Introduction to Petroleum Economics
Economics Overview

- Economics and Economic Analysis are Vital to the success of the oil & gas industry
  - Expense projects - Maintain reserves or production
  - Capital projects - Attain reserves or production

- Incremental Analysis and the ‘Do-nothing’ case are key to evaluating economic viability
Why Economics?

• Integrate all the technical analysis into a recommendation(s)
• Evaluate the recommendation(s) for profit potential with an economic analysis
• Make a final recommendation(s) to management based on technical and economic evaluations

Economics is typically the focal point of all the technical work - The Bottom Line.
Overall Flow of Funds

Absorbing Funds
- Loan capital
- Shareholders’ funds

Generating Money
- Loan repayments
- Shareholders’ profit

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 with lifetime > 1 yr (platforms, facilities, wells)

- **Opex**
  Operating expenditure for assets with lifetime < 1 yr (maintenance, insurance)

- **Government take**
  (royalties, taxes)
Cash Flow

**Cash Flow (CF) = Cash Inflows - Cash Outflows**

Cash Flows are classified as:

- **Revenues** = (+) R
- **Investments** = (-) I
- **Expenses** = (-) E
- **Federal Income Tax** = (-) FIT
- Sale of Oil, Gas, NGLs, CO2, sulphur, etcera
- Sale of Surplus Equipment
- Processing fees and royalties
- Sale of Producing Properties
- Expense reduction
Investments

- Bonuses (Purchase Leases)
- Exploration (Seismic, Drilling)
- Tangible investment (Pipe, Equipment, Platform)
- Intangible drilling costs
- Intangible other investment
Expenses

Direct operating costs
- Differ from investments, may be discontinued at any time to shut in production
- Should include expenses caused by the proposed investment
- Are expressed as a fixed amount per well, fixed amount per field, or variable amount per unit of production

Other Direct costs - Non routine or anticipated periodic costs
- Periodic expense workovers
- Plug and abandonment costs
Expenses

Other Expenses (E)
- Production taxes
- Tariffs
- Transportation fees
Expenses

Indirect Expenses (E), Overhead

- Money required to run the business above the field level
- Costs for salaries, offices, supplies, and equipment
- Investment and expense overhead are included in economic analysis

- For example in the U.S., overhead rates are:
  - 10% on Investments
  - 24% on Direct Operating costs
Net Cash Flow

Net Cash Flow = R - I - E - FIT = NCF

[ The term Net refers to some reductions may have been made to reflect only the owners perspective.]

- Economic yardsticks are then developed from the NCF

  - $\sum$ NCF by year = Actual Value Profit (AVP)

  - Discounting is used to determine PVP, PVP/I, DCFR
## NCF Summary

### Revenue
- Sale of Oil & Gas
- Sale of Other Products
- Sale of Surplus Eqpt.
- Sale of Prod. Properties

### Investments
- Drilling
- Eqpt. purchase
- Pipelines
- Platforms

### Expenses
- Operating costs
- Maintenance costs
- Overhead
- Eqpt. Replacement
- Repair workovers
- Fuel costs
- P & A costs

### Fed IncTax / [Outside Share]
- Taxes
  - [Taxes / Royalties / Govt Take]
Net Cash Flow Indicators

First oil date

Cumulative Cash Flow, $M

Time (years)

Maximum losses?

Economic Lifetime
Cumulative Cash Flow

Cumulative Cash Surplus

Payout Time

Field life net cash flow

Maximum Exposure

Cash Surplus ($M)

Time (years)
Economic Yardsticks

**Profit or Actual Value Profit (AVP)**

\[ \text{Profit (AVP)} = \text{All Cash In} - \text{All Cash out} \]

\[ \text{Actual Value Profit (AVP)} = \sum \text{NCF by year} \]

---

**Profit to Investment Ratio (P/I)**

\[ \frac{P}{I} = \frac{\text{Profit}}{\text{Investment}} \]

\[ \frac{P}{I} = \frac{\text{AVP}}{I} \]
Payout / Payback

How long does it take to break even?
How long is the investment at risk?

Payout = Length of time required for the total cash outlay to be recovered through the profit generated by the project.

- Measured from the time of first investment
- Indicates the riskiness of the opportunity
- Not a good yardstick to compare large and small opportunities
## NCF Example

<table>
<thead>
<tr>
<th>Year</th>
<th>Revenue</th>
<th>Investment</th>
<th>Expense</th>
<th>FIT</th>
<th>NCF</th>
<th>Cumulative NCF</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>10</td>
<td>100</td>
<td>-10</td>
<td>-10</td>
<td>-10</td>
<td>-10</td>
</tr>
<tr>
<td>1</td>
<td>20</td>
<td>14</td>
<td>1</td>
<td>5</td>
<td>-5</td>
<td>-5</td>
</tr>
<tr>
<td>2</td>
<td>20</td>
<td>14</td>
<td>1</td>
<td>5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>20</td>
<td>14</td>
<td>1</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>20</td>
<td>14</td>
<td>1</td>
<td>5</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>5</td>
<td>20</td>
<td>14</td>
<td>1</td>
<td>5</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100</strong></td>
<td><strong>10</strong></td>
<td><strong>70</strong></td>
<td><strong>5</strong></td>
<td><strong>15</strong></td>
<td></td>
</tr>
</tbody>
</table>

- \( \text{AVP} = \sum \text{NCF} = \) 
- \( \text{P/I} = \frac{\text{AVP}}{\text{I}} = \) 
- \( \text{Payout} = \)
Discounting / Time Value of Money

- In order to evaluate future profit, we need to ‘discount’ future $ to ‘today’ $.
- By discounting NCF, we develop discounted cash flow, DCF, and various discounted cash flow yardsticks.

