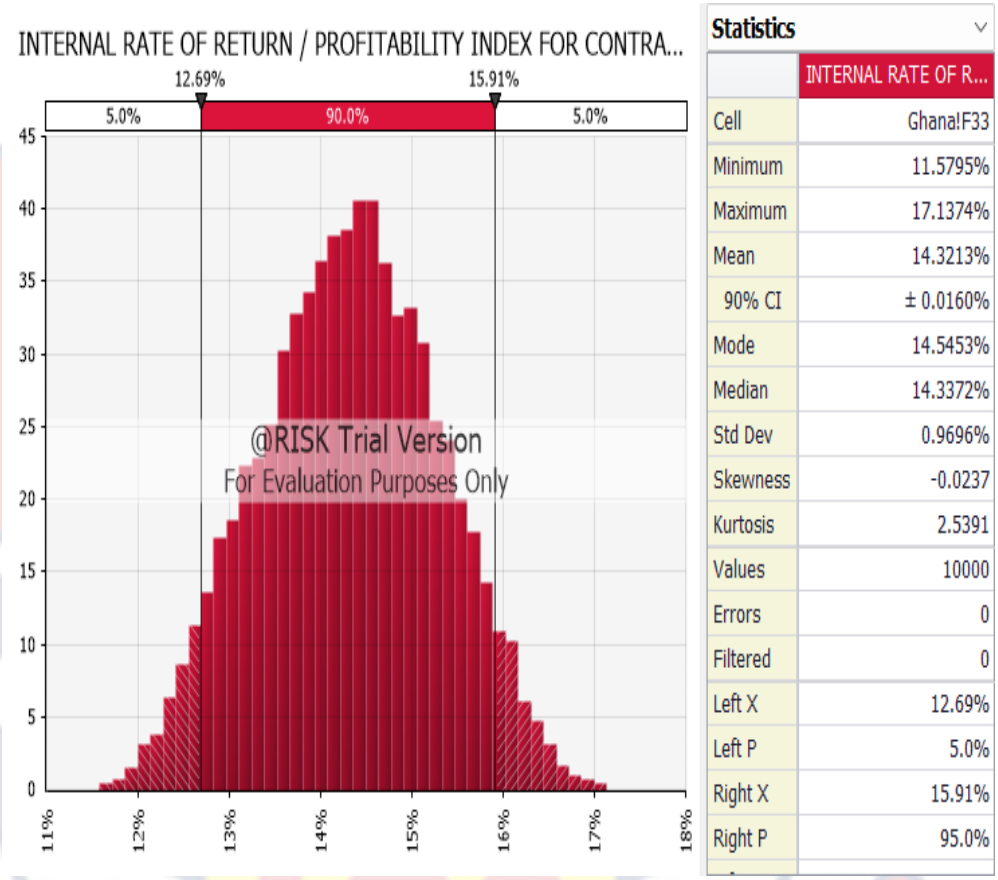


Figure 7: Ghana RT 1997 Contractor's Stochastic IRR

Source: Stochastic model (2022)

Figure 7 depicts the outcome of the project's IRR. The IRR measures the profitability of a project so its an indicator that the investor will be much interested. The @RISK graph is divided into three percentiles and they are the 5 percentiles, 90 percentiles and 95 percentiles. The first percentile shows that there is 5% chance that the IRR is less than 12.69% and a 5% chance of being greater than 15.91%. Furthermore, there is a 90% chance that the IRR will be between 12.69% and 15.91%. The 90% chance have both values greater than the assumed discount rate so this boost the investors confidence to invest in such upstream petroleum project.

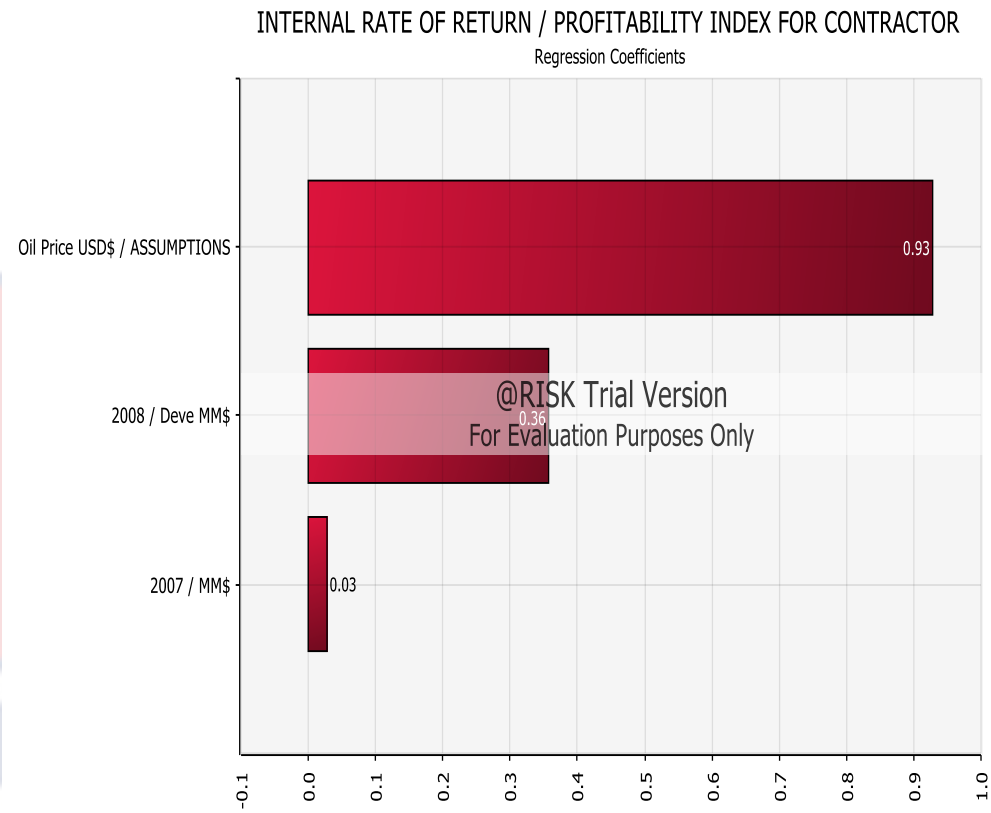


Figure 8: Ghana RT 1997 Contractor's Stochastic IRR Sensitivity Input

Source: Stochastic model (2022)

Figure 8 depicts the factors that influenced the IRR outcome and their sensitivity. This shows the input variables and their effect on the IRR profitability indicator. The crude oil price had the greatest impact of 93%. That is, as the price of oil rises, so will the project's IRR. So every investor will opt for increment in the price of crude since it has greater impact on the project's internal rate of return (IRR). The development and exploration costs also had a positive impact on the IRR, with 36% and 3%, respectively.

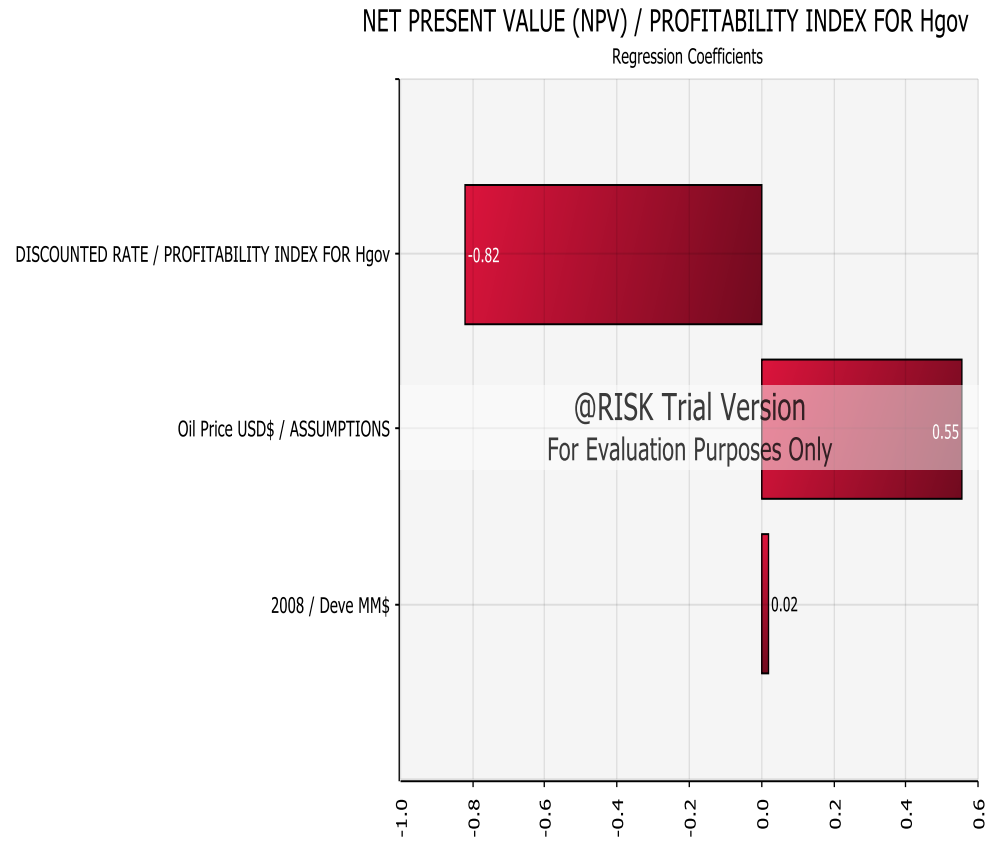


Figure 9: Ghana RT 1997 Host Government Stochastic NPV Sensitivity Input

Source: Stochastic model (2022)

Figure 9 show the sensitive input variable performed on the NPV of the host government. Discounted rate affected the NPV negatively by 82%. Crude oil price affected positively by 55% and also the development cost affected positively by 2%.

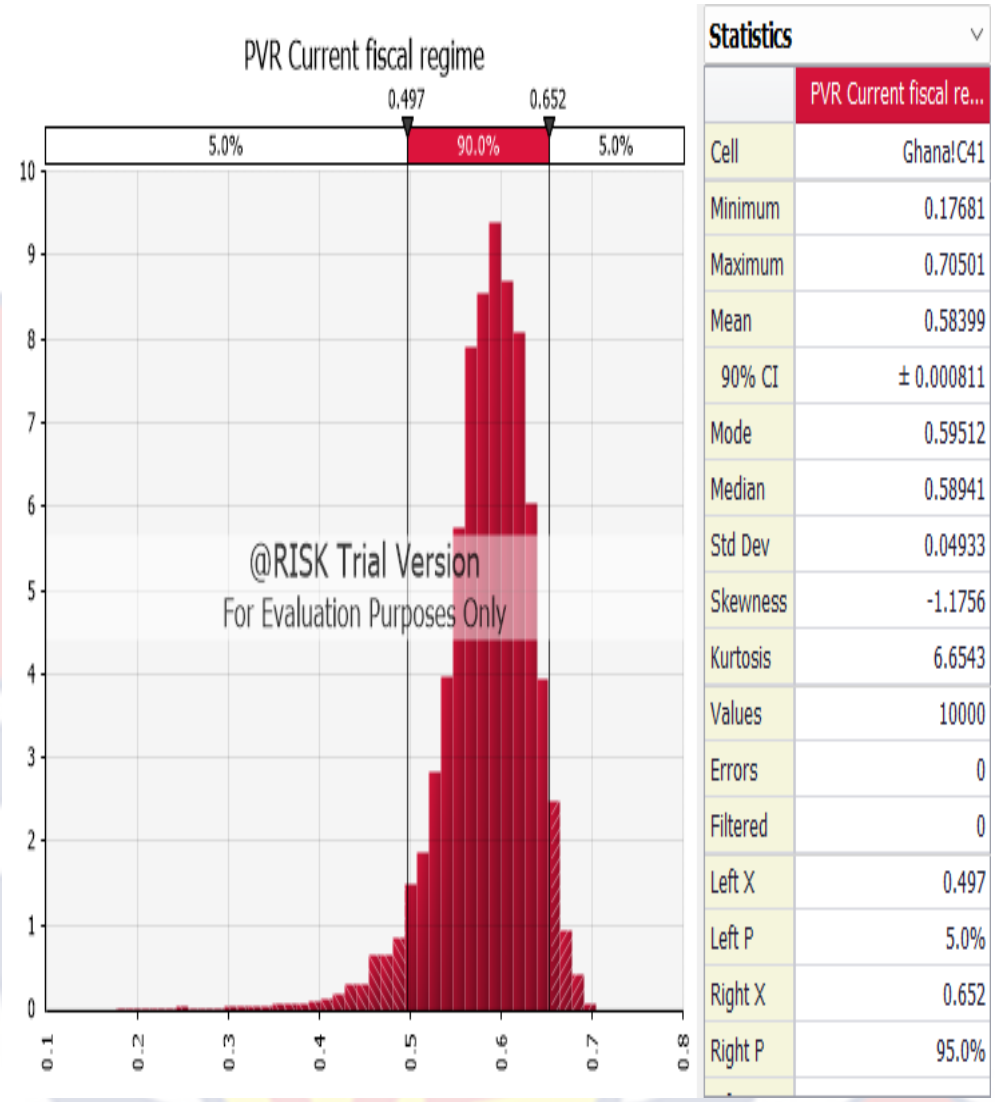


Figure 10: Ghana RT 1997 Stochastic PVR

Source: Stochastic model (2022)

Figure 10 depicts the stochastic modeling of Ghana's existing fiscal regime. The present value ratio (PVR) is a profitability measurement which is used to evaluate projects. A project should be accepted when the PVR is greater than zero (0) and rejected when the PVR is less than zero (0). According to the graph, the PVR has a 5% chance of being less than 0.497 and a 5% chance of being greater than 0.652. The PVR will almost certainly fall between 0.497 and 0.652. All the values in all probability are greater zero which means the project is highly profitable.

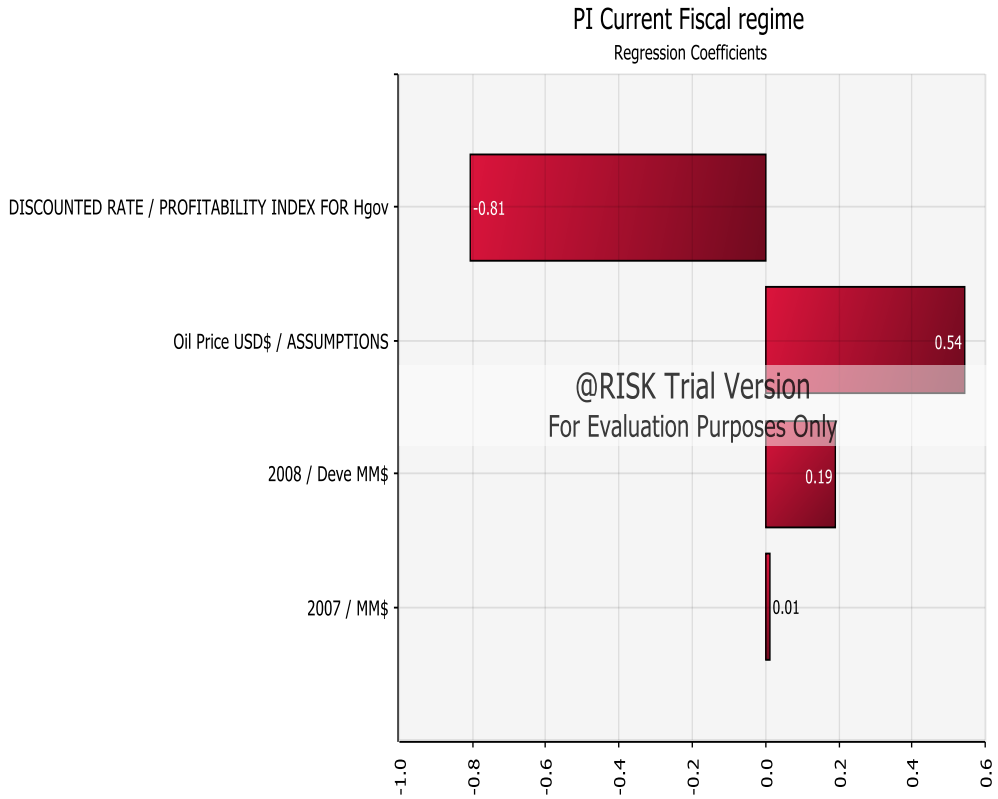


Figure 11: Ghana RT 1997 Stochastic PI Sensitivity Input

Source: Stochastic model (2022)

Figure 11 depicts how sensitive the input variables were on the project's Profitability index (PI). The PI is also another profitability measurement which says a project should be accepted when the value is greater one (1) and should be rejected when its less than one. The price of oil increased the PI by 54%. This means that the higher crude prices get, the better it effects on the PI of the projects. Development costs increased it by 19%, and exploration costs by 1%. The discount factor brought the PI down by 81%.

