A Study on Sensitivity Analysis in Project Evaluation

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ABSTRACT

Sensitivity analysis holds a lot of importance for evaluating any project, if risk/sensitivity analyses are not thorough during the project preparation, project performance may fall short of expected standards. Post evaluation reports indicate, in several cases, overstatement of expected benefits, overly optimistic estimations of implantation schedules and inadequate treatment of uncertainties that are widely prevalent in the macroeconomic, social and institutional environment.

***The General objective** is to understand the significance of the sensitivity analysis in the value evaluation of the project. **The main objective** is to learn the concepts and techniques employed in the analysis and selection of investment proposals with special emphasis on economical feasibility. To address these issues we need to be more systematic. Provisions should be made in project preparation and processing, for analysis of preventive and contingent measures. So the need of risk and sensitivity analysis is felt. **This project discusses the sensitivity analysis of pipeline line project used for computing the internal rate of return and pay back period of the project.** Since financial decisions are commonly supported via a point value of some criterion of economic relevance (net present value, economic value added, internal rate of return, pay back period, etc.), we focus on local sensitivity analysis. In particular, we present the differential importance measure and discuss its relation to elasticity and other local sensitivity analysis techniques in the context of discounted cash flow valuation models. We will present general results of the net present value and internal rate of return sensitivity on changes in the cash flows. Specific results are obtained for a valuation model of project under severe survival risk used in the industry sector of oil and gas generation.*

Keywords: Sensitivity analysis, macroeconomic, economic feasibility, net present value, internal rate of return, discounted cash flows, value evaluation.

INTRODUCTION

Sensitivity analysis is an important aspect of any project evaluation. Computing the net present value (NPV), equivalent annuity (EA), or internal rate of return (IRR) simply with traditionally based on a single set of assumptions can be misleading and imprudent. One can assume that factors such as interest rates, tax rates, capital expenditure, operational expenditure, and price levels are random variants. Parameters can be specified, and the project values under a variety of conditions can be calculated.

This paper illustrates the development of a method for performing sensitivity analysis based on experimental approach. Feasibilities under various conditions is computed for decision making.

The petroleum industry is divided into three major components, **Upstream, Midstream and Downstream.** Midstream operations are usually included in the downstream category only.

THE UPSTREAM OIL SECTOR

The Upstream oil sector refers to the searching for and the recovery and production of the crude oil and natural gas. The upstream sector is also known as the Exploration and Production sector.

It includes the searching of underwater or underground oil and gas fields, drilling of exploratory wells, operating and bringing the crude oil and/or natural gas to the surface.

Upstream Oil and Gas activities: -

- Surveys Geological and Geophysical (Seismic).
- Analysis / Interpretation of data collected from the surveys for evaluation of prospects of specific acreages fo identifying viable/ promising locations for drilling.
- Drilling of exploratory and development wells.
- Study of offshore and onshore production systems.
- Feasibility study.
- Oil and Gas lift design.
- Flow line optimization study.
- Pipeline network, design, analysis, and debottlenecking of injection gas for gas lift.
- Long distance transportation of oil and gas.
- Well and reservoir performance analysis.

THE MIDSTREAM OIL SECTOR

- **The Midstream oil sector** refers to the storing, marketing and transporting commodities such as crude oil, natural gas, liquids (mainly ethane, propane and butane) and sulphur.

THE DOWNSTREAM OIL SECTOR

The Downstream oil sector refers to the refining of crude oil and selling and distribution of natural gas and products

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derived from crude oil. Such products include (LPG) i.e. liquefied petroleum gas, gasoline or petrol, jet fuel, diesel oil, other fuel oils and petroleum coke.

This sector includes oil refineries, petrochemical plants, petroleum product distribution, retail outlets and natural gas distribution companies. The downstream industry gives the consumers products such as gasoline, diesel, and jet fuel, heating oil, lubricants, synthetic rubber, plastics, fertilizers, pesticides, natural gas and propane.

Downstream oil and gas activities: -

- Repairing the refineries
- Refinery expansion projects, cost effectiveness solutions for refineries.
- Feasibility studies for reallocation of refineries.
- Construction activities for refinery process plants.
- Start up operation and maintenance services for refinery process plant.
- Maintenance and inspection services.