**DCF:** Discounted cash flow is the concept which recognizes the time value of money by discounting future outlays and inflows to a present value reference (usually time zero).

---

**End of Year Discounting**

\[
\begin{align*}
F &= P \times (1 + i)^n \\
P &= F \times (1 + i)^{-n}
\end{align*}
\]

**Mid Year Discounting**

\[
P = \frac{F}{(1 + i)^{n-0.5}}
\]

---

**Discount Factors**

\[
\begin{align*}
1/(1 + i)^n & \quad \text{end of year} \\
1/((1 + i)^{n - 0.5}) & \quad \text{mid year}
\end{align*}
\]

---

where:

- \( F \) = Future value
- \( P \) = Present value
- \( i \) = Annual interest rate (frac.)
- \( n \) = Number of years
Guidelines for Economic Analysis

- Use Tax Rate = 38% (35% federal, 3% effective state) for U.S. based projects
- Use guideline discount rate of 12%
- Use mid-year (or mid-period) discounting
- Include appropriate overhead rates in economic analysis
- \( PVP(12\%) > 0 \) indicates the project is attractive to the company  =>  \( DCFR > 12\% \)
- Maximize PVP of projects through prioritisation
Present Value Profit (PVP)

\[ PVP = \sum \text{annual DCF values} \]  
(PVP also known as: NPV)

PVP to Investment Ratio (PVP/I) or PVP/PVI

\[ \frac{PVP}{I} = \frac{PVP}{\text{Investment}} \]

( PVP/PVI, PVI = present value of the investment stream)
DCF Example

Note: No discounting in year zero

- PVP(12%) = ∑ annual DCF values = 9.1
- PVP(12%)/I = 9.1/10 = 0.91
Economic Yardsticks

Discounted Cash Flow Rate of Return (DCFR)

DCFR = Discount rate at which PVP=0.0

- DCFR is the bank rate of interest made on an investment in a project, or the interest rate that discounts the sum of net cash flows of the project to zero.

- DCFR is also known as, IRR, IIR, ROR, DCFROR, or simply Return.

- To determine the DCFR:
  - NCF is discounted at various discount rates => various PVP’s
  - Find the discount rate at which PVP=0
  - Iterative process to solve for DCFR
  - Graphical presentation is a Present Value Profile
# DCF Example

<table>
<thead>
<tr>
<th>Year</th>
<th>Revenue</th>
<th>Investment</th>
<th>Expense</th>
<th>FIT</th>
<th>NCF</th>
<th>NCF</th>
<th>D.F. @ 12%</th>
<th>DCF</th>
<th>DCF</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>10</td>
<td>10</td>
<td>-10</td>
<td>-10</td>
<td>-10</td>
<td>1.0000</td>
<td>-10.0</td>
<td>-10.0</td>
<td>-10.0</td>
</tr>
<tr>
<td>1</td>
<td>20</td>
<td>14</td>
<td>1</td>
<td>5</td>
<td>-5</td>
<td>0.9449</td>
<td>4.7</td>
<td>4.7</td>
<td>-5.3</td>
</tr>
<tr>
<td>2</td>
<td>20</td>
<td>14</td>
<td>1</td>
<td>5</td>
<td>0</td>
<td>0.8437</td>
<td>4.2</td>
<td>4.2</td>
<td>-1.1</td>
</tr>
<tr>
<td>3</td>
<td>20</td>
<td>14</td>
<td>1</td>
<td>5</td>
<td>5</td>
<td>0.7533</td>
<td>3.8</td>
<td>3.8</td>
<td>2.7</td>
</tr>
<tr>
<td>4</td>
<td>20</td>
<td>14</td>
<td>1</td>
<td>5</td>
<td>10</td>
<td>0.6726</td>
<td>3.4</td>
<td>3.4</td>
<td>6.1</td>
</tr>
<tr>
<td>5</td>
<td>20</td>
<td>14</td>
<td>1</td>
<td>5</td>
<td>15</td>
<td>0.6005</td>
<td>3.0</td>
<td>3.0</td>
<td>9.1</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>100</td>
<td>10</td>
<td>70</td>
<td>5</td>
<td>15</td>
<td>9.1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Discount Rate % | PVP
---|---
0   | 15.0
10  | 9.9
12  | 9.1
20  | 6.4
30  | 3.9
40  | 2.0
50  | 0.6
55.5| 0.0
60  | -0.5
70  | -1.3
80  | -2.1
90  | -2.7
100 | -3.1

PVP’s calculated at various discount rates => Present Value Profile