Stochastic analysis performance of the proposed fiscal regime

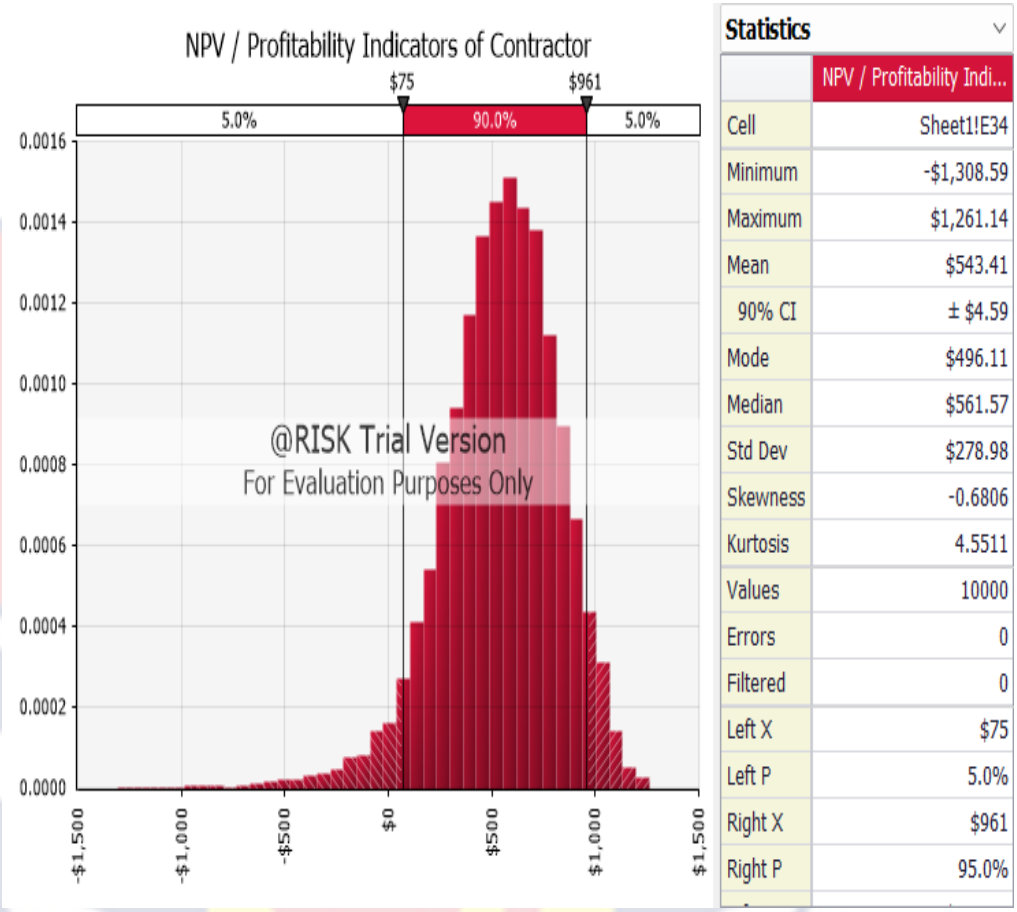


Figure 12: Proposed Regime Contractor's Stochastic NPV

Source: Stochastic model (2022)

Figure 12 depicts the NPV of the contractor in the proposed fiscal regime based on the results of the stochastic modelling. There is a 5% chance that the NPV will be less than $75 million. Furthermore, there is a 5% chance that the NPV will be greater than $961 million. There is a 90% chance that the NPV will be between $75 million and $961 million.

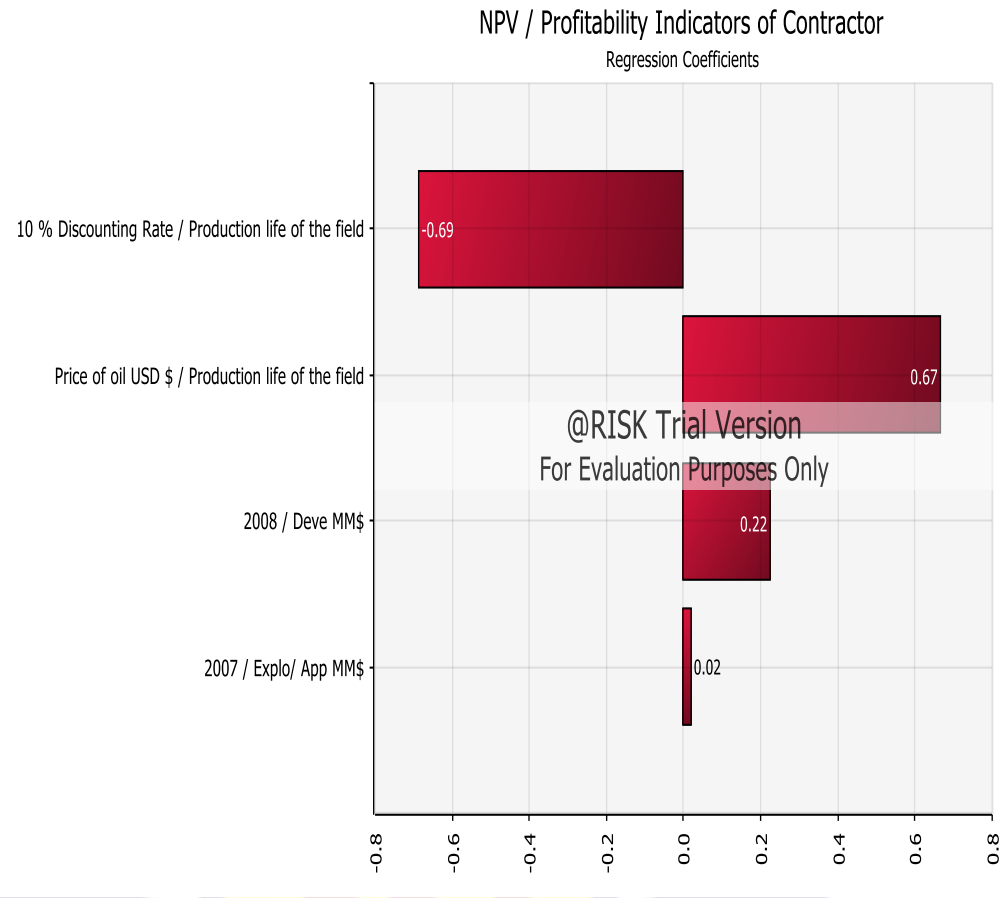


Figure 13: Proposed Regime Contractor's Stochastic NPV Sensitivity Analysis

Source: Stochastic model (2022)

Figure 13 depicts the various input variables and their sensitivity to the contractor's NPV in the proposed upstream fiscal regime. The price of crude oil has a 67% positive impact on the NPV. In other words, as the price of crude oil rises, so will the contractor's net present value. The development and exploration costs had a 22% and 2% positive impact on the NPV, respectively. The discounting factor had a 69% negative impact on the NPV.

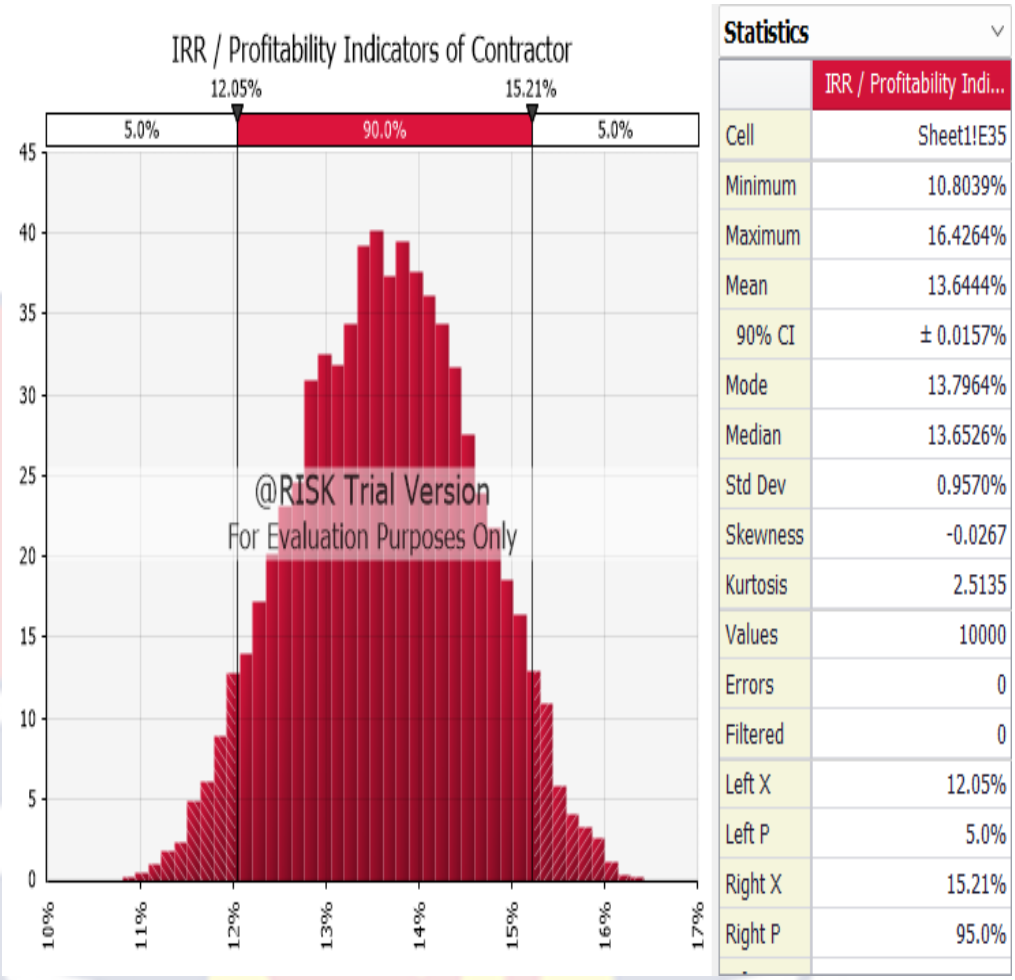


Figure 14: Proposed Regime Stochastic IRR

Source: Stochastic model (2022)

Figure 14 shows the stochastic modelling of IRR of the proposed fiscal regime. The figure indicates that there is 5% chance that the IRR will be less than 12.05%. There is also 5% chance that the IRR will be greater than 15.21%. There is 90% certainty that the IRR will fall between 12.05% and 15.21%.

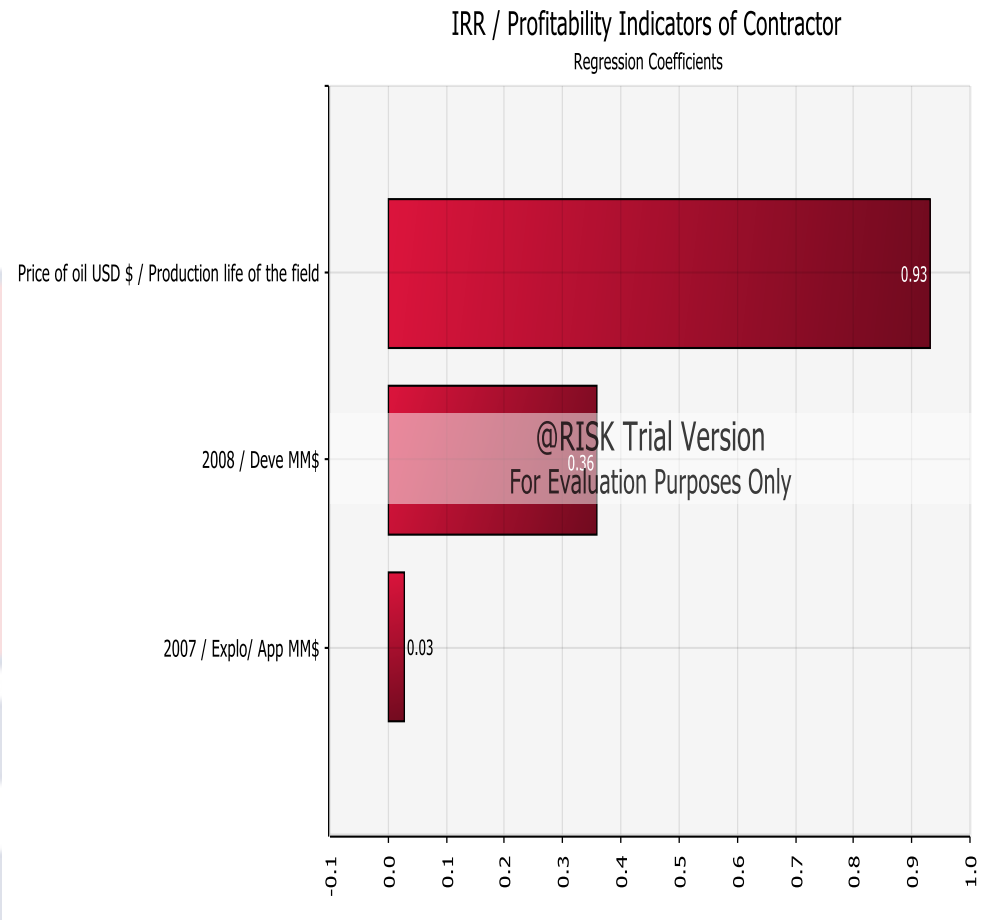


Figure 15: Proposed Regime Stochastic IRR Sensitivity Analysis

Source: Stochastic model (2022)

Figure 15 shows the input variables that affected the IRR. The oil price affected it positively with a percentage of 93%. Meaning, anytime oil price increases, the IRR of the project will increase making the project more attractive and profitable. Development cost and exploration cost affected it positively with a percentage of 36% and 3% respectively.

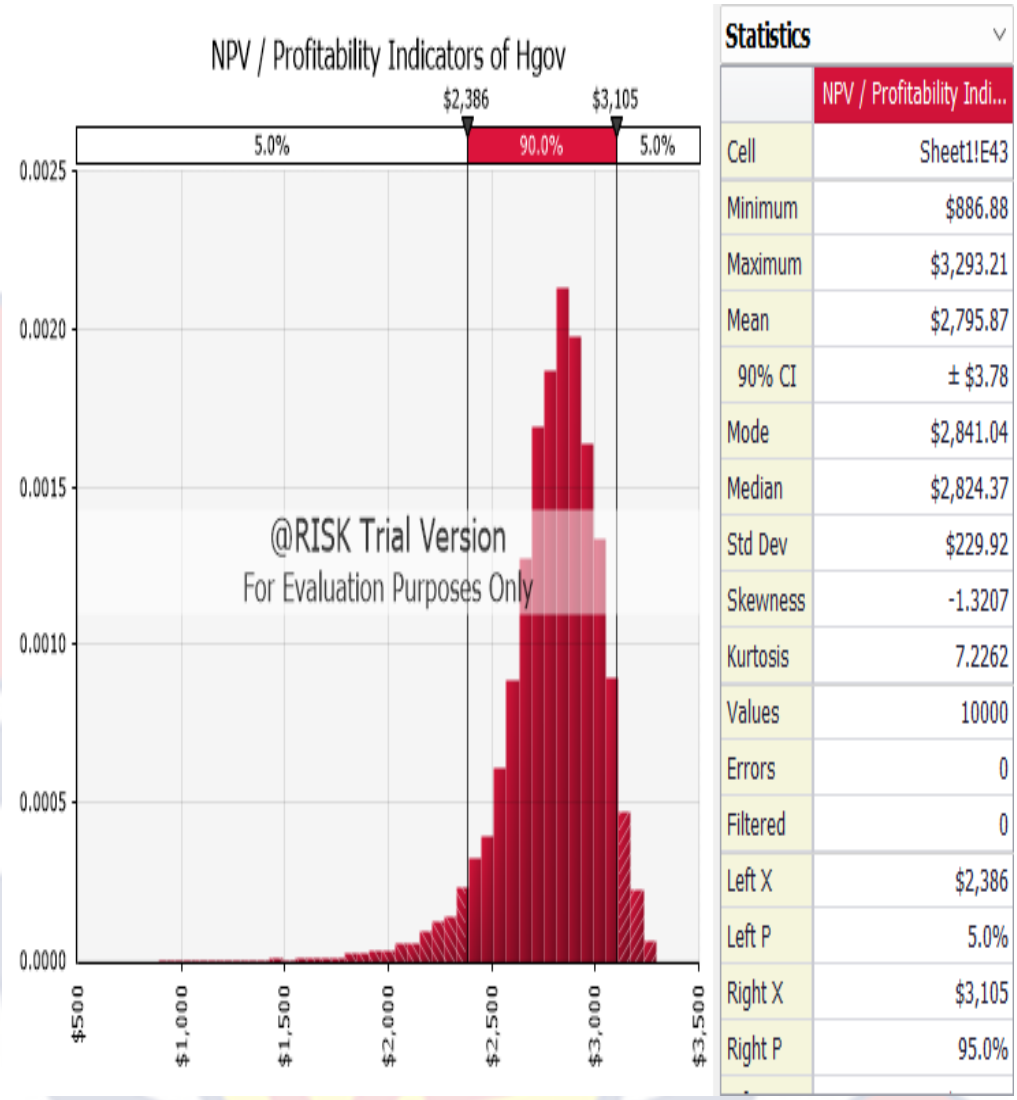


Figure 16: Proposed Regime Host Government Stochastic NPV

Source: Stochastic model (2022)

Figure 16 depicts the outcome of the host government's NPV in the proposed upstream fiscal regime. There is a 5% chance that the NPV will be less than $2.386 billion, and a 5% chance that it will be more than $3.105 billion. There is also a 90% chance that the NPV will be between $2.386 billion and $3.105 billion.

