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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

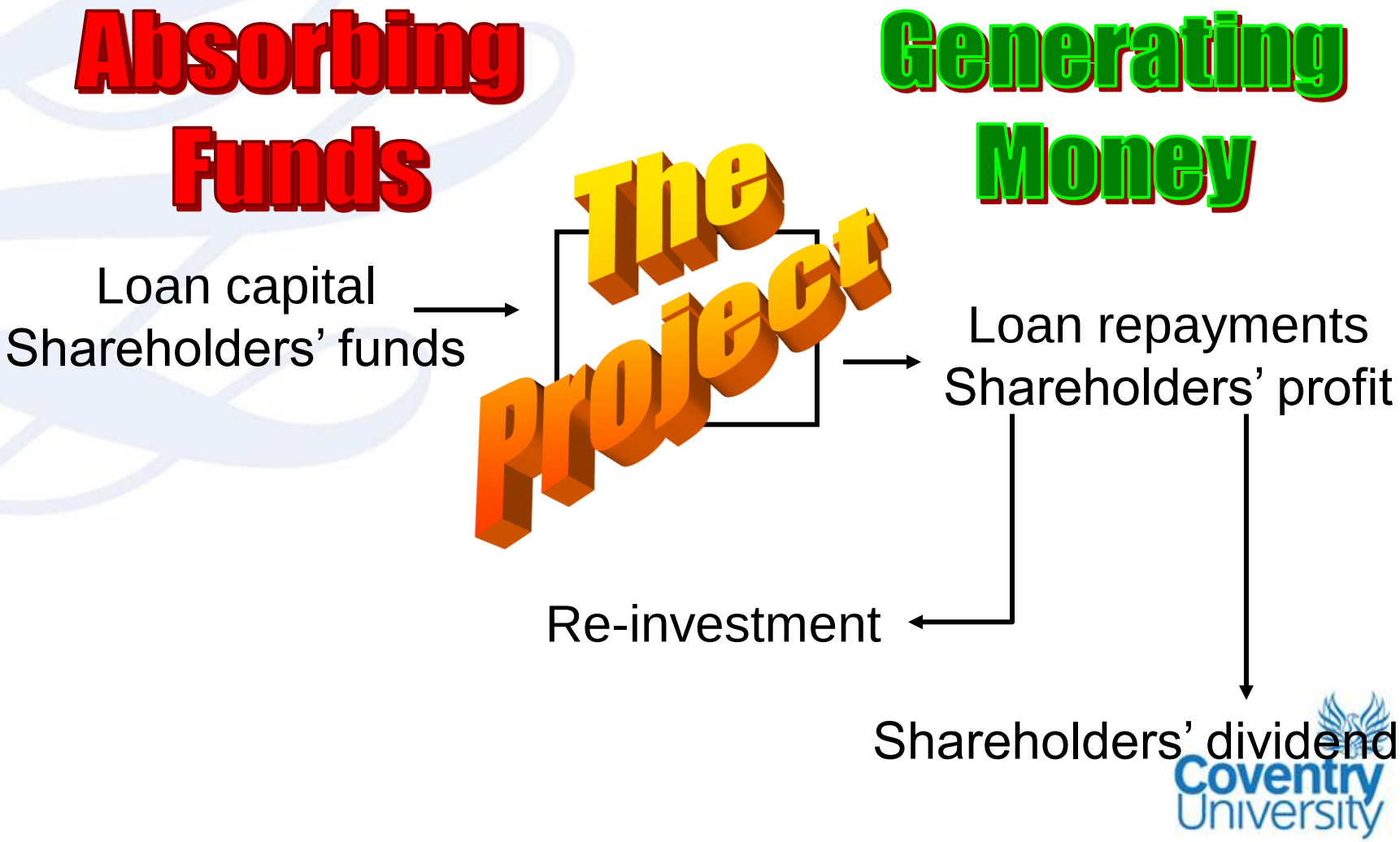
- Incremental Analysis and the ‘Do-nothing’ case are key to evaluating economic viability

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



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)

