Petroleum Economic Decision Tools
We must remember
- oil companies are BUSINESSES whose primary aim is to generate cash for their investors
- investment decisions are therefore among the most important decisions that a company can take

Everyone of us must at all times be aware of
- current trends in oil and gas prices,
- targets,
- financial returns,
- budgets for wells and fields...
It is not to put holes in the ground
• It is not to move equipment and materials underground
• It is not to complete wells as cheaply as possible
• It is not necessarily to produce fluids as fast as possible

It is to maximize rate of return on the investments
Alignment of Goals and Strategies
- Economic drivers
- Productivity targets
- Geographic and Operational constraints

Reservoir Competency

Proper Well Design
- Take drilling, completion and production concerns into account
- Maintain philosophy that equipment is designed to meet application, application is not adapted to fit equipment
- Life of reservoir productivity

Project Execution

Monitoring
Situations Requiring Economic Analysis

- Establishing economic feasibility of an investment or rate acceleration opportunity *(screening)*
- Weighing the relative merits of several investment prospects, when funds are not available for all *(ranking)*
- Evaluating purchase proposals from *several suppliers*
- *Buy or Lease* decisions
- Determining a value/price for *buying/selling producing properties*
- Establishing the *cost of borrowing funds* from lending institutions
- *Replacement* of existing equipment or service
- Choosing among mutually *exclusive alternatives*:
  - Initial investments are substantially different
  - Timing of cash flows is substantially different
Decisions Through The Life Cycle of Petroleum Project

- Apply Bid License
- Accept Work Program
- 3 D-Seismic
- Drill a Wild Cat
- Appraisal
- Develop

In All these Phases you have to take Decision

Investment Analysis is used as a managerial tool to take such Decision
Economic Yardsticks

• Measures that do not consider the time value of money
  – Profit
  – Payout time
  – Cost to find & develop reserves or unit development cost

• Measures that do consider the time value of money (Capital Budgeting/Methods of Project Analysis)
  – Net Present Value (NPV)
  – Rate of Return (IRR)
  – Profitability Index (PI)
Profit = Revenue - Expenses

Money taken in

Money going out
- initial investment
- capital expenses
- operating costs
- taxes

Annual Profit = Annual Net Cash Flow

Total Profit = Cumulative Net Cash Flow
Payout Time

\[ \text{Payout} = \text{Time from investment to positive net cash flow} \]

Usually easy to calculate

- Can be days to several years
- Time of payout may be criterion for investment (in combination with other decision methods)
Cost of Finding Reserves

Cost to find and develop reserves = Investment/Reserves

( $/bbl or $/Mscf )

General measure for comparing exploration and development opportunities
Example

Restoring a Well to Production

- A well is shut in after it can no longer flow naturally
- After review a proposal is prepared for recompletion at a cost of US$750,000.
- This recompletion includes a fracture stimulation job and installation of gas lift. The team is very confident that well can be successfully returned to production.
- Predicted production estimate is also provided.

What management would like to know here?

- the total profit,
- payout time, and
- cost to find and develop reserves
### Example

#### Restoring a Well to Production

<table>
<thead>
<tr>
<th>Year</th>
<th>Production STB/yr</th>
<th>Revenue Cash Flow M$</th>
<th>Expenses M$</th>
<th>Taxes M$</th>
<th>Investment M$</th>
<th>Net Cash Flow M$</th>
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<tbody>
<tr>
<td>0</td>
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## Example; Solution

### Restoring a Well to Production

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**Total Profit = US $ 972,000**
### Example; Solution

#### Restoring a Well to Production

**Cumulative net cash flow \( \approx \) initial investment**

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**TOTAL** 200,000 4,000 1,180 1,148 750 972

**Payout time is 1.7 years**
### Example; Solution

#### Restoring a Well to Production

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**Cost to Develop Reserves = $750 M/200 MSTB = $3.75/bbl**
Time Value of Money

Which would you choose...

now?

or

3 years from now?
Which would you choose... or now? or 3 years from now?
Time Value of Money

Which would you choose...

or

now?  or  3 years from now?
Time Value of Money

Which would you choose . . .

or

now? 3 years from now?

$1 now > $1 3 years from now.
Time Value of Money

Which would you choose ... 

$1 now < $7 3 years from now.
Time Value of Money

Which would you choose . . .

or

Time Value of Money helps us decide.