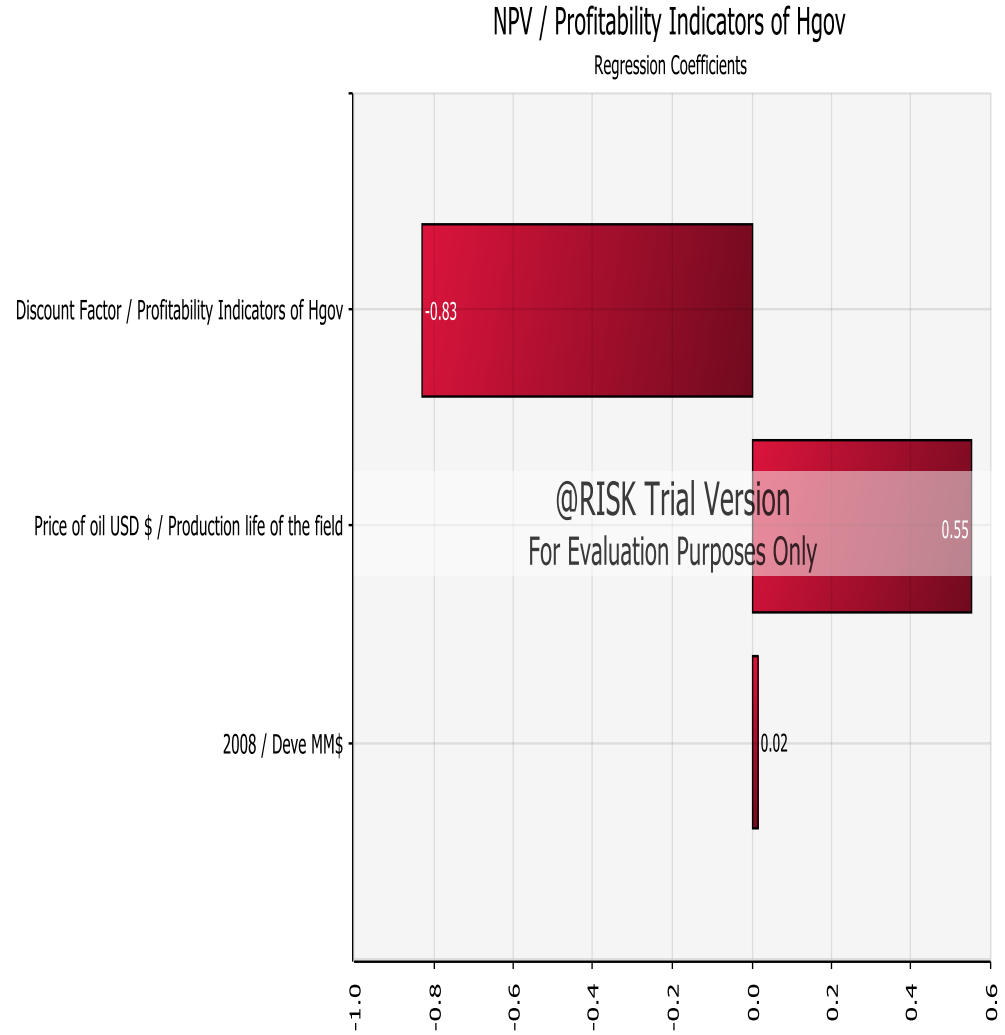
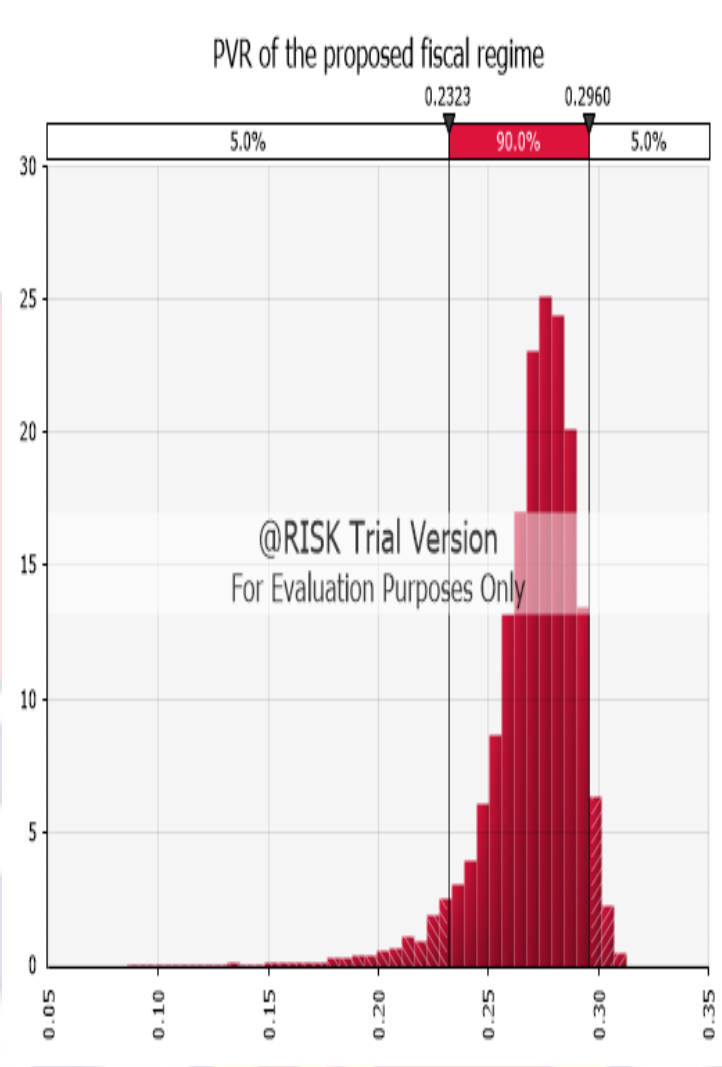


Figure 17: Proposed Regime Host Government Stochastic NPV Sensitivity Analysis

Source: Stochastic model (2022)

Figure 17 shows the input variables that affected the NPV. Crude oil price affected the NPV positively by 55%. Development cost also affected by 2%. On the contrary, the discount factor affected negatively by 83%.



Statistics

	PVR of the proposed ...
Cell	Sheet1!E48
Minimum	0.08594
Maximum	0.31288
Mean	0.27063
90% CI	± 0.000339
Mode	0.27742
Median	0.27411
Std Dev	0.02063
Skewness	-1.7152
Kurtosis	8.9751
Values	10000
Errors	0
Filtered	0
Left X	0.2323
Left P	5.0%
Right X	0.2960
Right P	95.0%

Figure 18: Proposed Regime Stochastic PVR

Source: Stochastic model (2022)

Figure 18 shows the present value ratio (PVR) of the proposed fiscal regime. The figure depicts that there is 5% chance that the PVR will be less than 0.2323. There is also 5% chance that the PVR will be greater than 0.2960. There is 90% certainty that the PVR will fall between 0.2323 and 0.2960.

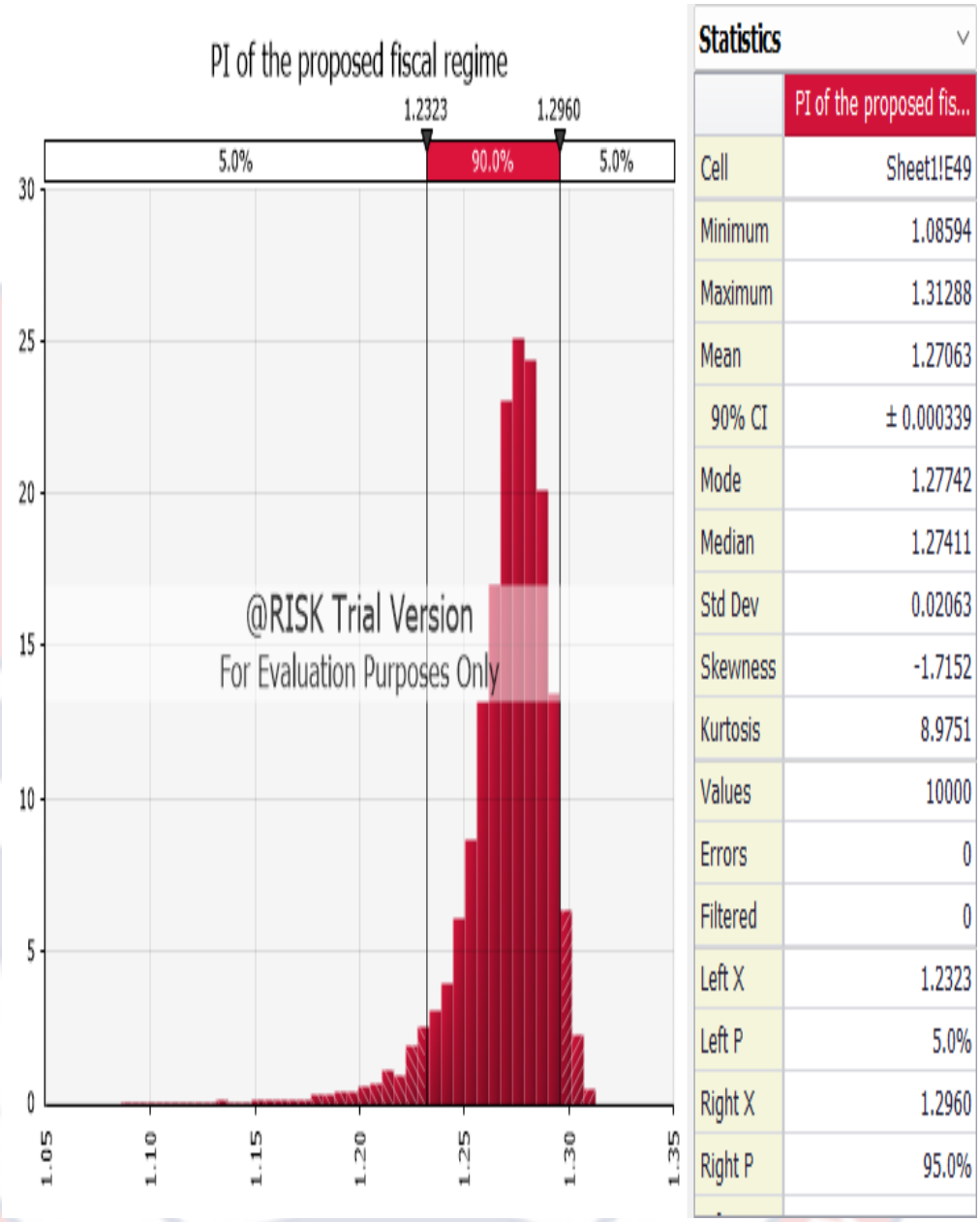


Figure 19: Proposed Regime Stochastic PI

Source: Stochastic model (2022)

Figure 19 shows the profitability index (PI) of the proposed fiscal regime. The figure shows that there is 5% chance that the PI of the project will be less than 1.2323. Also there is 5% chance that the PI will be greater than 1.2960. There is 90% certainty that, the PI will lie between 1.2323 and 1.2960.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Introduction

The study's overarching goal was to evaluate and strengthen Ghana's fiscal regimes in order to expand value creation. In line with this, the study sought to assess the current upstream petroleum fiscal regime underlying Ghana's petroleum resources development and compare it to that of oil-producing African countries. In addition, the study developed and applied a petroleum economic modelling framework for optimal resource exploration and production in order to maximise value, and it finally qualified the degree of risk and uncertainty inherent in the petroleum business.

Summary

The study was carried out to investigate and gain access to Ghana's current petroleum fiscal regime in order to strengthen its value creation. This was accomplished by comparing the current fiscal regime to that of other six (6) African oil producing nations located on the Gulf of Guinea, where Ghana is also located. These countries were chosen at random based on the ages of their upstream fiscal regimes and their petroleum production capabilities. There are some countries that produce more than Ghana, while others produce less.

Using data from the great Jubilee Field, an economic model for all countries were created. For the model, an assumed crude oil price of $75 per barrel of crude was used for all countries. All countries used the same cost of exploration and development (CAPEX) and operation (OPEX). All of the unique components of the upstream petroleum fiscal regime were then incorporated

into the modelled fiscal regimes, ensuring that each country has its own unique fiscal regime.

From the deterministic result of the petroleum economic model, the summary of the fiscal regime of the various countries with Ghana inclusive are;

1. Ghana's current petroleum fiscal regime was ranked second after Uganda in terms of the Contractor's Net Present Value (NPV). Uganda's fiscal regime provides $1.012 billion to the Contractor, while Ghana's fiscal regime provides $934.411 million. It was followed by the Ivory Coast, which contributed $826.30 million, and Congo, which contributed $672.71 million.
2. Nigeria's fiscal regime provides the government with the highest Net Present Value for the Host Government, valued at $5.2 billion. Then came Cameron, who gave the host government 4.8 billion dollars. Ghana's upstream petroleum fiscal regime gave the host government $3.02 billion, ranking sixth among the seven (7) countries.
3. The proposed upstream petroleum fiscal regime model was developed based on the same deterministic results. The royalty in this proposed model is a sliding scale that is linked to the project's R-factor so that it can create value for the host government. It generated a $3.02 billion Net Present Value. This value is greater than the value generated by the current upstream petroleum fiscal regime. Using the monte-carlo simulation tool @Risk, a stochastic and sensitivity analysis was then performed on both Ghana's current and proposed petroleum fiscal regimes to quantify risk and uncertainty.

Conclusions

Based on the findings of the study, the following conclusions were drawn:

- Ghana's current upstream petroleum fiscal regime was successfully assessed. A deterministic petroleum economic model for Ghana was developed using the Great Jubilee field's petroleum production profile. It was then compared to other oil producing African countries. The NPV for the government take was calculated to be $2.8 billion. It ranked the existing upstream petroleum fiscal regime of Ghana sixth in comparison to the governments NPVs of Nigeria, Congo, Uganda, Cameroon, Ivory Coast, and Guinea. The host government take of Ghana's upstream petroleum fiscal regime was greater than Ivory Coast's value of $2.10 billion. This means that in terms for the Host government take of all the countries, the existing upstream fiscal regime performed better than only one country which is the fiscal regime of Ivory Coast.
- An optimal resource framework was successfully modelled using a proposed upstream petroleum regime to maximise value for the government of Ghana. The host government's NPV increased by 15.6% as a result of the proposed modelled upstream petroleum fiscal regime. This means that, the sliding scale tied to the R-Factor of the petroleum project regime expanded value creation. When the fixed royalty was replaced with a sliding scale royalty tied to the R-factor, the host government's NPV increased from $2.863 billion to $3.019 billion. This proposed upstream petroleum fiscal regime reduces contractor take by 16.7%. Ghana's current upstream petroleum fiscal regime had a contractor take of $934.41 million, while the proposed fiscal regime had a take of

$778.59 million. The IRR for both upstream petroleum fiscal regimes was greater than the assumed discount rate of 10% which means both regimes are profitable to investors.

- The risks and uncertainty of Ghana's upstream petroleum business decision were successfully quantified using Monte-Carlo simulation techniques for both the current, proposed fiscal regimes of Ghana and the other oil producing countries in Africa. According to the research, the contractor take NPV of the current fiscal regime has a 90% certainty of falling between $192 million and $1.12 billion. It also concluded that the current fiscal regime's PVR will fall between 0.497 and 0.652 with 90% certainty. According to the study, the host government NPV of the proposed fiscal regime has a 90% certainty of being between $2.386 Billion and $3.105 Billion. It also concluded that the proposed fiscal regime's PI will fall between 1.232 and 1.296 with 90% certainty.

Recommendations

Based on the summary and conclusions, the following recommendations are made:

- The study recommended that the calculation of additional oil entitlements, which is a major component of the existing fiscal regime, be tied to R-factor rather than Rate of Ratio (ROR). This component is supposed to generate revenue for the host government, but it has never delivered on that promise. It has never been triggered since November 2010, when Ghana began producing petroleum. Inasmuch as R-Factor linked to the sliding scale royalty expanded the revenue base of the

government, it will further increase should it be tied to the additional oil entitlement (AOE).

- The sliding scale royalty can also be linked to the Great Jubilee field's production profile. The Royalty is a significant component of the host government's revenue mobilization, so sliding it against the production rate will result in a win-win profit for both the host government and the contractor.
- Furthermore, the Sliding scale royalty can be linked to the price of crude oil. Crude oil prices can fall to their lowest point and then skyrocket. The royalty tiered to it will account for windfall profit. When crude prices rise, the royalty rises, and when prices fall, the royalty falls, both of which serve as incentives to contractors.

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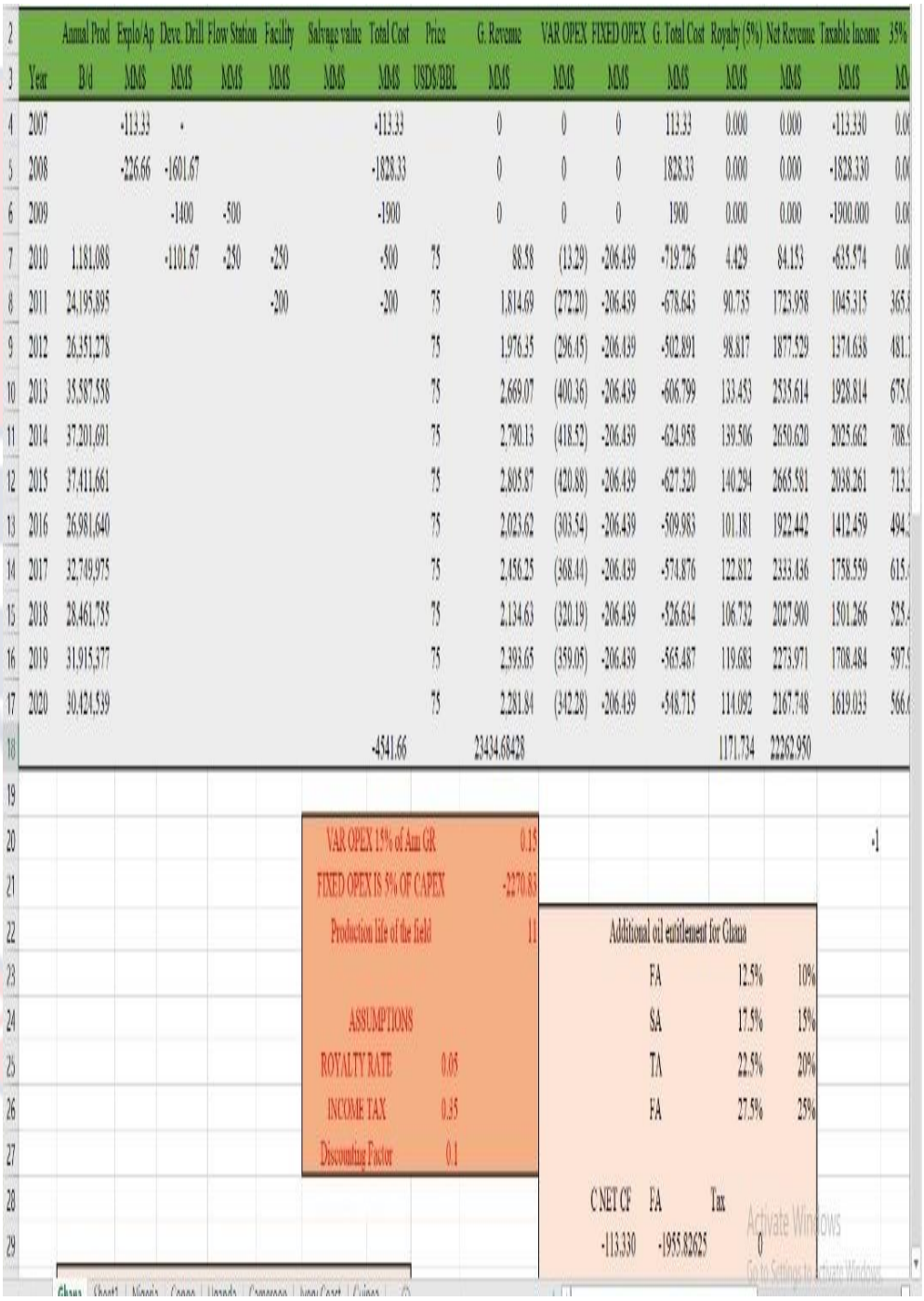
APPENDICES