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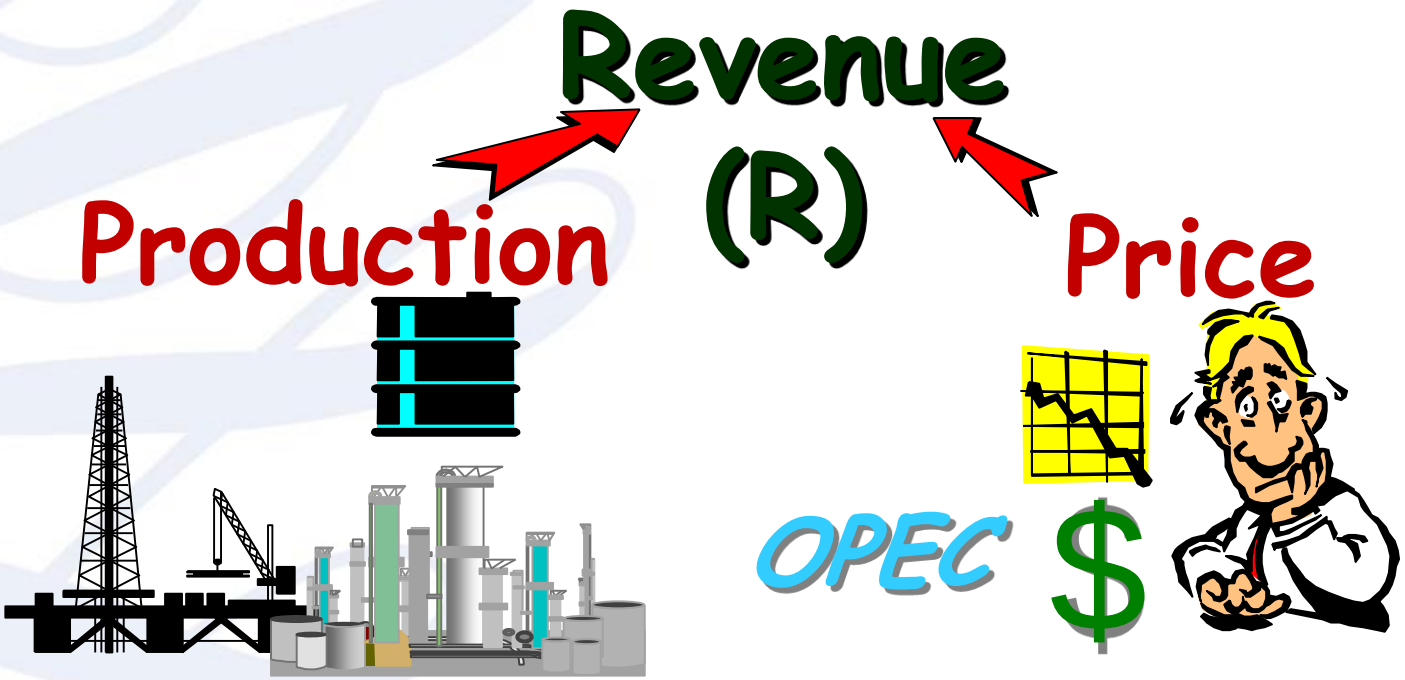
Cash Flow

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)