A dollar today is worth more than a dollar tomorrow!
Future Value (FV)

- Future value measures the nominal future sum of money that a given sum of money is "worth" at a specified time in the future assuming a certain interest rate (or more generally, rate of return).
- It is the present multiplied by the accumulation function

\[ FV = PV \times (1 + i)^n \]

- \( i \) = Interest Rate
- \( n \) = Number of periods
- \( PV \) = Present Value, \( FV \) = Future Value

What is $10,000 worth in 20 years at an interest rate of 15%/year?

\[ FV = $10,000 \times (1 + 0.15)^{20} \]

\[ FV = $163,665 \]
Present Value (PV)

- **Present value** is the value on a given date of a future payment or series of future payments, discounted to reflect the *time value of money* and other factors such as *investment risk*.

\[
PV = F V \times (1 + i)^{-n}
\]

- \( i = \text{Interest Rate} \)
- \( n = \text{Number of periods} \)
- \( PV = \text{Present Value} \), \( FV = \text{Future Value} \)

I want $15,000 in the bank in 5 years. I feel I can earn 15%/year, how much will I need to invest today?

\[
PV = $15000 \times \left( \frac{1}{1 + 0.15} \right)^5
\]

\[
PV = $7,458
\]
Capital Recovery Factor

- Provides the amount of a series of equal payments when a principal amount, PV, is invested at a given rate. Used to compare facilities with unequal lifetimes.

\[
CF = PV \left( \frac{i(1+i)^n}{(1+i)^n - 1} \right)
\]

- \(i\) = Interest Rate
- \(n\) = Number of periods
- \(PV\) = Present Value
- \(CF\) = Capital Recovery Factor

A lease needs compression. Two vendors respond to the bid request:
- Vendor A offers compression for $450M with a 6 year life
- Vendor B offers compression for $500M with an 8 year life.

Evaluate the bids.

\[
CF_A = 450,000 \left( \frac{0.15(1+0.15)^6}{(1+0.15)^6 - 1} \right) = $118,912
\]

\[
CF_B = 500,000 \left( \frac{0.15(1+0.15)^8}{(1+0.15)^8 - 1} \right) = $111,426
\]
Present Worth Factor

- Often used in evaluating a lease vs. buy scenario. This equation calculates Present Value of a lease payment plan, assuming equal payments.

\[ PV = CF \left[ \frac{(1+i)^n - 1}{i(1+i)^n} \right] \]

You can lease compression equipment for $300M per year for five years, or you can purchase the equipment for $800M today. What is the best alternative. Therefore, best to purchase equipment.

\[ PV = 300,000 \left[ \frac{(1+0.15)^5 - 1}{0.15(1+0.15)^5} \right] \]

\[ PV = $1.005 Million \]
NPV puts all costs and revenues into equivalent basis (present value) and sums them up.

Or simply

\[ \text{NPV} = \text{PV of Future Benefits} - \text{PV of the Cost} \]

Logically, if NPV > 0, benefits exceed costs, and the project should be accepted. If NPV < 0, the project should be rejected.

If the \text{Net Present Value} is positive, the project will increase the present wealth of the company by the NPV amount.

The general rule followed in comparing projects is to choose one that results in highest NPV.
A discount rate of 10% is assumed as the company’s marginal rate. Project cost $500 in year 0. Operating expense $200/year for 4 years. Cash flow is positive but declining over the years.

### Present Value of $1 @ 10%

<table>
<thead>
<tr>
<th>Year</th>
<th>Present Value (Today's Value)</th>
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<tbody>
<tr>
<td>0-1</td>
<td>0.9516</td>
</tr>
<tr>
<td>1-2</td>
<td>0.8611</td>
</tr>
<tr>
<td>2-3</td>
<td>0.7791</td>
</tr>
<tr>
<td>3-4</td>
<td>0.705</td>
</tr>
<tr>
<td>4-5</td>
<td>0.6379</td>
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### Arithmatic of determining NPV

<table>
<thead>
<tr>
<th>Year</th>
<th>Benefit ($)</th>
<th>Cost ($)</th>
<th>Cash Flow ($)</th>
<th>PV of $1</th>
<th>Discounted Cash Flow ($)</th>
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<tbody>
<tr>
<td>0-1</td>
<td>0</td>
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<td>-500</td>
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<tr>
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<td>250</td>
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<td>50</td>
<td>0.705</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>1450</strong></td>
<td><strong>-1300</strong></td>
<td><strong>150</strong></td>
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<td><strong>60</strong></td>
</tr>
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</table>
Net positive cash flow over the life of the project is $150, before discounting.