APPENDIX A

Economic model for the Fiscal Regime of Ghana R/T (1997)



Year	Annual Prod B/d	Explo/Ap MMS	Deve. Drill MMS	Flow Station MMS	Facility MMS	Salvage value MMS	Total Cost MMS	Price USD/BBL	G. Revenue MMS	VAR OPEX MMS	FIXED OPEX MMS	G. Total Cost MMS	Royalty (5%) MMS	Net Revenue MMS	Taxable Income MMS	35% MMS
2007		-113.33	-				-113.33		0	0	0	113.33	0.000	0.000	-113.330	0.00
2008		-226.66	-1601.67				-1828.33		0	0	0	1828.33	0.000	0.000	-1828.330	0.00
2009			-1400	-500			-1900		0	0	0	1900	0.000	0.000	-1900.000	0.00
2010	1,181,088		-1101.67	-250	-250		-500	75	88.58	(13.29)	-206.439	-719.726	4.429	84.153	-635.574	0.00
2011	24,195,895				-200		-200	75	1,814.69	(272.20)	-206.439	-678.643	90.735	1723.958	1045.315	365.6
2012	26,351,278							75	1,976.35	(296.45)	-206.439	-502.891	98.817	1877.529	1374.638	481.1
2013	35,587,558							75	2,669.07	(400.36)	-206.439	-606.799	133.453	2535.614	1928.814	675.0
2014	37,201,691							75	2,790.13	(418.52)	-206.439	-624.958	139.506	2650.620	2025.662	708.5
2015	37,411,661							75	2,805.87	(420.88)	-206.439	-627.320	140.294	2665.581	2038.261	713.3
2016	26,981,640							75	2,023.62	(303.54)	-206.439	-509.983	101.181	1922.442	1412.459	494.2
2017	32,749,975							75	2,456.25	(368.44)	-206.439	-574.876	122.812	2333.436	1758.559	615.4
2018	28,461,755							75	2,134.63	(320.19)	-206.439	-526.634	106.732	2027.900	1501.266	525.4
2019	31,915,377							75	2,393.65	(359.05)	-206.439	-565.487	119.683	2273.971	1708.484	597.9
2020	30,421,539							75	2,281.84	(342.28)	-206.439	-548.715	114.092	2167.748	1619.033	566.6
							-4541.66		23434.68428				1171.734	22262.950		

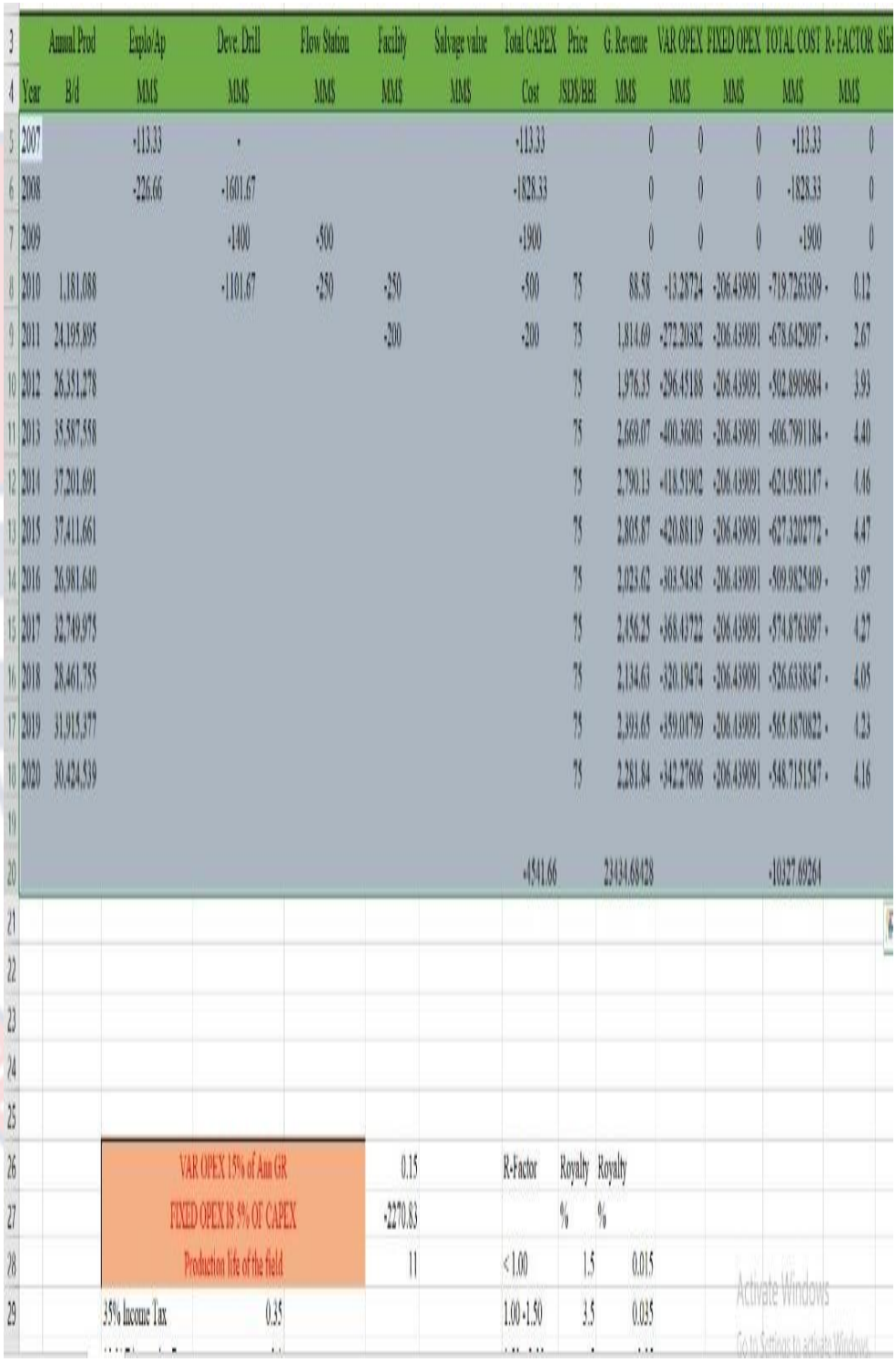
VAR OPEX 15% of Ann GR	0.15
FIXED OPEX IS 5% OF CAPEX	-2270.83
Production life of the field	11
ASSUMPTIONS	
ROYALTY RATE	0.05
INCOME TAX	0.35
Discounting Factor	0.1

Additional oil entitlement for Ghana		
FA	12.5%	10%
SA	17.5%	15%
TA	22.5%	20%
FA	27.5%	25%

CNET CF	FA	Tax
-113.330	-1955.82625	0

APPENDIX B

Economic model for the Proposed Fiscal Regime of Ghana

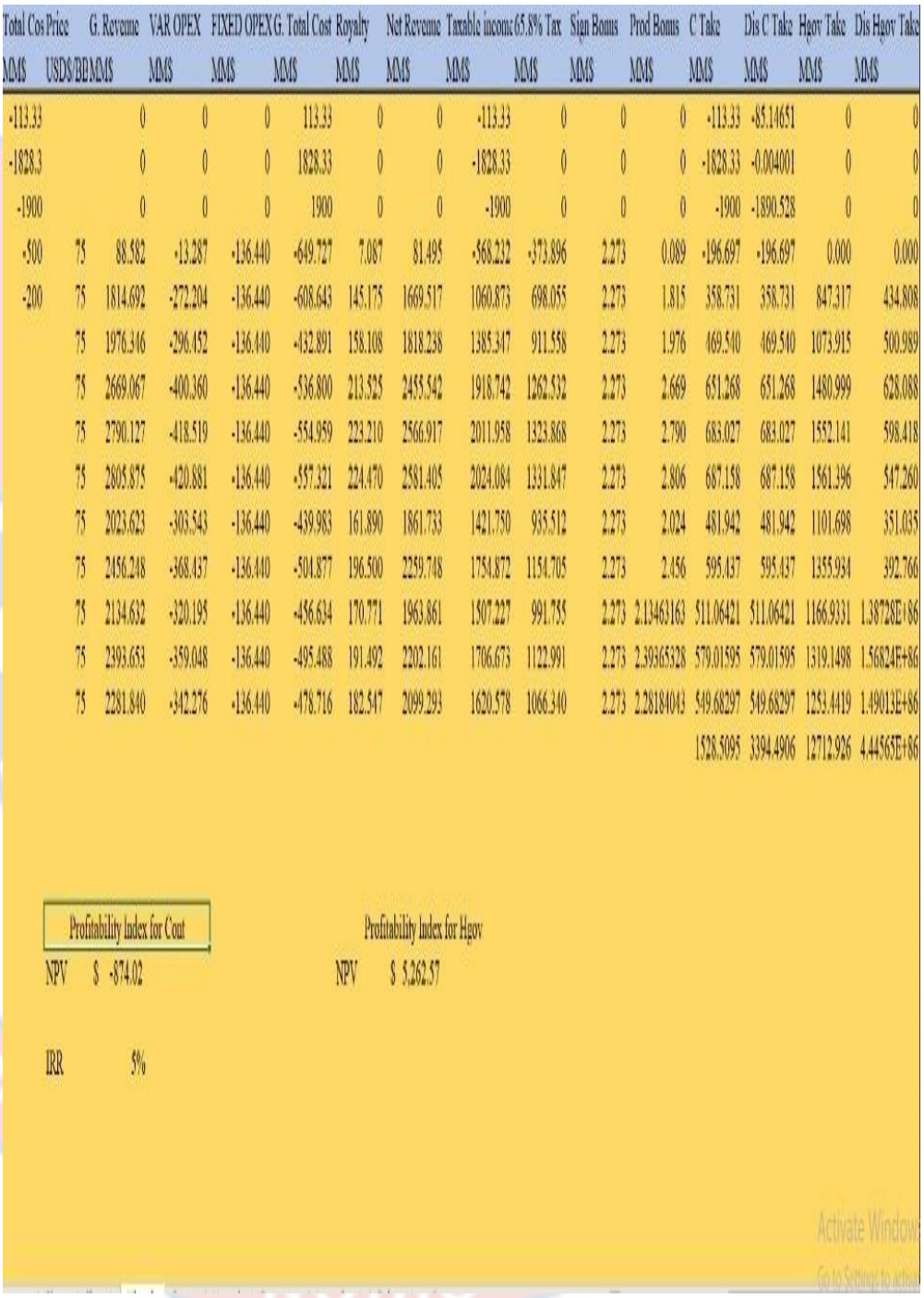


	Annual Prod	Explo/Ap	Deve. Drill	Flow Station	Facility	Salvage value	Total CAPEX	Price	G Revenue	VAR OPEX	FIXED OPEX	TOTAL COST	R-FACTOR	Sli
Year	B/d	MM$	MM$	MM$	MM$	MM$	Cost	/SD$/BBl	MM$	MM$	MM$	MM$	MM$	
2007		-113.33	-				-113.33		0	0	0	-113.33	0	
2008		-226.66	-1601.67				-1828.33		0	0	0	-1828.33	0	
2009			-1400	-500			-1900		0	0	0	-1900	0	
2010	1,181.088		-1101.67	-250	-250		-500	75	88.58	-13.28724	-206.439091	-719.7263309	-	0.12
2011	24,195.895				-200		-200	75	1,814.69	-272.20582	-206.439091	-678.6429097	-	2.67
2012	26,351.278							75	1,976.35	-296.45188	-206.439091	-502.8909684	-	3.93
2013	35,587.558							75	2,669.07	-400.36003	-206.439091	-606.7991184	-	4.40
2014	37,201.691							75	2,790.13	-418.51902	-206.439091	-624.9581147	-	4.46
2015	37,411.661							75	2,805.87	-420.88119	-206.439091	-627.3202772	-	4.47
2016	26,981.640							75	2,023.62	-303.54345	-206.439091	-509.9825409	-	3.97
2017	32,749.975							75	2,456.25	-368.43722	-206.439091	-574.8763097	-	4.27
2018	28,461.755							75	2,134.63	-320.19474	-206.439091	-526.6338347	-	4.05
2019	31,915.377							75	2,393.65	-359.04799	-206.439091	-565.4870822	-	4.23
2020	30,424.539							75	2,281.84	-342.27606	-206.439091	-548.7151547	-	4.16
							-4541.66		23434.68428			-10327.69264		

VAR OPEX 15% of Ann GR	0.15	R-Factor	Royalty %	Royalty %
FIXED OPEX IS 5% OF CAPEX	-2270.83			
Production life of the field	11	<1.00	1.5	0.015
35% Income Tax	0.35	1.00-1.50	3.5	0.035

APPENDIX C

Economic model for the Fiscal Regime of Nigeria R/T (2000)



Total Cos	Price	G. Revenue	VAR OPEX	FIXED OPEX	G. Total Cost	Royalty	Net Revenue	Taxable income	65.8% Tax	Sign Bonus	Prod Bonus	C Take	Dis C Take	Hgov Take	Dis Hgov Take
MM$	USD$/BBL	MM$	MM$	MM$	MM$	MM$	MM$	MM$	MM$	MM$	MM$	MM$	MM$	MM$	MM$
-113.33		0	0	0	113.33	0	0	-113.33	0	0	0	-113.33	-85.14651	0	0
-1828.3		0	0	0	1828.33	0	0	-1828.33	0	0	0	-1828.33	-0.004001	0	0
-1900		0	0	0	1900	0	0	-1900	0	0	0	-1900	-1890.528	0	0
-500	75	88.582	-13.287	-136.440	-649.727	7.087	81.495	-568.232	-373.896	2.273	0.089	-196.697	-196.697	0.000	0.000
-200	75	1814.692	-272.204	-136.440	-608.643	145.175	1669.517	1060.873	698.055	2.273	1.815	358.731	358.731	847.317	434.808
	75	1976.346	-296.452	-136.440	-432.891	158.108	1818.238	1385.347	911.558	2.273	1.976	469.540	469.540	1073.915	500.989
	75	2669.067	-400.360	-136.440	-536.800	213.525	2455.542	1918.742	1262.532	2.273	2.669	651.268	651.268	1480.999	628.088
	75	2790.127	-418.519	-136.440	-554.959	223.210	2566.917	2011.958	1323.868	2.273	2.790	683.027	683.027	1552.141	598.418
	75	2805.875	-420.881	-136.440	-557.321	224.470	2581.405	2024.084	1331.847	2.273	2.806	687.158	687.158	1561.396	547.260
	75	2023.623	-303.543	-136.440	-439.983	161.890	1861.733	1421.750	935.512	2.273	2.024	481.942	481.942	1101.698	351.035
	75	2456.248	-368.437	-136.440	-504.877	196.500	2259.748	1754.872	1154.705	2.273	2.456	595.437	595.437	1355.934	392.766
	75	2134.632	-320.195	-136.440	-456.634	170.771	1963.861	1507.227	991.755	2.273	2.13463163	511.06421	511.06421	1166.9331	1.38728E+86
	75	2393.653	-359.048	-136.440	-495.488	191.492	2202.161	1706.673	1122.991	2.273	2.39365328	579.01595	579.01595	1319.1498	1.56824E+86
	75	2281.840	-342.276	-136.440	-478.716	182.547	2099.293	1620.578	1066.340	2.273	2.28184043	549.68297	549.68297	1253.4419	1.49013E+86
												1528.5095	3394.4906	1271.2926	4.44565E+86

Profitability Index for Cost

NPV $ -874.02

IRR 5%

Profitability Index for Hgov

NPV $ 5,262.57

APPENDIX D

Economic model for the Fiscal Regime of Guinea R/T (2006)

Year	Annual Pr	Explo/Aq	Deve. Dr	Flow Station	Facility	Salvage	Total Cost	Price	G. Revenue	VAR OPEX	FIXED OPEX	G. Total Cost	royalty	Net Revenue	Taxable Income	Tax	Sign Bonu	Prod Bonus	N
	Bid	MM$	MM$	MM$	MM$	MM$	MM$	USD$/BB	MM$	MM$	MM$	MM$	MM$	MM$	MM$	MM$	MM$	MM$	
2007		-113.33	-				-113.33		0	0	0	-113.33	0	0	-113.33	0	0	0	
2008		-226.66	-1601.7				-1828.33		0	0	0	-1828.33	0	0	-1828.33	0	0	0	
2009			-1400	-500			-1900		0	0	0	-1900	0	0	-1900	0	0	0	
2010	1181088		-1101.7	-250	-250		-500	75	88.582	-13.287	-136.440	-649.727	11.516	77.066	-572.661	0.000	0.136	0.455	
2011	24195895				-200		-200	75	1814.692	-272.204	-136.440	-608.643	235.910	1578.782	970.139	339.549	0.136	0.455	
2012	26351278							75	1976.346	-296.452	-136.440	-432.891	256.925	1719.421	1286.529	450.285	0.136	0.455	
2013	35587558							75	2669.067	-400.360	-136.440	-536.800	346.979	2322.088	1785.289	624.851	0.136	0.455	
2014	37201691							75	2790.127	-418.519	-136.440	-554.959	362.716	2427.410	1872.452	655.358	0.136	0.455	
2015	37411661							75	2805.875	-420.881	-136.440	-557.321	364.764	2441.111	1883.790	659.327	0.136	0.455	
2016	26981640							75	2023.623	-303.543	-136.440	-439.983	263.071	1760.552	1320.569	462.199	0.136	0.455	
2017	32749975							75	2456.248	-368.437	-136.440	-504.877	319.312	2136.936	1632.059	571.221	0.136	0.455	
2018	28461755							75	2134.632	-320.195	-136.440	-456.634	277.502	1857.130	1400.495	490.173	0.136	0.455	
2019	31915377							75	2393.653	-359.048	-136.440	-495.488	311.175	2082.478	1586.991	555.447	0.136	0.455	
2020	30424539							75	2281.840	-342.276	-136.440	-478.716	296.639	1985.201	1506.486	527.270	0.136	0.455	