REVIEW OF LITERATURE

Razak R.A.: Kocaoglu D.F in Portland International Conference in 2001, mentioned in their report on **Evaluation and selection processes of petroleum exploration and development projects: an empirical study**, that the main activities of petroleum companies are to find, develop and produce petroleum. Evaluation and selection of petroleum exploration and development (E&D) projects are important steps to ensure the success of the potential projects as well as the long-term survival of the companies. The study describes the evaluation and selection process of petroleum E&D projects by petroleum companies. The study indentifies important decision-making components in project evaluation and selection, which include the objectives of the projects, the information sources used to identify the projects, the influencing variables, the methodologies used and the sources of information used for the evaluation and selection.

Prasanta Kumar Dey in his article **Analytic hierarchy process helps evaluate project in Indian oil pipeline industry** published in the year 2004, said that, conventionally, oil pipeline projects are evaluated thoroughly by the owner before investment decision Is made using market, technical and financial analyses sequentially. The impact of assessment often suggests alternative sites, technologies, and/or implementation methodology, necessitating revision of technical and financial analysis. The issues are addressed via an integrated project evaluation and selection model. The effectiveness of the model has been demonstrated through a case application on cross-country petroleum pipeline project in India.

Risk- based maintenance model for offshore oil and gas pipeline: a case study, by prasanta Kumar Dey, Stephen O. Ogunlana published in a journal in the year 2004 states that offshore oil and gas pipelines are vulnerable to environment as any leak and burst cause oil/gas spill resulting in huge negative impact on marine lives. Risk-based inspection and analysis is particularly important for oil and gas pipeline systems. as any failure in the system will not only affect productivity negatively but also has tremendous negative environment impact, analysis helps the pipelines operators to analyze the health of pipeline dynamically. The model's effectiveness has been demonstrated through real life application on oil and gas pipeline in the Gulf of Thailand.

S. Thomas Ng, Jingzhu Xie in the year 2008 in their paper **a simulation model for evaluating the tariff stability of concession based PPP proposals** published in the journal, **Construction Innovation: Information, process, management** devise a simple but practical model to assist decision makers in evaluating the tariff stability of concession schemes. To develop such a model necessitates the identification of parameters that contribute to an increase or decline in investment return. With that a Monte- Carlo-based simulation model is devised to determine the probability that the tariff regime remains unchanged even when the identified risks do occur at the operational stage. Sensitivity analysis is performed to identify the most influential factors to investment return and tariff stability. The result of the scenario indicate that the internal rate of return could be profoundly influenced by the risk factors which reaffirm the needs for a more comprehensive model for tariff stability evaluation. The model could b extended to other types of public-private partnerships schemes upon suitable adjustment.

Capital asset management process: the case of Hose & Fittings Corporation Sung C. Bae, Bell J.C. Park, Tracy Wagner published in the journal International Journal of Managerial Finance in the year 2005 comments that, the capital asset management process offers significant improvements over the traditional process. First, it links various functions that trigger capital requirements. Through an actual versus plan measurement, capital plans become more accurate and predictable. Forecasting beyond one year also enhances the planning and management of resources. Second, the process promotes a more accurate evaluation of costs and benefits of capital projects. The suggested evaluation technique include detailed qualitative analysis, real option and EVA analyses, and applying project/division costs of capital in place of a company cost of capital.

Sensitivity analyses in multi-attribute decision support for offsite nuclear emergency and recovery management was published in the journal International Journal of Energy Sector Management In the year 2007 by Valentin Bertsch suggests that the management of emergency situations in nuclear power generation requires consideration of technical, economic, environmental, socio-psychological and political aspects. Various expert groups with diverse background knowledge are involved in such a decision-making process. Since the preference parameters are inherently afflicted with uncertainties, thorough sensitivity analyses are important to visualize the impact of the uncertainties in an understandable way.