When the cash flow is adjusted for the present value of the dollar, the NPV is found to be $60.

The proposed investment is better than doing nothing because:
  – All the costs are covered
  – 10% opportunity cost of the company’s funds is realised
  – In addition project yield an additional $60 return
Decision Method Number 2; IRR

- IRR = the rate of return earned on the project
- IRR is the rate that makes the Net Present Value of a series of costs and revenues equal to zero
  - The interest rate that equates the equivalent worth of an alternative’s cash inflows to cash outflows
  - \( PV(\text{inflow}) = PV(\text{outflow}) \)
- Logically, if IRR > the cost of capital to finance the project, the project should be accepted
- If IRR < cost of capital, the project should be rejected
- The IRR is a relative measure, and does not measure an increase in the company’s wealth
• Profitability index identifies the relationship of investment to payoff of a proposed project

\[ PI = \frac{PV \text{ of Future Benefits}}{PV \text{ of the Cost}} \]

• Profitability Index is also known as Profit Investment Ratio, abbreviated to P.I. and Value Investment Ratio (V.I.R.)

• When various projects are converted into a profitability index, selection is further facilitated

• Profitability index is a good tool for ranking projects because
  – it allows you to clearly identify the amount of value created per unit of investment,
  – thus if you are capital constrained you wish to invest in those projects which create value most efficiently first

• Rules for selection or rejection of a project:
  – If \( PI > 1 \) then accept the project
  – If \( PI < 1 \) then reject the project
Profitability Index Example

• Calculating PI for example
  – Present Value of total benefits from the project = 272,600
  – Present Value of total cost on the project = 250,000
  – PI = 272,600/250,000= 1.09

• Since PI>1.00, the project may be accepted
The payback period

Recap from previous discussion on payback:

- Payback period = the number of years it will take to return the original investment
- Calculation of payback period ignores the time value of money (This is a critical flaw!)

- Payback period is recognized today to be an inappropriate way to make capital budgeting decisions
- However, it is still a number that is useful to some decision makers in combination with one of the three other methods already explained
Flow of Funds

Absorbing Funds

- Loan capital
- Shareholders’ funds

Generating Money

- Loan repayments
- Shareholders’ profit

The Project

Re-investment

Shareholders’ dividend
Calculating Project Cash Flow

Cash Flow = Revenues - Expenditures

Revenue Items (Payments received)
- Gross revenues from sales of hydrocarbons
- Payments for farming out project or part of project

Expenditure Items (Payments made)
- Capex
  Capital expenditure on assets (platforms, facilities, wells)
- Opex
  Operating expenditure for assets (maintenance, insurance)
- Government take
  (PSA’s, royalties, taxes)
Components of Cash Flow

- Cash flow, $M
- Time, years
- Components: Capex, Cash Surplus, Royalty, Opex, Tax

Graph showing cash flow over time, with bars for each component.
Net Cash Flow Indicators

First oil date

Payout time

Maximum losses?

Economic Lifetime

Cumulative Cash Flow, $M

Time (years)

Time (years)
Cumulative Cash Flow

- **Cumulative Cash Surplus**
- **Payout Time**
- **Maximum Exposure**

Cash Surplus ($M)

Cumulative Cash Surplus accrues to investor at end of economic lifetime of project

Time (years)

Field life net cash flow
Summary

- Time value of money is important in estimating profitability
- Profit, payout, and cost to find and develop reserves are not affected by the time value of money
- NPV, IRR and PI are dependent on the time value of money
- Either the NPV, IRR, or PI methods can be used to make good decisions about capital budgeting investments
- Uncertainty about the future cash flow estimates is problematic
- Payback period is often calculated for investment projects, but it should not be used by itself to make accept/reject decisions
- Also we need to remember:
  - invest in projects where the value of future return is greater than the cost
  - larger monetary benefits, (i.e. Profits) over the smaller ones
  - earlier benefits (quick return) over the later ones
Thank You for assistance on Economic Optimization, reach us:

adnan@petrosol.co

Visit our website: http://www.petrosol.co
Any enquiry please contact us: support@petrosol.co