NPV Cont $ 660.06 NPV Hgov $ 3,479.57

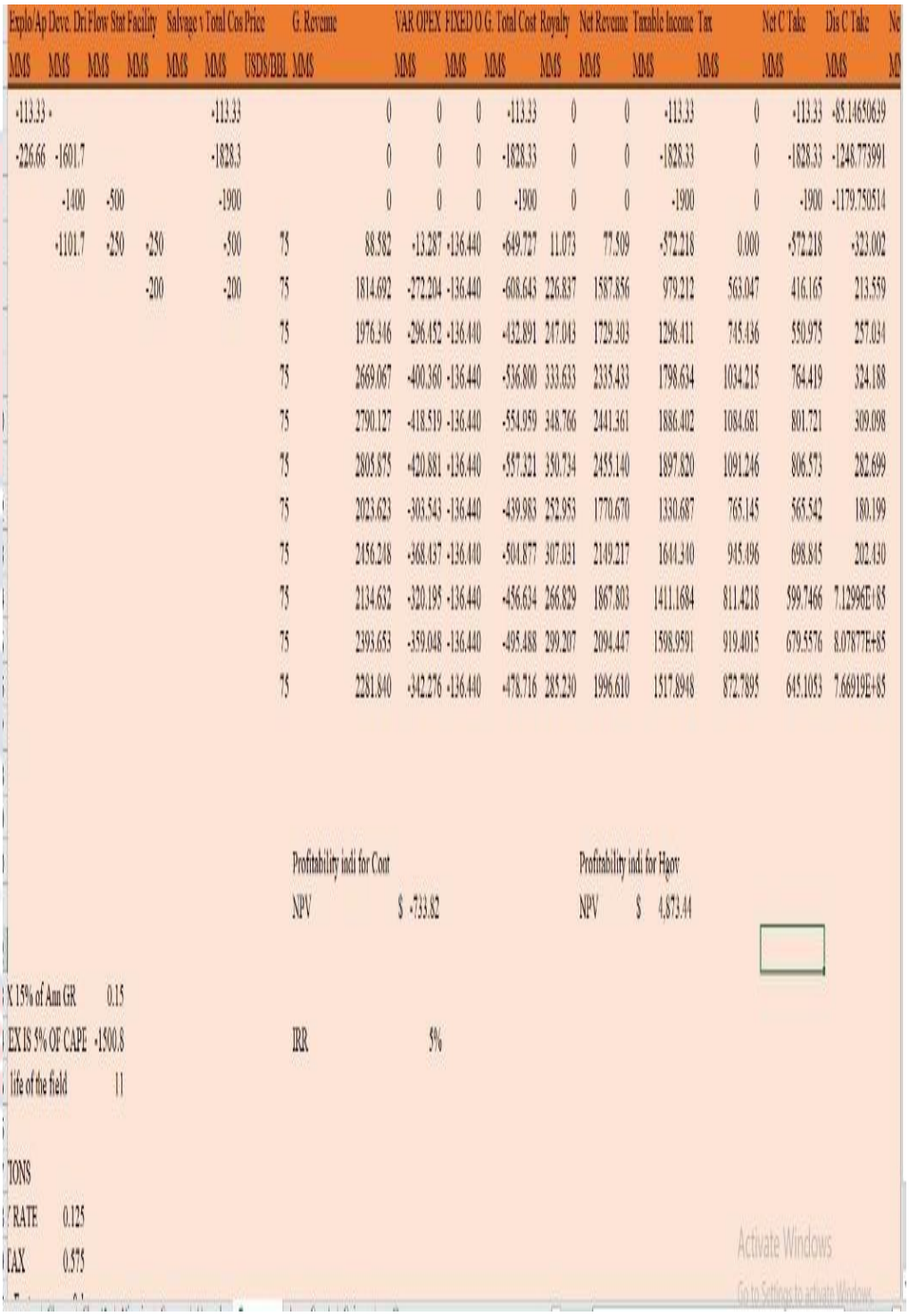
VAR OPEX 15% of Ann GR 0.15
FIXED OPEX IS 5% OF CAPE -1500.8
Production life of the field 11

IRR 13%

ASSUMPTIONS
ROYALTY RATE 0.13
INCOME TAX 0.35
Discounting Factor 0.1
Sign Bonus $ M 1.5 0.13636
Prod Bonus $ M 5 0.45455

APPENDIX E

Economic model for the Fiscal Regime of Cameroon R/T (1995)



Explo/Ap	Deve. Dri	Flow Stat	Facility	Salvage v	Total Cos	Price	G. Revenue	VAR OPEX	FIXED O	G. Total Cost	Royalty	Net Revenue	Taxable Income	Tax	Net C Take	Dis C Take	Ne
MMS	MMS	MMS	MMS	MMS	MMS	USD/BBL	MMS	MMS	MMS	MMS	MMS	MMS	MMS	MMS	MMS	MMS	M
-113.33	-				-113.33			0	0	0	-113.33	0	0	-113.33	0	-113.33	-85.14650639
-226.66	-1601.7				-1828.3			0	0	0	-1828.33	0	0	-1828.33	0	-1828.33	-1248.773991
	-1400	-500			-1900			0	0	0	-1900	0	0	-1900	0	-1900	-1179.730514
	-1101.7	-250	-250		-500	75	88.582	-13.287	-136.440	-649.727	11.073	77.509	-572.218	0.000	-572.218	-323.002	
			-200		-200	75	1814.692	-272.204	-136.440	-608.643	226.837	1587.856	979.212	563.047	416.165	213.559	
						75	1976.316	-296.452	-136.440	-432.891	247.043	1729.303	1296.411	745.436	550.975	257.034	
						75	2669.067	-400.360	-136.440	-536.800	333.633	2335.433	1798.634	1034.215	764.419	324.188	
						75	2790.127	-418.519	-136.440	-554.959	348.766	2441.361	1886.402	1084.681	801.721	309.098	
						75	2805.875	-420.881	-136.440	-557.321	350.734	2455.140	1897.820	1091.246	806.573	282.699	
						75	2023.623	-303.543	-136.440	-439.983	252.953	1770.670	1330.687	765.145	565.542	180.199	
						75	2456.248	-368.437	-136.440	-504.877	307.031	2149.217	1644.340	945.496	698.845	202.430	
						75	2134.652	-320.195	-136.440	-456.634	266.829	1867.803	1411.1684	811.4218	599.7466	7.12996E+85	
						75	2393.653	-359.048	-136.440	-495.488	299.207	2094.447	1598.9591	919.4015	679.5576	8.07877E+85	
						75	2281.840	-342.276	-136.440	-478.716	285.230	1996.610	1517.8948	872.7695	645.1053	7.66919E+85	

Profitability indi for Cont

NPV $ -733.82

Profitability indi for Hgov

NPV $ 4,873.44

X 15% of Ann GR 0.15

EX IS 5% OF CAPE -1500.8

life of the field 11

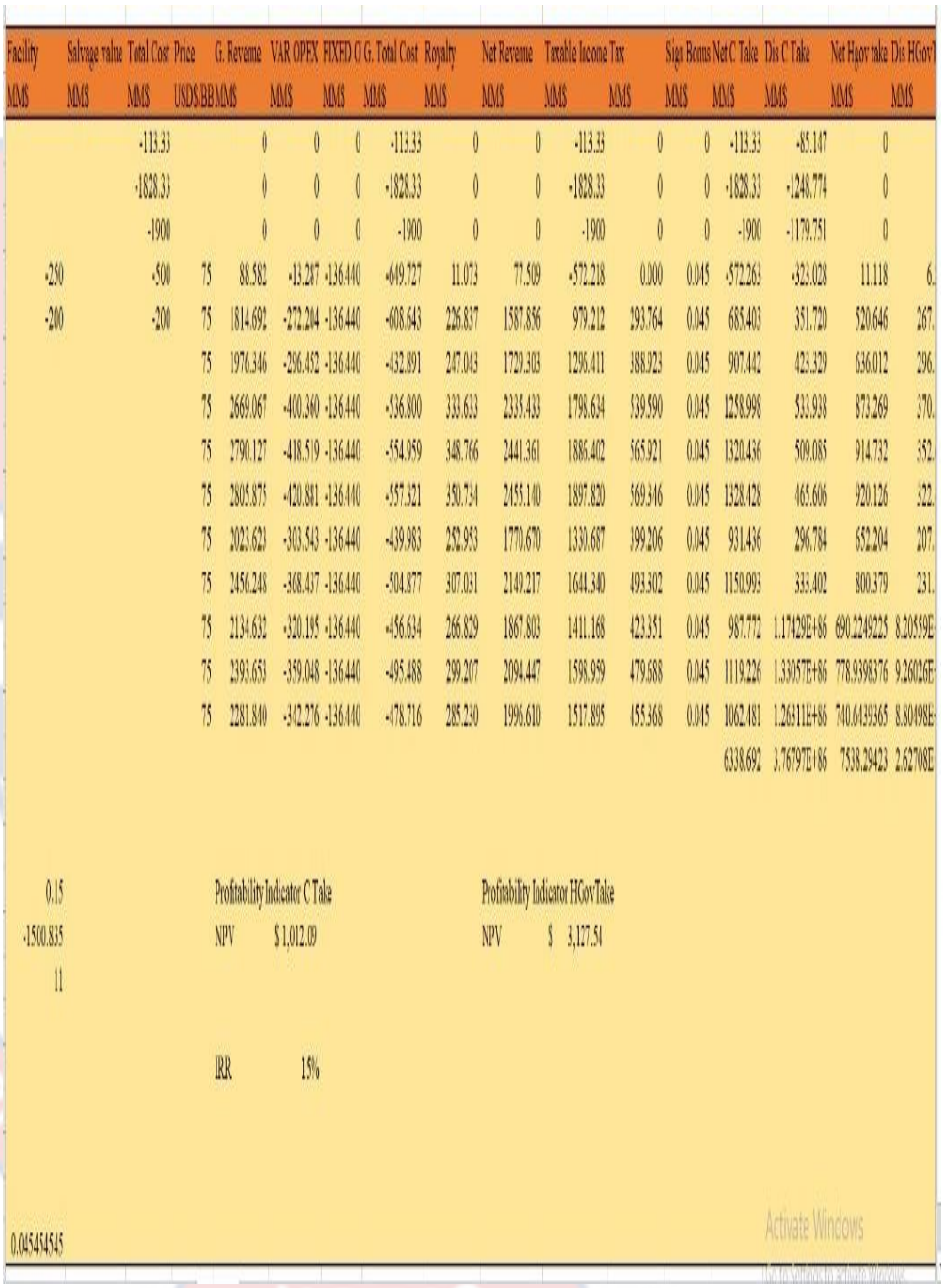
TIONS

RATE 0.125

TAX 0.575

APPENDIX F

Economic model for the Fiscal Regime of Uganda R/T (2010)

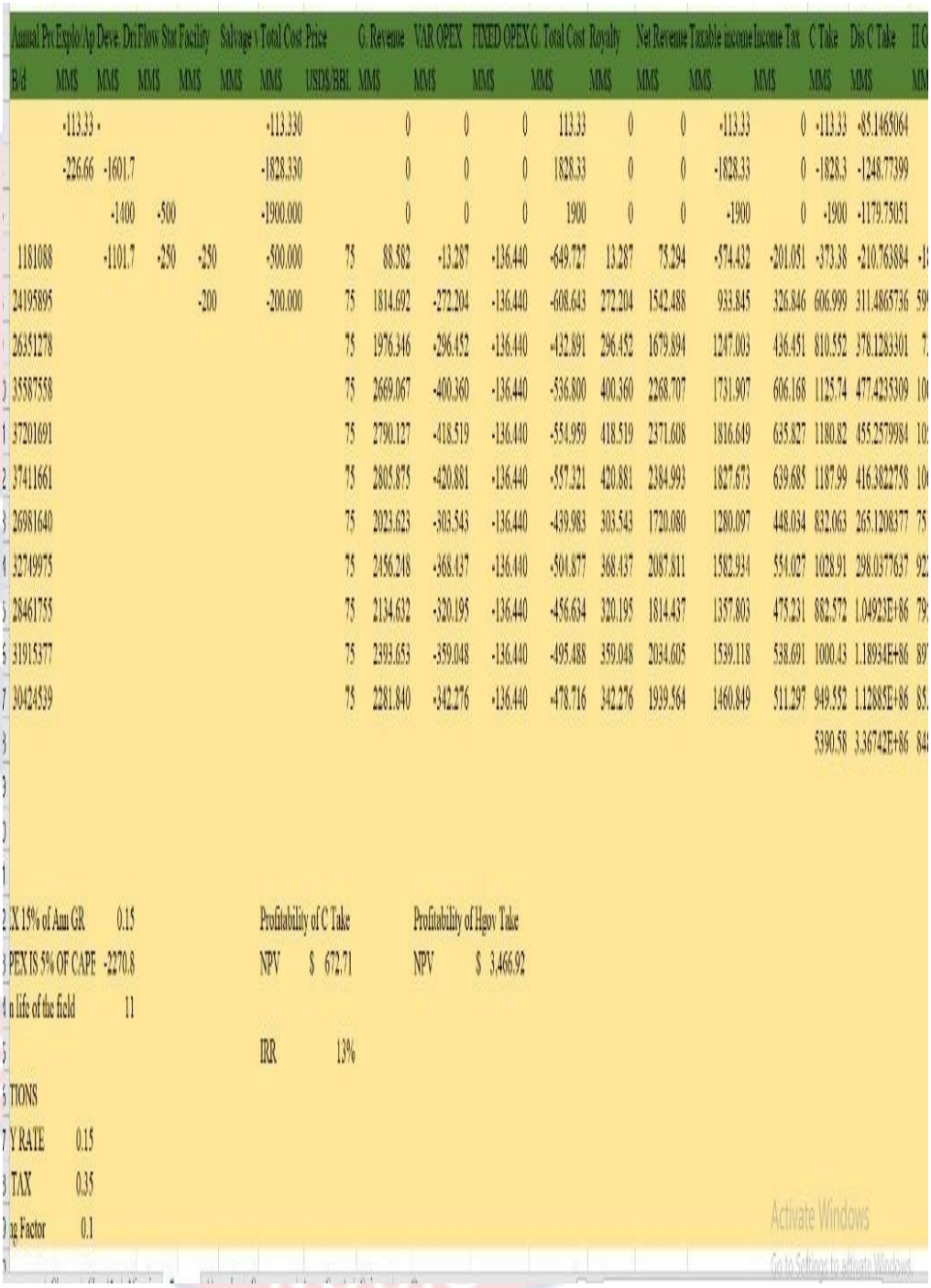


Facility MM$	Salvage value MM$	Total Cost MM$	Price USD$/BB		G. Revenue MM$	VAR OPEX MM$	FIXED O MM$	G. Total Cost MM$	Royalty MM$	Net Revenue MM$	Taxable Income MM$	Tax MM$	Sign Bonus MM$	Net C Take MM$	Dis C Take	Net Hgov take MM$	Dis HGov MM$
		-113.33			0	0	0	-113.33	0	0	-113.33	0	0	-113.33	-85.147	0	
		-1828.33			0	0	0	-1828.33	0	0	-1828.33	0	0	-1828.33	-1248.774	0	
		-1900			0	0	0	-1900	0	0	-1900	0	0	-1900	-1179.751	0	
-250		-500		75	88.582	-13.287	-136.440	-649.727	11.073	77.509	-572.218	0.000	0.045	-572.263	-323.028	11.118	6.
-200		-200		75	1814.692	-272.204	-136.440	-608.643	226.837	1587.856	979.212	293.764	0.045	685.403	351.720	520.646	267.
				75	1976.346	-296.452	-136.440	-432.891	247.043	1729.303	1296.411	388.923	0.045	907.442	423.329	636.012	296.
				75	2669.067	-400.360	-136.440	-536.800	333.633	2335.433	1798.634	539.590	0.045	1258.998	533.938	873.269	370.
				75	2790.127	-418.519	-136.440	-554.959	348.766	2441.361	1886.402	565.921	0.045	1320.436	509.085	914.732	352.
				75	2805.875	-420.881	-136.440	-557.321	350.734	2455.140	1897.820	569.346	0.045	1328.428	465.606	920.126	322.
				75	2023.623	-303.543	-136.440	-439.983	252.953	1770.670	1330.687	399.206	0.045	931.436	296.784	652.204	207.
				75	2456.248	-368.437	-136.440	-504.877	307.031	2149.217	1644.340	493.302	0.045	1150.993	333.402	800.379	231.
				75	2134.632	-320.195	-136.440	-456.634	266.829	1867.803	1411.168	423.351	0.045	987.772	1.17429E+86	690.2249225	8.20559E
				75	2393.653	-359.048	-136.440	-495.488	299.207	2094.447	1598.959	479.688	0.045	1119.226	1.33057E+86	778.9398376	9.26026E
				75	2281.840	-342.276	-136.440	-478.716	285.230	1996.610	1517.895	455.368	0.045	1062.481	1.26311E+86	740.6439365	8.80198E
														6338.692	3.76797E+86	7538.29423	2.62708E

0.15	Profitability Indicator C Take		Profitability Indicator HGovTake
-1500.835	NPV	$ 1,012.09	NPV $ 3,127.54
11			
	IRR	15%	
0.045454545			

APPENDIX G

Economic model for the Fiscal Regime of Congo R/T (1997)