K. Lawson's research paper pipeline corrosion risk analysis – **an assessment of deterministic and probabilistic methods** published in the year 2005,This paper compares and contrasts two approaches to the treatment of pipeline corrosion "risk" –

the probabilistic approach and the more traditional, deterministic approach. The probabilistic approach to the assessment of pipeline corrosion risk deals with many of the uncertainties that are common to the data employed and those with regard to the predictive models that are used also. Rather than considering each input parameter as an average value the approach considers the inputs as a series of probability density functions, the collective use during the assessment of risk yields a risk profile that is quantified on the basis of uncertain data. This approach differs from the traditional deterministic assessment in that the output yields a curve that shows how the "risk" of failure increases with time. The pipeline operators simply chooses the level of risk that is acceptable and then devises s strategy to deal with those risks. The traditional approach merely segments the output risks as either "high", "medium" or "low". The probabilistic assessment approach that effectively mirrors pipeline operators, provides a superior basis upon which to manage risk and would therefore likely maximize both safety and business performance.

OBJECTIVE OF STUDY

The objective of the project was to take out different feasibilities with changes in gas prices, changes is tax rates, changes in the capital expenditure and depreciation rates and methods.

Change in capital expenditure is the main criteria to compare the results of different feasibilities and compute the sensitivities.

Depreciation though is very important for the estimation of taxes, which is considered only for actual cash inflow from the project. Otherwise calculation of depreciation is not considered in Project evaluation on account of being a non-cash item.

Project evaluation is based on two things: -

1. Future projection based working.
2. Cash flows

Area of my Evaluation of Gas Pipeline Project is one of the regions of ONGC. There were 2 wells before the execution of the project, but as the process of taking the gas out of the wells started the consultants forecasted that two more wells would be lined up in the year 2009-2010 all of which will be connected with a pipeline, to take out the gas from the wells through the pipeline.

The basic feasibility sheet is been evaluated on the basis of the revenue details, cost details (which includes capital expenditure, operational expenditure), tax details and then the net cash inflows and discounted cash inflows are been calculated. And on the basis of net cash inflows IRR and PAY BACK PERIOD is calculated to know in how many years will the project cover its cost and start generating a surplus.

Analysis is done by computing different feasibilities by observing the change on the rate of return and pay back period by changing the capital expenditure, tax rates, gas prices etc...

RESEARCH METHODOLOGY

Capital budgeting theory is founded on discounted cash flow techniques. The most important capital budgeting problem is the single project accept-reject decision. Under certainty, the firm would accept the project if its net present value, using the riskless interest rate, were positive, or equivalently, if the project's internal rate of return exceeding the riskless interest rate. Under uncertainty (where, uncertainty and risk have coincidental meanings) the single project accept-reject investment decisions is analogously evaluated; the firm would accept the project if the net present value of the expected cash flows, using a discount rate that reflects the degree of risk inherent in the project, were positive. And the project will also be accepted if its expected internal rate of return exceeded its risk-adjusted cost of capital. This project offers a practical approach for evaluating capital projects.

The methodology used in this project is summarized below.

1. Identify components of cash flows.

2. Compute the revenue details including gas total revenue and condensate total revenue, Capital expenditure details, Operational details, and Tax details.

3.Different feasibilities are calculated considering all the details.

4.Carry out the sensitivity analysis on the project evaluation

DATA ANALYSIS

(TABLE 1)

GAS FIELD TALLY

BEFORE EXECUTION OF THE PROJECT

The projection of the project is done from the year (1997-2022). Annual production for the gas well AK#2 and AK#6 is recorded and total of it is taken, then its daily production is taken and cumulative production is computed from the annual production.

Till 2007 the figures are actual and after that till 2022 it is forecasted.

(TABLE 2)

AFTER EXECUTION OF THE PROJECT

As the project started two more wells came up AK#1 and AU#2. Total of their daily production is computed. Annual production is calculated by multiplying it by 365 and dividing by 1000000 for MMSCM (million standard cubic meter), then total and cumulative is calculated accordingly.

(TABLE 3)

REVENUE DETAILS

The revenue details from the year 2007-2022 are calculated from the Expected sale before and after the project. Additional sale is calculated by subtracting expected sale before and after the project, daily additional sale is computed by dividing additional sale by 365 and multiplying it by 10,00,000 to convert it to standard cubic meter.