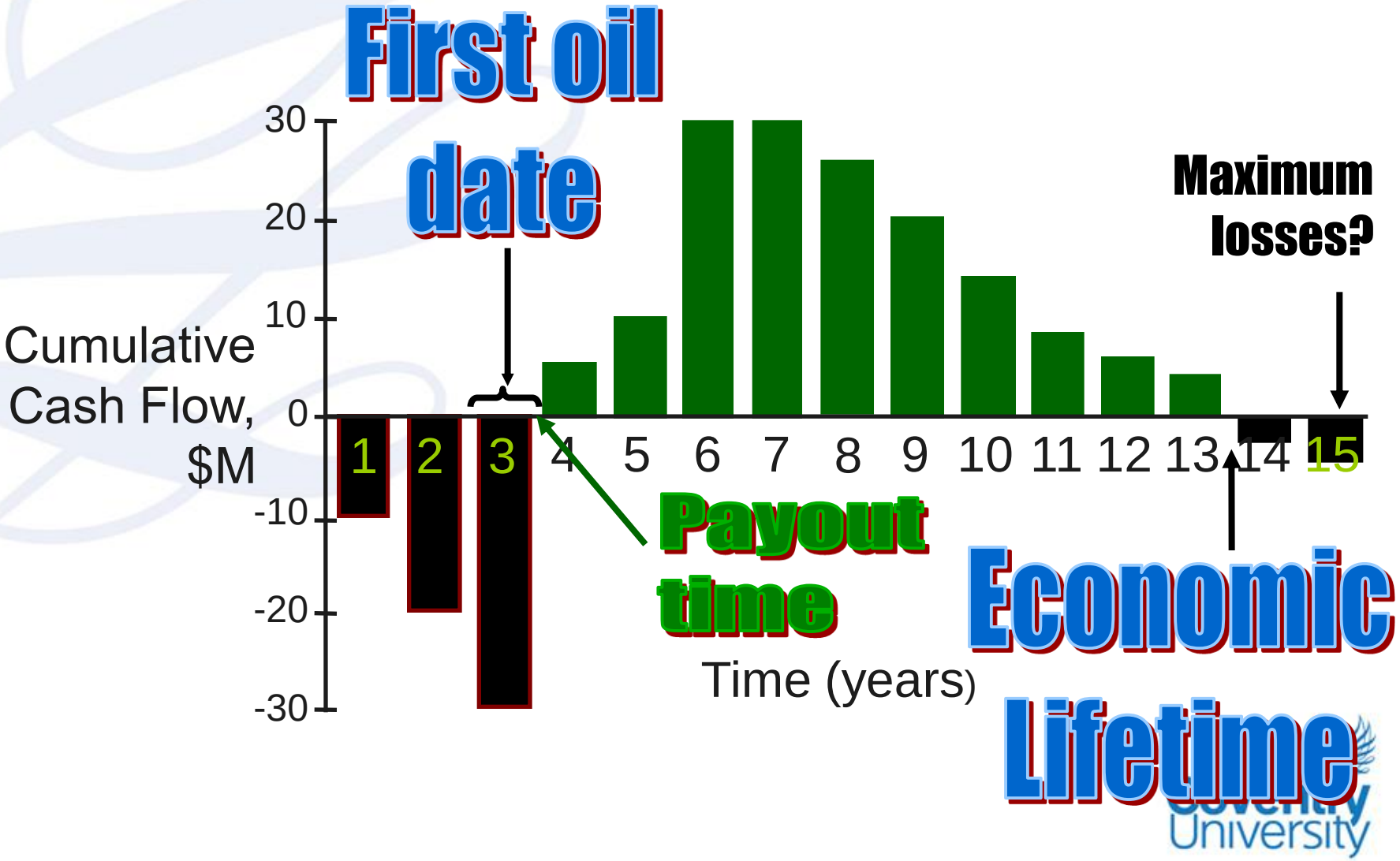
  - Discounting is used to determine PVP, PVP/I, DCFR