Annual Prc	Explo/Ap	Deve	Dri	Flow Stat	Facility	Salvage v	Total Cost	Price		G. Revenue	VAR OPEX	FIXED OPEX	G. Total Cost	Royalty	Net Revenue	Taxable income	Income Tax	C Take	Dis C Take	H G
Bid	MM$	MM$	MM$	MM$	MM$	MM$	MM$	USD$/BBL		MM$	MM$	MM$	MM$	MM$	MM$	MM$	MM$	MM$	MM$	MM
	-113.33	-					-113.330			0	0	0	113.33	0	0	-113.33	0	-113.33	-85.1465064	
	-226.66	-1601.7					-1828.330			0	0	0	1828.33	0	0	-1828.33	0	-1828.3	-1248.77399	
		-1400	-500				-1900.000			0	0	0	1900	0	0	-1900	0	-1900	-1179.75051	
1181088		-1101.7	-250	-250			-500.000		75	88.582	-13.287	-136.440	-649.727	13.287	75.294	-574.432	-201.051	-373.38	-210.763884	-1
24195895				-200			-200.000		75	1814.692	-272.204	-136.440	-608.643	272.204	1542.488	933.845	326.846	606.999	311.48657736	59
26351278									75	1976.346	-296.452	-136.440	-432.891	296.452	1679.894	1247.003	436.451	810.552	378.1283301	7
35587558									75	2669.067	-400.360	-136.440	-536.800	400.360	2268.707	1731.907	606.168	1125.74	477.4235309	10
37201691									75	2790.127	-418.519	-136.440	-554.959	418.519	2371.608	1816.649	635.827	1180.82	455.2579984	10
37411661									75	2805.875	-420.881	-136.440	-557.321	420.881	2384.993	1827.673	639.685	1187.99	416.3822758	10
26981640									75	2023.623	-303.543	-136.440	-439.983	303.543	1720.080	1280.097	448.034	832.063	265.1208377	75
32749975									75	2456.248	-368.437	-136.440	-504.877	368.437	2087.811	1582.934	554.027	1028.91	298.0377637	92
28461755									75	2134.632	-320.195	-136.440	-456.634	320.195	1814.437	1357.803	475.231	882.572	1.04923E+86	79
31915377									75	2393.653	-359.048	-136.440	-495.488	359.048	2034.605	1539.118	538.691	1000.43	1.18934E+86	89
30424539									75	2281.840	-342.276	-136.440	-478.716	342.276	1939.564	1460.849	511.297	949.552	1.12885E+86	85
																		5390.58	3.36742E+86	84

X 15% of Ann GR	0.15	Profitability of C Take	
PEX IS 5% OF CAPE	-2270.8	NPV	$ 672.71
n life of the field	11		
		IRR	13%

TIONS	
Y RATE	0.15
TAX	0.35
ng Factor	0.1

Profitability of Hgov Take	
NPV	$ 3,466.92

APPENDIX H

Economic model for the Fiscal Regime of Ivory Coast R/T (1996)

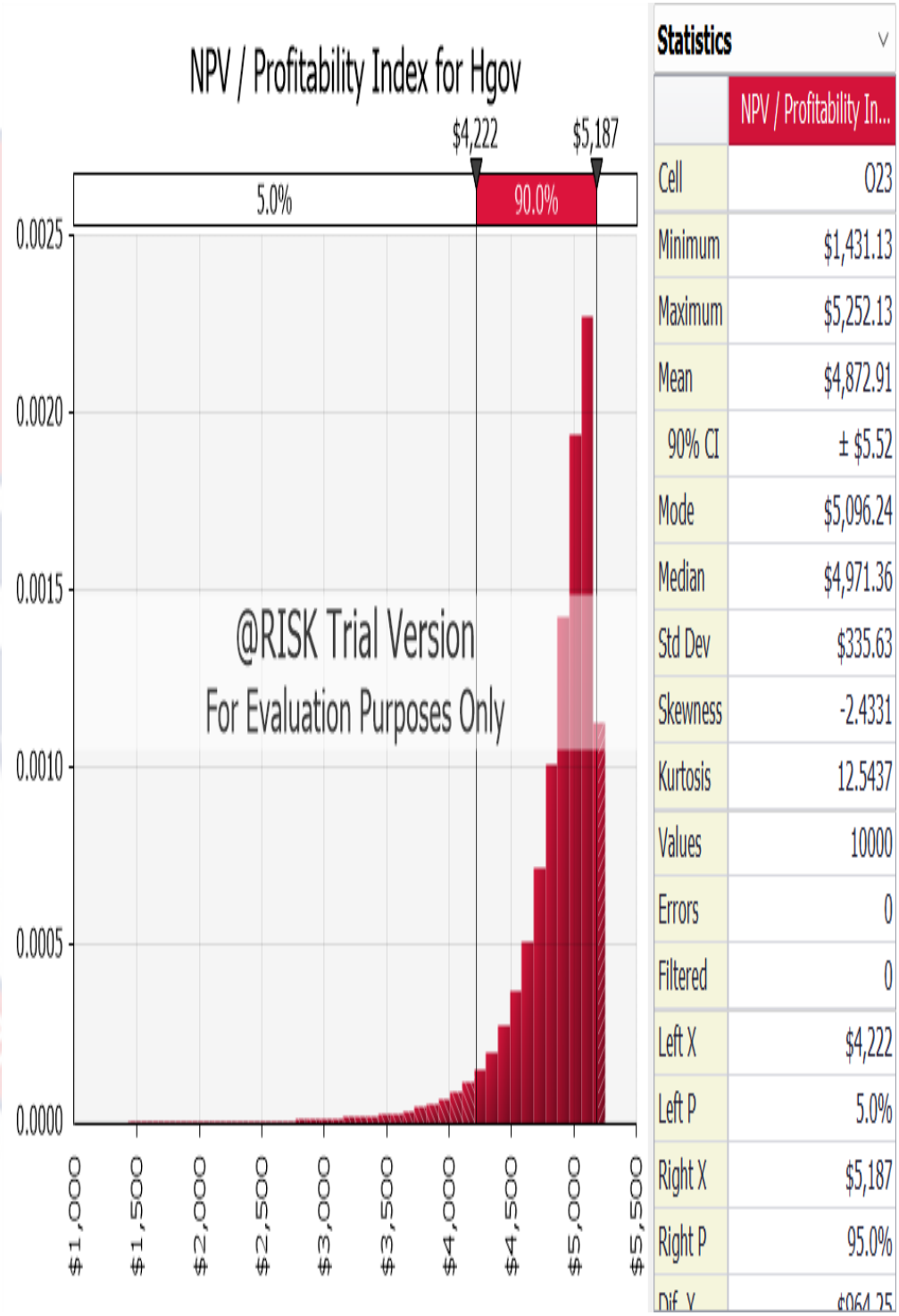
Total Cost MM$	Price USD$/BBL	G. Revenue MM$	VAR OPEX MM$	FIXED OPEX MM$	G. Total Cost MM$	Royalty MM$	Net Revenue MM$	Taxable Income MM$	Tax MM$	Sign Bonus MM$	Prod Bonus MM$	Net C Take MM$	Dis C Take MM$	Net Hgov take MM$	Dis Hgov Take MM$
-113.33		0.000	0.000	0.000	113.330		0.000	-113.330	0.000	0.000		-113.330	-85.147	0.000	0
-1828.33		0.000	0.000	0.000	1828.330		0.000	-1828.330	0.000	0.000		-1828.330	-1248.774	0.000	0
-1900		0.000	0.000	0.000	1900.000		0.000	-1900.000	0.000	0.000		-1900.000	-1179.751	0.000	0
-500	75	88.582	-13.287	-136.440	-649.727	11.073	77.509	-572.218	-154.499	1.091	1.09	-417.719	-235.792	-141.244	-79.7287
-200	75	1814.692	-272.204	-136.440	-608.643	226.837	1587.856	979.212	264.387	1.091	1.09	714.825	366.818	493.406	253.1951
	75	1976.346	-296.452	-136.440	-432.891	247.043	1729.303	1296.411	350.031	1.091	1.09	946.380	441.493	599.256	279.5574
	75	2669.067	-400.360	-136.440	-536.800	333.633	2335.433	1798.634	485.631	1.091	1.09	1313.003	556.841	821.446	348.1734
	75	2790.127	-418.519	-136.440	-554.959	348.766	2441.361	1886.402	509.329	1.091	1.09	1377.074	530.922	860.276	331.6738
	75	2805.875	-420.881	-136.440	-557.321	350.734	2455.140	1897.820	512.411	1.091	1.09	1385.408	485.577	865.327	303.2920
	75	2023.623	-303.543	-136.440	-439.983	252.953	1770.670	1330.687	359.286	1.091	1.09	971.402	309.518	614.420	195.7732
	75	2456.248	-368.437	-136.440	-504.877	307.031	2149.217	1644.340	443.972	1.091	1.09	1200.368	347.704	753.185	218.1708
	75	2134.632	-320.195	-136.440	-456.634	266.829	1867.803	1411.168	381.015	1.091	1.09	1030.153	1.22467E+86	650.026	7.7277E+85
	75	2393.653	-359.048	-136.440	-495.488	299.207	2094.447	1598.959	431.719	1.091	1.09	1167.240	1.38765E+86	733.107	8.71539E+85
-4541.66	75	2281.840	-342.276	-136.440	-478.716			2760.556	745.350		1.09	2015.206	2.39573E+86	746.441038	8.8739E+85

Profit Indi Cont	
NPV	$ 1,547.20
IRR	17%
PVR	0.34066861
PI	1.34066861

Profit Indi Hgov Take	
NPV	$2,854.91

APPENDIX I

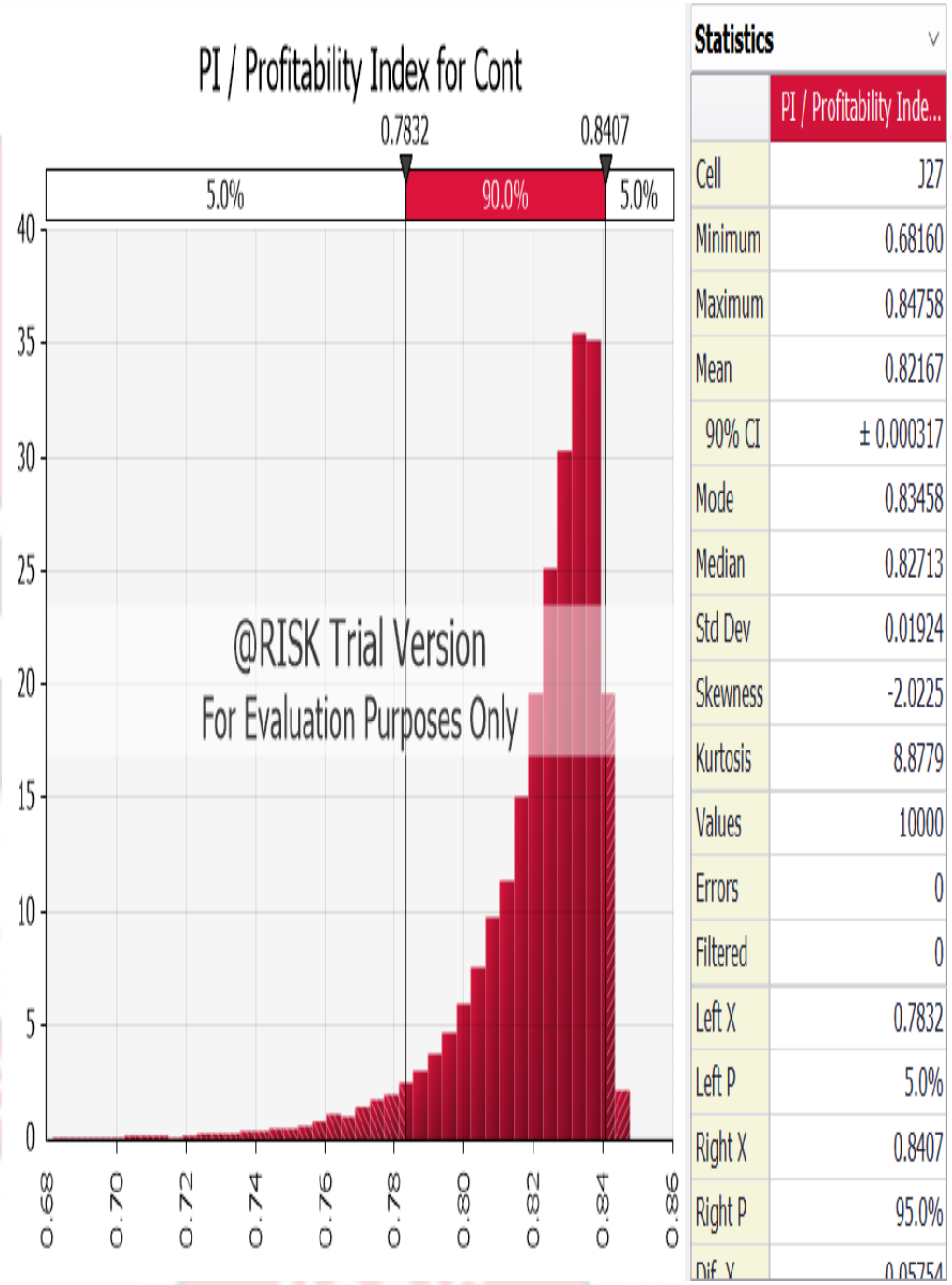
NPV Stochastic analysis performance of Nigeria's R/T (2000)



Statistics	NPV / Profitability In...
Cell	O23
Minimum	$1,431.13
Maximum	$5,252.13
Mean	$4,872.91
90% CI	± $5.52
Mode	$5,096.24
Median	$4,971.36
Std Dev	$335.63
Skewness	-2.4331
Kurtosis	12.5437
Values	10000
Errors	0
Filtered	0
Left X	$4,222
Left P	5.0%
Right X	$5,187
Right P	95.0%
Dif. X	$964.25

APPENDIX J

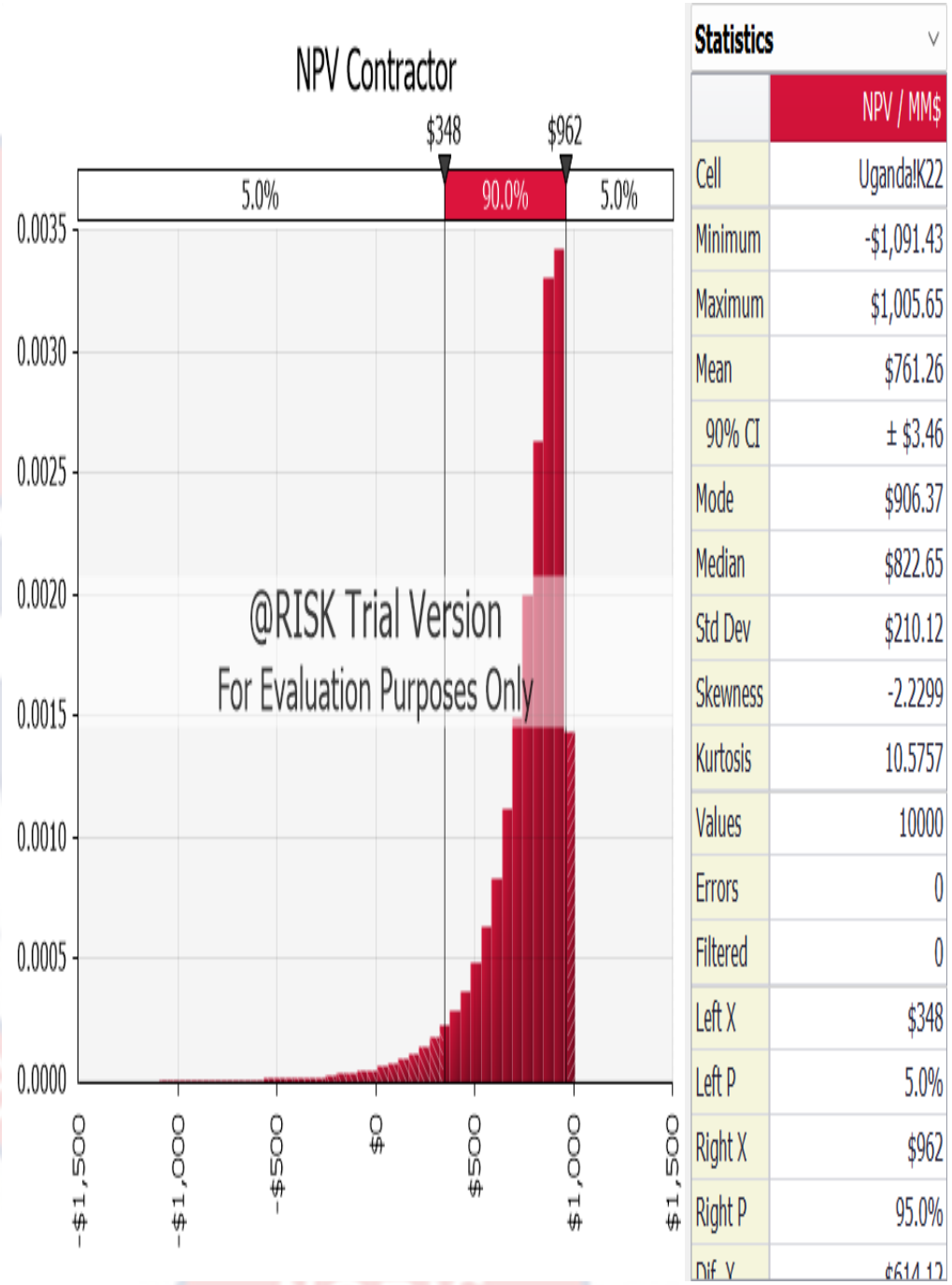
Nigeria R/T (2000) Regime Stochastic PI



Statistics	PI / Profitability Inde...
Cell	J27
Minimum	0.68160
Maximum	0.84758
Mean	0.82167
90% CI	± 0.000317
Mode	0.83458
Median	0.82713
Std Dev	0.01924
Skewness	-2.0225
Kurtosis	8.8779
Values	10000
Errors	0
Filtered	0
Left X	0.7832
Left P	5.0%
Right X	0.8407
Right P	95.0%
Dif. X	0.05754