Additional revenue after sale is the main focus area, which is calculated by multiplying additional sale after project by the gas price i.e. 1920 per 1000 so we multiply it by (1920*1000) and as the units are in lakhs we divide it by 100000.

Production of barrels is calculated as per the rate provided to

ONGC i.e. Total additional condensate production @ 1M3/day is considered.

Condensate sp. Gravity is taken as 0.8 one tone is considered to be 7.33 barrels.

So it is calculated as 1*365*0.8*7.33.

These barrels containing the gas will be then mixed with crude and then it will be sold, the basic crude price is $ 30 per barrel and exchange rate is $1=Rs.46 is considered as per revised corporate guidelines. Hence the calculation is done by multiplying the barrels by ($30*46), and then divided by 100,000.

Total revenue is computed by adding the gas total revenue by condensate total revenue after project. So total revenue comes to Rs.6720.42 lakhs.

(TABLE 4)

CAPITAL EXPENDITURE DETAILS

Capital Expenditure Details include the expenditure made by ONGC for bring the gas supply from the well to production area. It includes, the pipe cost, cost of the materials underground laying cost of pipe, river crossing of the pine line, cathodic protection cost, (cathodic protection is done to demolish the destructive particles in the gas inside the pipeline), Hydro testing cost, (Hydro testing is done before the final production takes place to check whether the gas is safe or not). Cadastral survey cost, (It is a land topography based survey to access the exact length of the pipeline and the structures like bridges, culverts (drains) and rivers etc. required.

Capital Expenditure also includes ROU i.e. right of use taken by ONGC from the government of the state where the gas well is situated and the pipeline is going.

Most of the rates are taken from the estimated of IOGPT i.e. Institute for Oil and Gas production technology. LAQ i.e. land acquisition, HES i.e. Head Engineering Services, and other institutions. From the Sub Total of Capital Expenditure 10% for contingencies is also kept aside. So the total Capital Expenditure comes to Rs. 750.18 lakhs

(TABLE 5)

OPERATIONAL EXPENDITURE DETAILS

Operational Expenditure includes salary of manpower required, vehicle required for to and fro path daily, transporting the crude oil, consumption by menthol pump, power consumption by menthol pump, maintenance of the Pipeline. Total Operational Expenditure comes to Rs.54.15 laths.

(TABLE 6)

DEPRECIATION

In project evaluation depreciation is not of much importance, it is calculated only for computing Net profit. ONGC's practice is to charge full depreciation in one year. In this case we took it in 2009-2010.

Full depreciation is considered within 12 months after commissioning. Depreciation has been calculated only on CAPEX for Pipeline and Machinery (which includes seamless pipe, cost of other material, cathodic protection and menthol dosing pump and drum)

(TABLE 7)

TAX DETAILS

Tax details include Total Revenue, OPEX, Operating Cost is increased annually @8% as per order No.DDN/PROJ/APPR/2005 Dated 19/07/05. Operational Profit it calculated by subtracting OPEX from revenue, and then depreciation is subtracted from operational profit to compute net profit. The tax is assumed as 35% on net profit. Otherwise tax rate is 40% on taxable profit, with a surcharge of 2.5% and education tax as 3%, which comes out to be 41.23%.

Now after all the details are calculated, different feasibilities are calculated by taking different parameters, For the Basic sensitivity we have taken the basic capital expenditure to take out basic feasibility. For sensitivity 1 we have slashed the CAPEX by 10%, then escalated it by 10 %, 20% till 50% and then crossing the maximum CAPEX "The Hurdle Rate"

(TABLE 9)

BASIC FEASIBILITY

For computations of feasibility things taken under consideration are Revenue, Cost (CAPEX and OPEX, CAPEX is distributed equally over two years (2007-08,2008-09) and operating cost is increasing @8% as per the order No.DDN/PAS/PROJ/2005.Dated 19.07.05) and **Tax**.

Net Cash Inflows are calculated by deducting Tax and Total Cost from Revenue.