NCF Summary

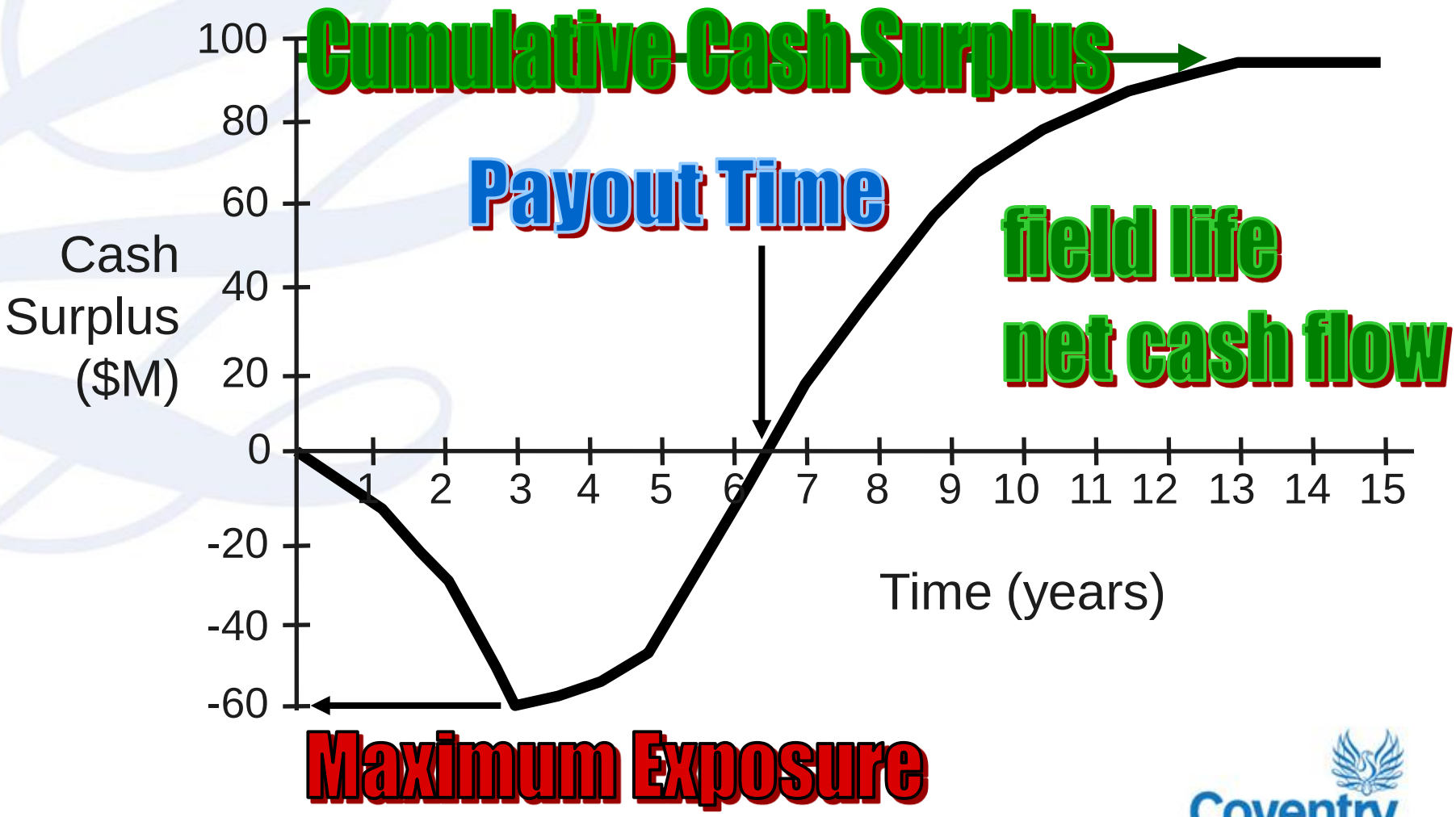
Revenue	Investments	Expenses	Fed IncTax / [Outside Share]
• Sale of Oil & Gas • Sale of Other Products • Sale of Surplus Eqpt. • Sale of Prod. Properties	• Drilling • Eqpt. purchase • Pipelines • Platforms	• Operating costs • Maintenance costs • Overhead • Eqpt. Replacement • Repair workovers • Fuel costs • P & A costs	• Taxes [Taxes / Royalties / Govt Take]

NCF = R - I - E - FIT

Net Cash Flow Indicators



Cumulative Cash Flow



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Economic Yardsticks

Profit or Actual Value Profit (AVP)

Profit (AVP) = All Cash In - All Cash out

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

Profit to Investment Ratio (P/I)

P/I = Profit / Investment

P/I = AVP / I

Economic Yardsticks

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

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NCF Example

Year	Revenue	Investment	Expense	FIT	NCF	Cumulative NCF
0		10			-10	-10
1	20		14	1	5	-5
2	20		14	1	5	0
3	20		14	1	5	5
4	20		14	1	5	10
5	20		14	1	5	15
Total	100	10	70	5	15	

- AVP = $\sum$ NCF =
- P/I = AVP/I =
- 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

$$F = P(1 + i)^{n}$$

$$P = F(1 + i)^{-n}$$

Mid Year Discounting

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

Discount Factors

$1/(1 + i)^{n}$ end of year

$1/(1 + i)^{n - 0.5}$ mid year

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

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Economic Yardsticks

Present Value Profit (PVP)

PVP = $\sum$ annual DCF values (PVP also known as: NPV)

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

PVP/I = PVP / Investment

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

DCF Example

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

Note: No discounting in year zero

- PVP(12%) = $\sum$ 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

Year	Revenue	Investment	Expense	FIT	NCF	Cumulative NCF	Mid Year D.F. @ 12%	DCF	Cumulative DCF
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5	20		14	1	5	15	0.6005	3.0	9.1
Total	100	10	70	5	15			9.1	

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