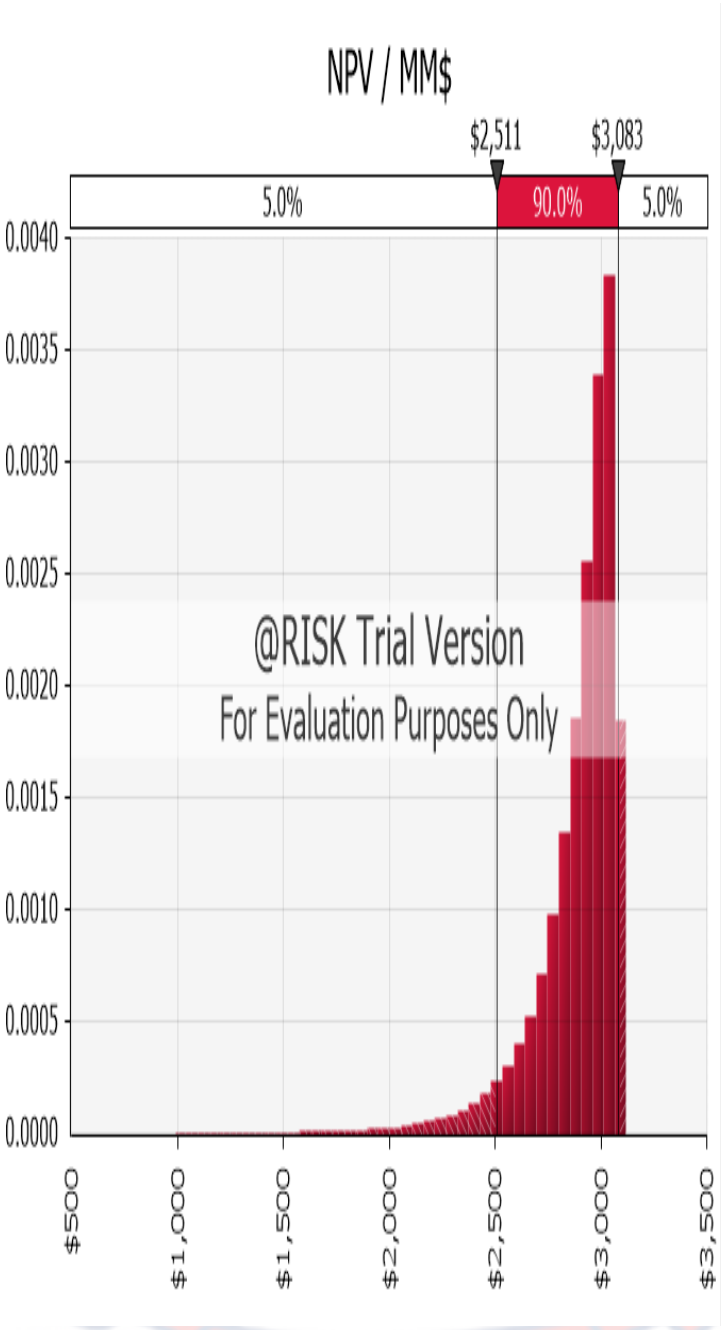
APPENDIX K

Uganda's R/T (2010) Regime Stochastic Contractor's NPV



APPENDIX L

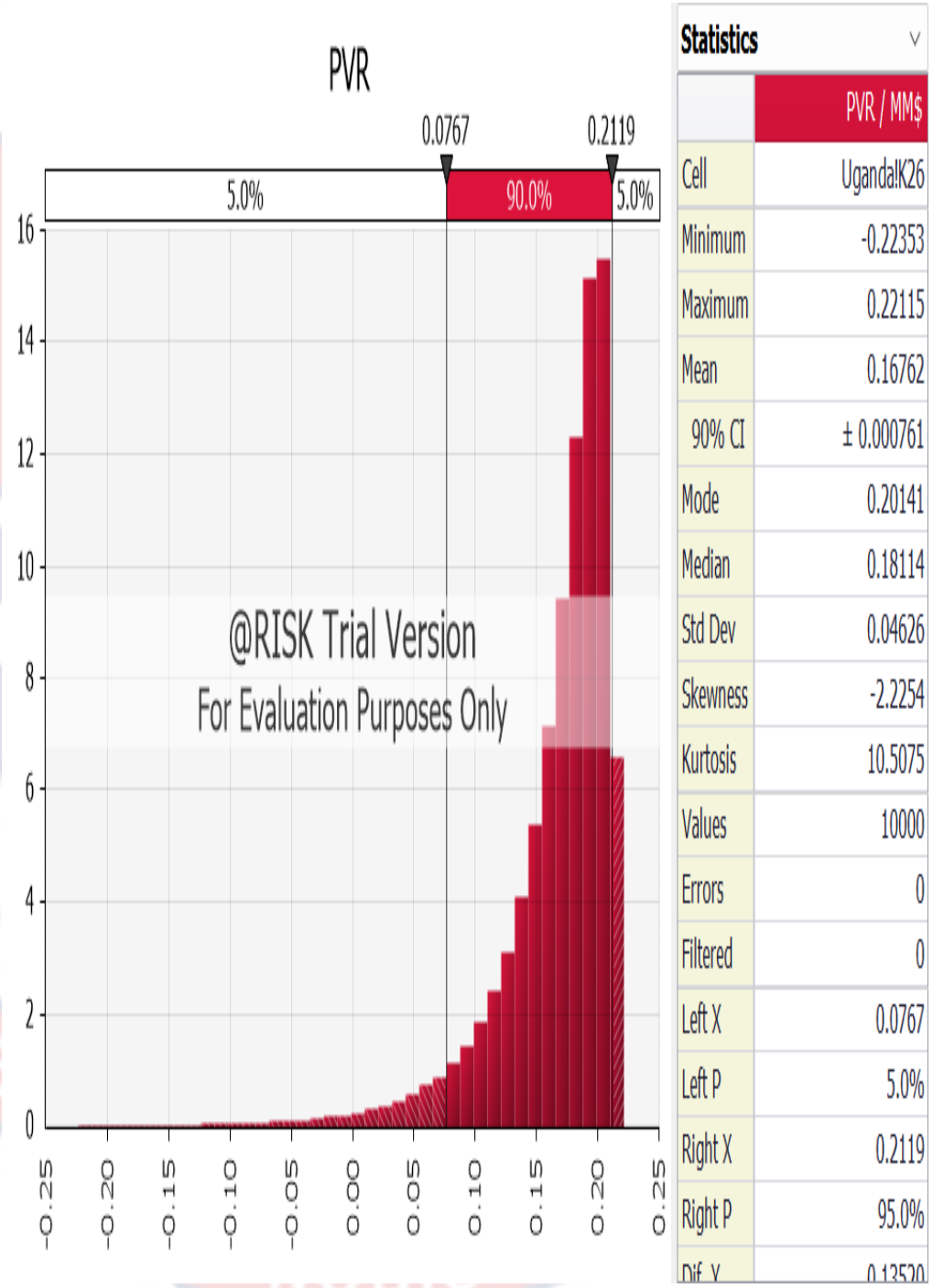
Uganda's R/T (2010) Regime Stochastic Contractor's NPV



Statistics	NPV / MM$
Cell	UgandaIP22
Minimum	$990.61
Maximum	$3,120.56
Mean	$2,896.65
90% CI	± $3.27
Mode	$3,039.18
Median	$2,955.02
Std Dev	$198.82
Skewness	-2.4224
Kurtosis	12.3585
Values	10000
Errors	0
Filtered	0
Left X	$2,511
Left P	5.0%
Right X	$3,083
Right P	95.0%
Dif. X	$571.37

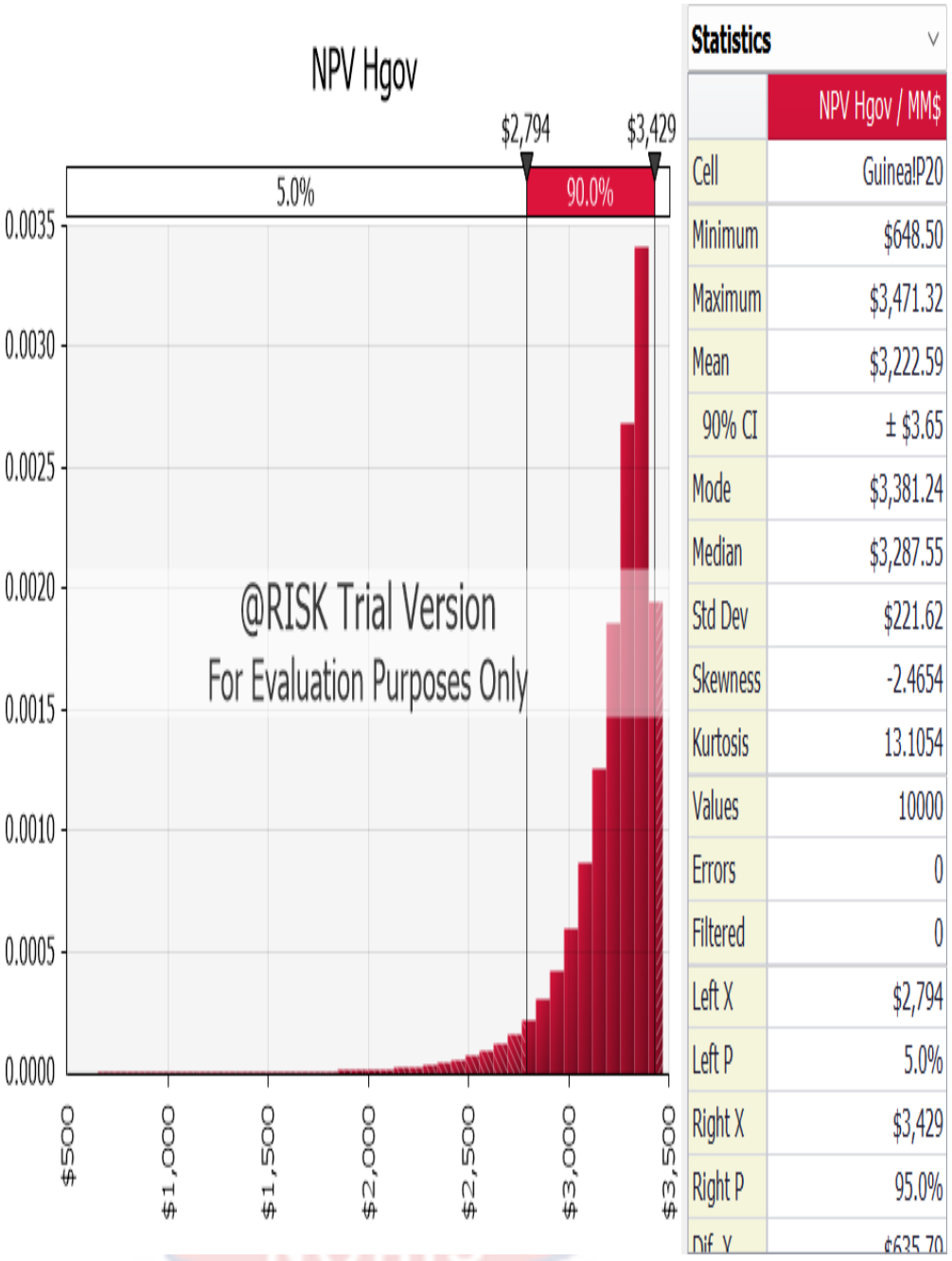
APPENDIX M

Uganda's R/T (2010) Regime Stochastic PVR



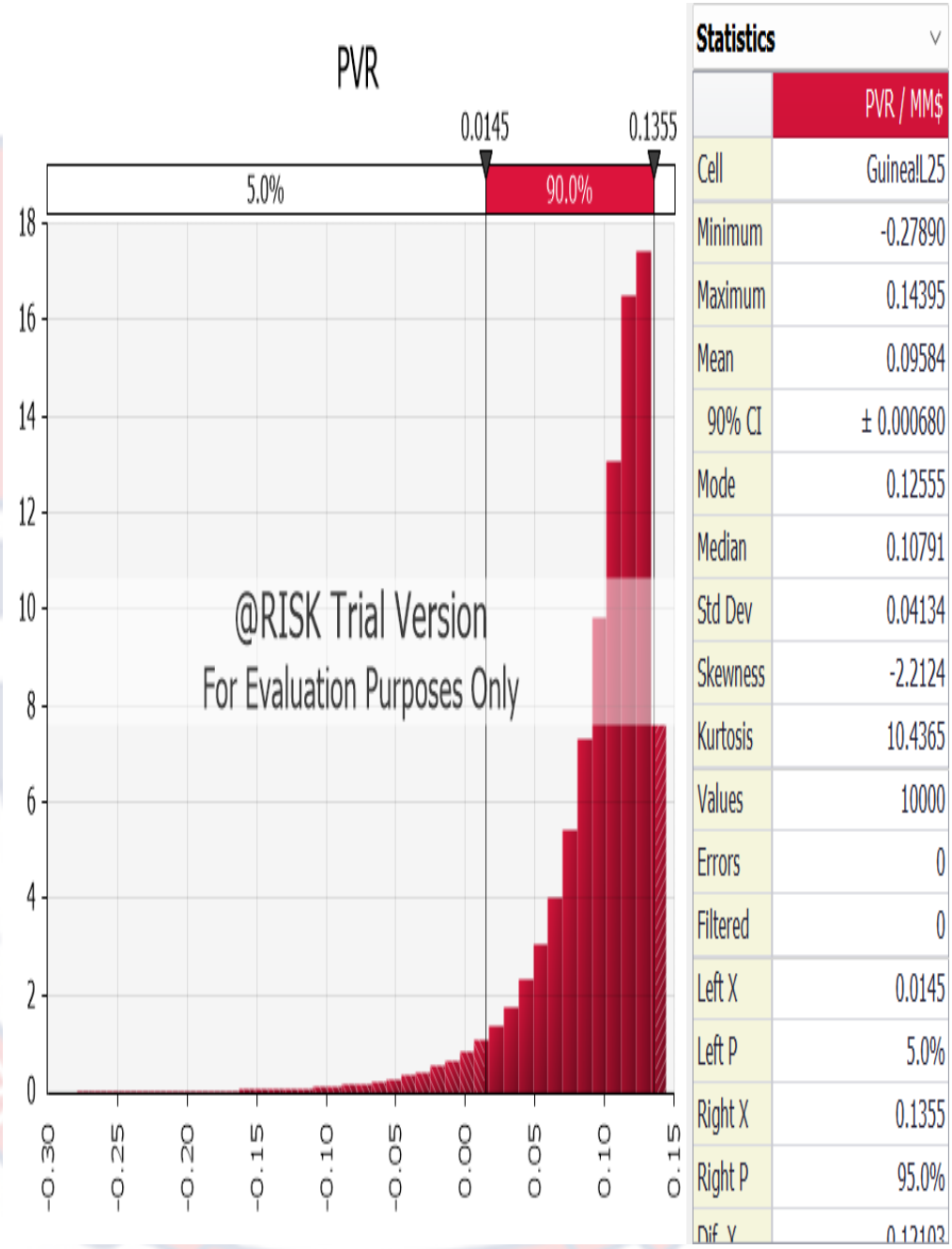
APPENDIX N

Guinea's R/T (2006) Regime Stochastic Host government's NPV



APPENDIX O

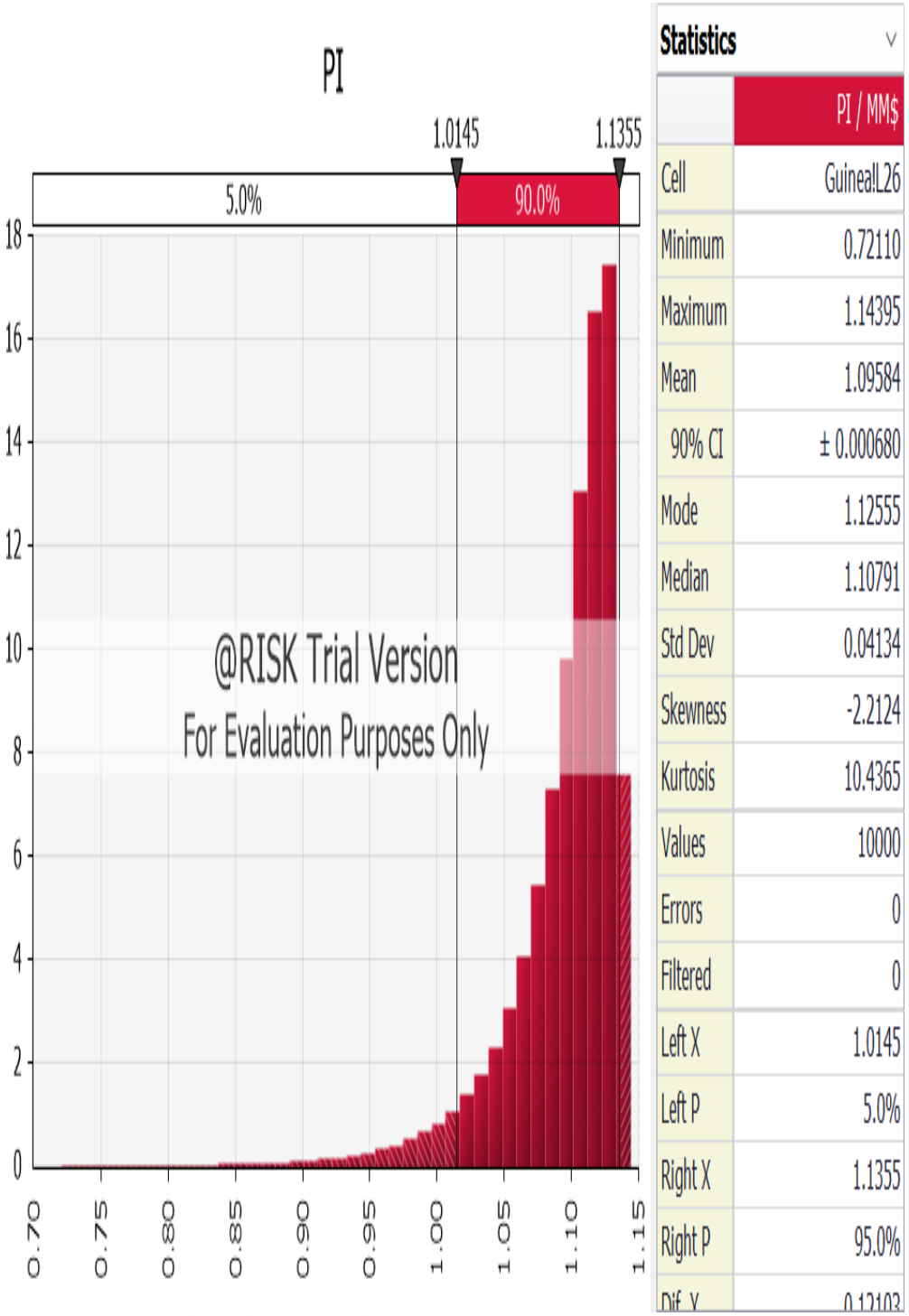
Guinea's R/T (2006) Regime Stochastic PVR