Discounted cash inflows are computed for calculating NET PRESENT VALUE @ Discount rate 12% and 16%.

The Internal Rate of Return and Pay Back Period are calculated from the Net Cash Inflows.

(TABLE 10, 11, 12, 13, 14, 15, 16) (Total 7 sensitivities)

All feasibilities are calculated as per the parameters from which we get different IRR's and PAY BACK PERIOD's.

FURTHER ANALYSIS

(TABLE 19,22,25) (Sensitivities 8,9,10)

Firstly we analyzed, by changing the gas prices from present day APM (administered price mechanism) i.e. Rs.1920 to present day Market Price i.e. Rs.2304. Then the price of gas was taken to be Rs.1920 for the first year with subsequent increase of 10% every year. In the third case, the proposed gas price is slashed by 40%.

Summary of sensitivity analysis

(TABLE 26)

All the 10 sensitivities are analyzed on the parameters of NPV@12%, NPV@16%, IRR (Internal rate of return of the project) and PAY BACK PERIOD.

We can observe that in the 1st sensitivity when we slash our Capital Expenditure by 10% from Rs.750 to Rs.675 the NPV @12% and 16% increases and the IRR also increases whereas the PAY BACK PERIOD decreases from 3.5 years to 3.1 years.

In the 2nd sensitivity we escalated our Capital Expenditure by 10% from 750 to 825, increasing the capital expenditure reduces both the NPV's and IRR but, increases the PAY BACK PERIOD. And in the same way when we increase our capital expenditure by 20%, 30%, 40% and 50%the IRR keeps on decreasing, increasing the PAY BACK PERIOD of the project.

In sensitivity 7, when the capital expenditure crosses the "Hurdle rate" and becomes 1500 i.e. double the basic expenditure, we can observe a sharp fall in the IRR to 14.37% from 29.96%(basic sensitivity) and a good increase in the PAY BACK PERIOD of 5.5 years from 3.5 years.

While analyzing it further, with a change in the gas prices keeping the capital expenditure constant to 750, In Sensitivity 8, when we changed the price of the gas barrels from Rs.1920 (administered price) to Rs.2304 (market price), we observe a increase in the IRR from 29.96% to 35.59% and a decrease in PAY BACK PERIOD from 3.5 years to 2.9 years.

In sensitivity 9, an every year increase of 10 % in the gas price increases the IRR enormously to 45.35% from 29.96%, and decreases the PAY BACK PERIOD to 2.6 years from 3.5, which can be very profitable for the project.

Sensitivity 10, in which we slashed the annual additional gas by 40% decreases the IRR to 16.37 from 29.96 which is not very preferable for the project it also increases the PAY BACK PERIOD to 6.3 years from 3.5 years.

So Sensitivity 10 will never be preferred, in case of changes in price of gas barrels sensitivity is the most preferred one where the PAY BACK PERIOD of the project is 2.6 years and the Internal Rate of Return is also the highest at 45.35% keeping the capital expenditure same as 750 and price of gas barrel to a 10 % increase every year, without giving much pressure to the consumers.

In terms of capital expenditure change, sensitivity1 in which we slash the capital expenditure by 10% is most preferable in terms of IRR with a 32.86% rate of return and PAY BACK PERIOD of 3.1 years.

CONCLUSION

The method presented takes into account the design and analysis of essential capital assets to study the impact of variations in the project valuation. All other significant inputs are also considered carefully so as to incorporate the effects in their variation on the project viability. The resulting analysis is more comprehensive and reveals the possible consequences that may occur on account of different possible turn of events The most critical input/assumption can be readily identified and be monitored closely for exercising control over the project, it thereby helps in identifying the conditions needed to meet the financial goals of the project.

The project Gas Pipeline Project is undertaken to compute the NET CASH INFLOWS, which gives the IRR and PY BACK PERIOD. Sensitivities analysis helps us understand the impact of changes of different parameters on the profitability of the project.

In any project undertaken we have to compute the capital expenditure requirements, operating expenditure requirements, how much revenue can be generated at different levels of prices for the saleable products, what tax is to be paid, and at the end in every project we compute the time in which the project will start generating profits.

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