Statistics	PVR / MM$
Cell	Guinea!L25
Minimum	-0.27890
Maximum	0.14395
Mean	0.09584
90% CI	± 0.000680
Mode	0.12555
Median	0.10791
Std Dev	0.04134
Skewness	-2.2124
Kurtosis	10.4365
Values	10000
Errors	0
Filtered	0
Left X	0.0145
Left P	5.0%
Right X	0.1355
Right P	95.0%
Dif. X	0.12103

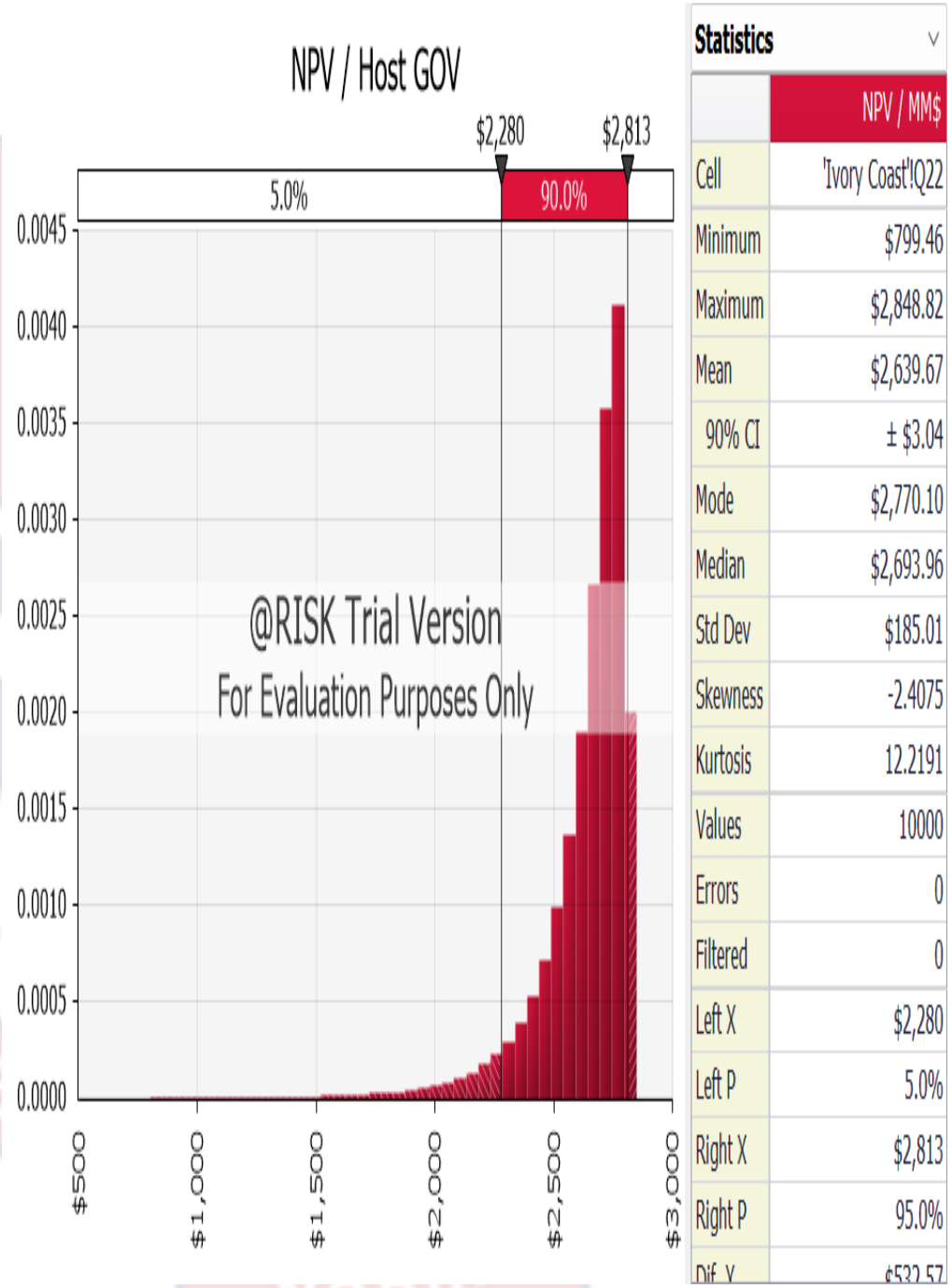
APPENDIX P

Guinea's R/T (2006) Regime Stochastic PVR



APPENDIX Q

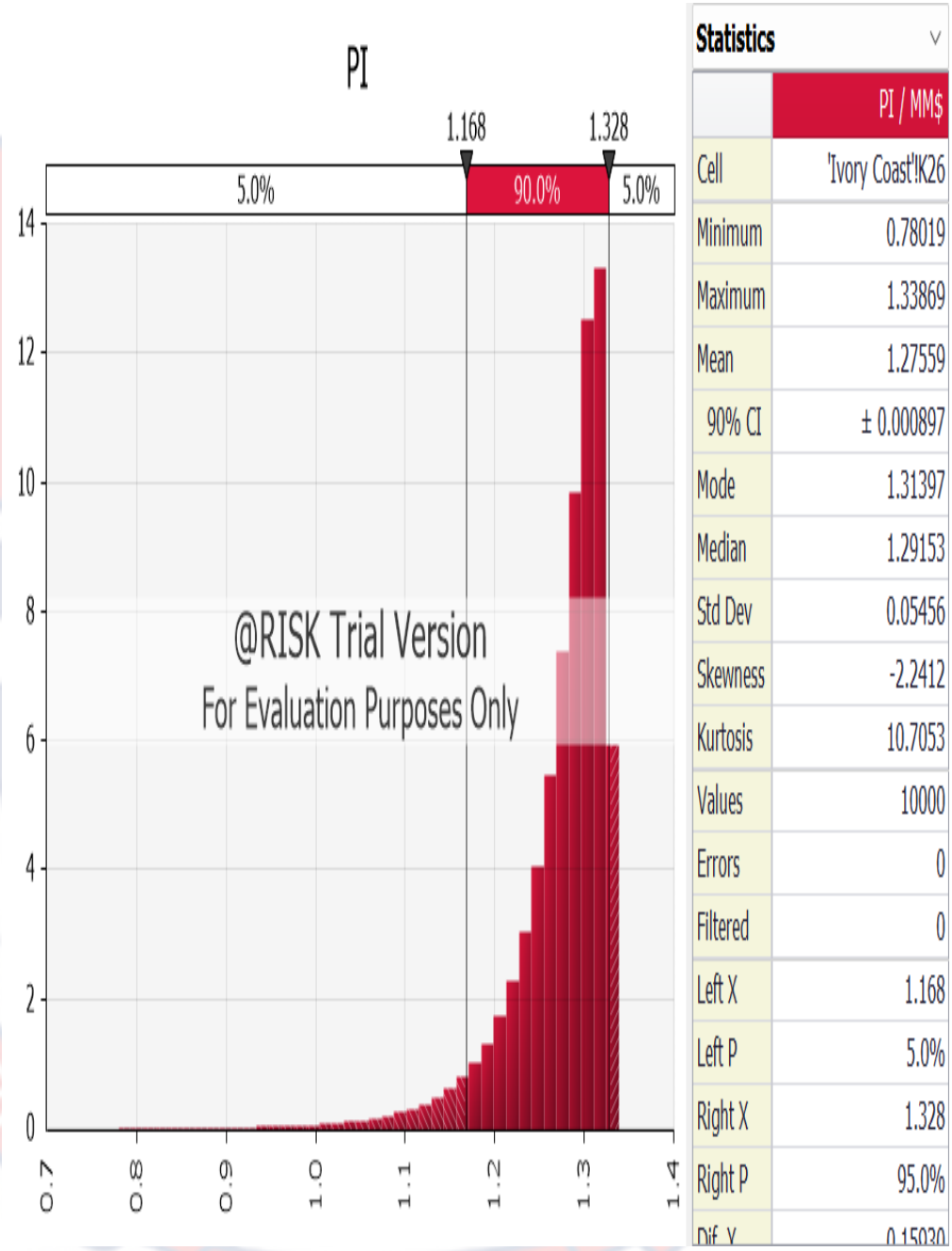
Ivory Coast's R/T (1996) Regime Stochastic Host government's NPV



Statistics	NPV / MM$
Cell	'Ivory Coast'!Q22
Minimum	$799.46
Maximum	$2,848.82
Mean	$2,639.67
90% CI	± $3.04
Mode	$2,770.10
Median	$2,693.96
Std Dev	$185.01
Skewness	-2.4075
Kurtosis	12.2191
Values	10000
Errors	0
Filtered	0
Left X	$2,280
Left P	5.0%
Right X	$2,813
Right P	95.0%
Dif. X	$532.57

APPENDIX R

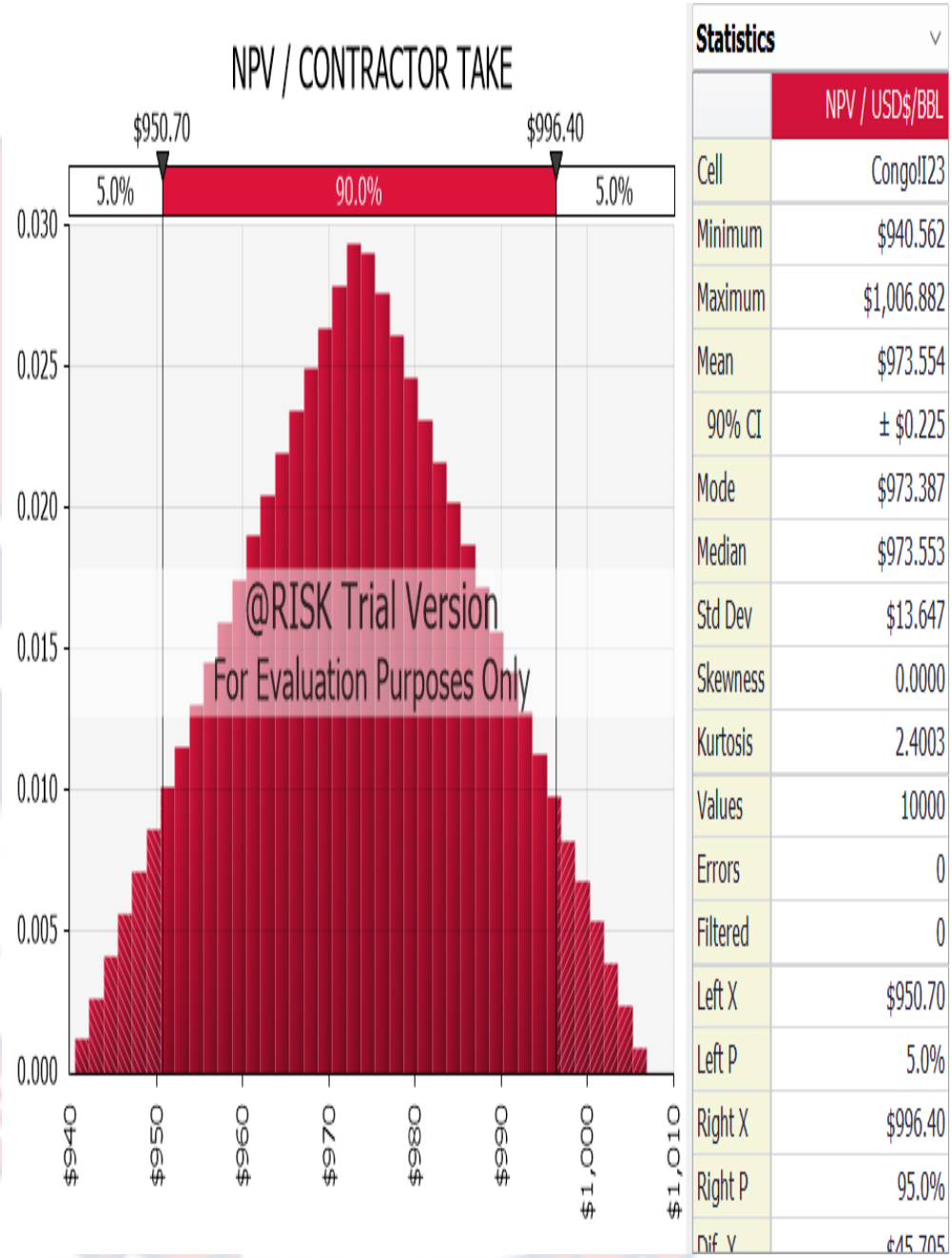
Ivory Coast's R/T (1996) Regime Stochastic PI



Statistics	PI / MM$
Cell	'Ivory Coast'!K26
Minimum	0.78019
Maximum	1.33869
Mean	1.27559
90% CI	± 0.000897
Mode	1.31397
Median	1.29153
Std Dev	0.05456
Skewness	-2.2412
Kurtosis	10.7053
Values	10000
Errors	0
Filtered	0
Left X	1.168
Left P	5.0%
Right X	1.328
Right P	95.0%
Dif. X	0.15030

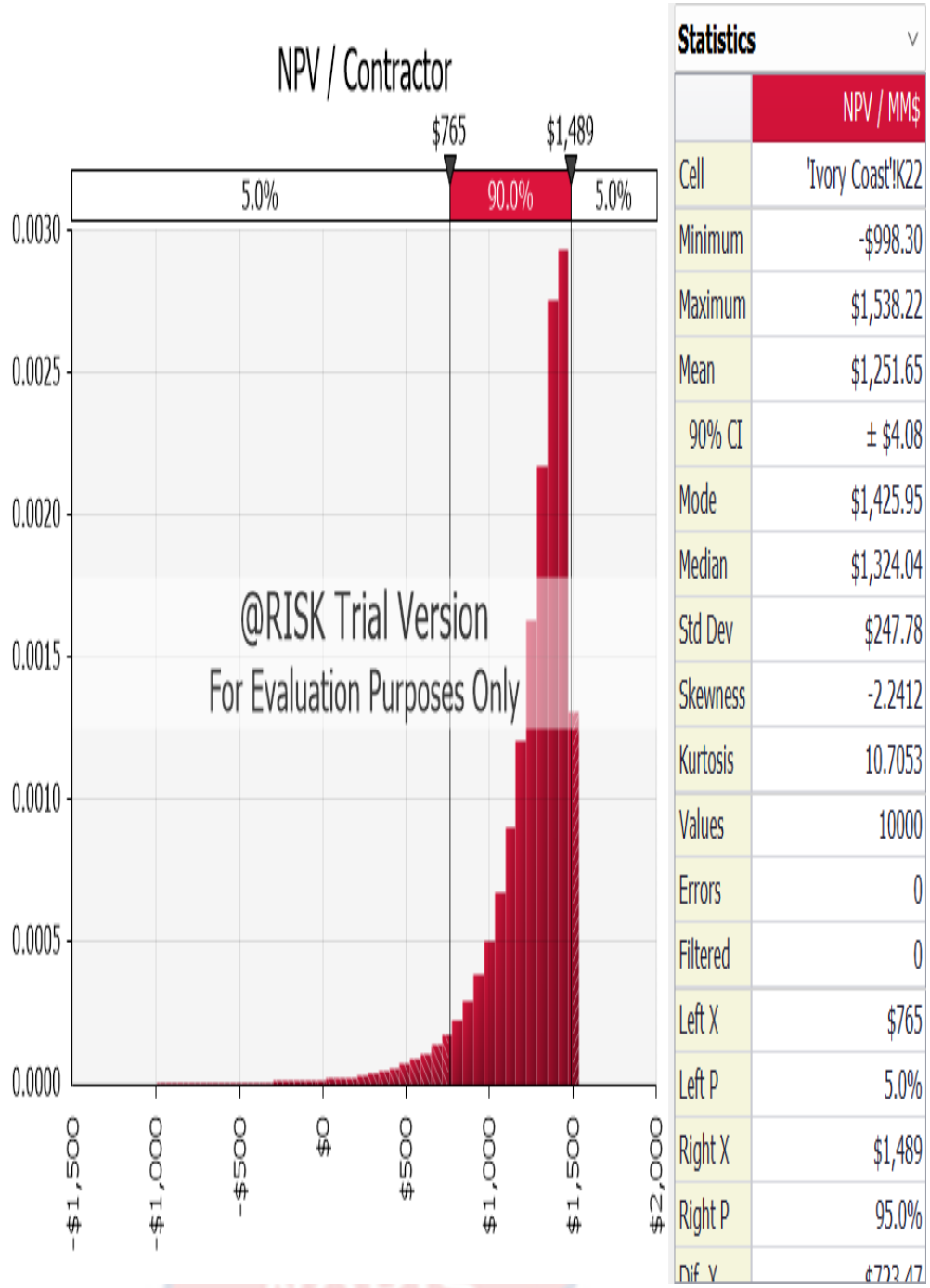
APPENDIX S

Congo's R/T (1997) Regime Stochastic Contractor's NPV



APPENDIX T

Cameroon's R/T (1995) Regime Stochastic Contractor's NPV



Statistics	NPV / MM$
Cell	'Ivory Coast'!K22
Minimum	-$998.30
Maximum	$1,538.22
Mean	$1,251.65
90% CI	± $4.08
Mode	$1,425.95
Median	$1,324.04
Std Dev	$247.78
Skewness	-2.2412
Kurtosis	10.7053
Values	10000
Errors	0
Filtered	0
Left X	$765
Left P	5.0%
Right X	$1,489
Right P	95.0%
Dif. X	$723.47