PPSDM Jakarta, October 30th, 2017

Company decision-making for geothermal projects

(GEOCAP course 1.07)

Topics: DCF analysis; CAPM; Govt Take; KPIs

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- **Spreadsheet exercise: start from scratch**
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- **CAPM, WACC**
- **Spreadsheet exercise**
- **Performance / decision indicators (metrics)**

E&P economics = maximizing the creation of value by decision-making under uncertainty *(forward looking)*

Framing decision alternatives
Valuation and comparison of decision alternatives
Selecting optimal decision path

Valuation of uncertain, future cashflows

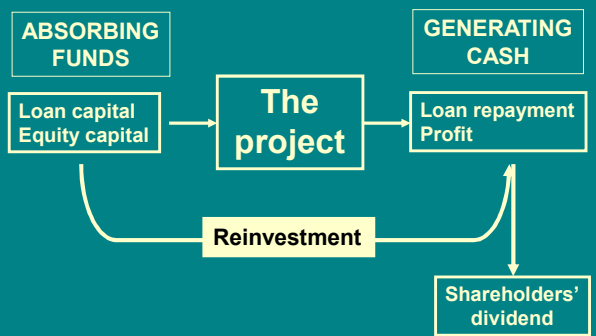
- **When analysing an investment opportunity for supporting a decision-making process, how should one treat uncertain, future cashflows?**
  - Include time-value of money? Inflation?
  - Include uncertainty? How? Which uncertainties?
  - Include risk? How? Which risks?
  - Include flexibility? How?
- **Is investing in subsurface (GTE, E&P) business special? Why?**

Difference finance vs. economics

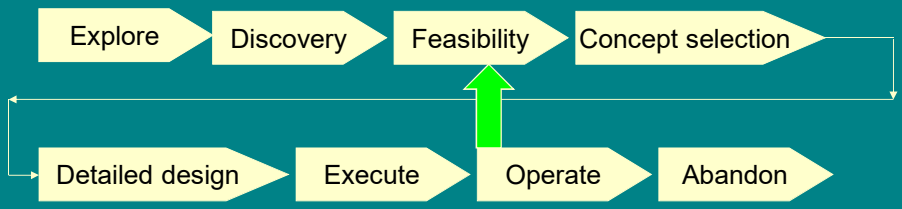
- Finance:
  - Securing cash (loans, equity, project cash flow)
  - Balancing cashflows from portfolio of projects
    - Corporate planning, input to project Final Investment Decision
  - Securing control (Control function)
  - Establishing corporate balance sheet (Accounting function)
  - Executing payments (Treasury function)
  - Shareholder relationships
  - Etc.
- Economics:
  - Projecting cashflows from projects and assessing added value from new projects
  - Support for investment decision-making leading to FID
    - Final Investment Decision

Project economics, basic principles

- Project absorbs and generates funds
- Project must generate sufficient return to pay interest on loans and dividends expected by shareholders
- Remaining cash to be used for reinvestments

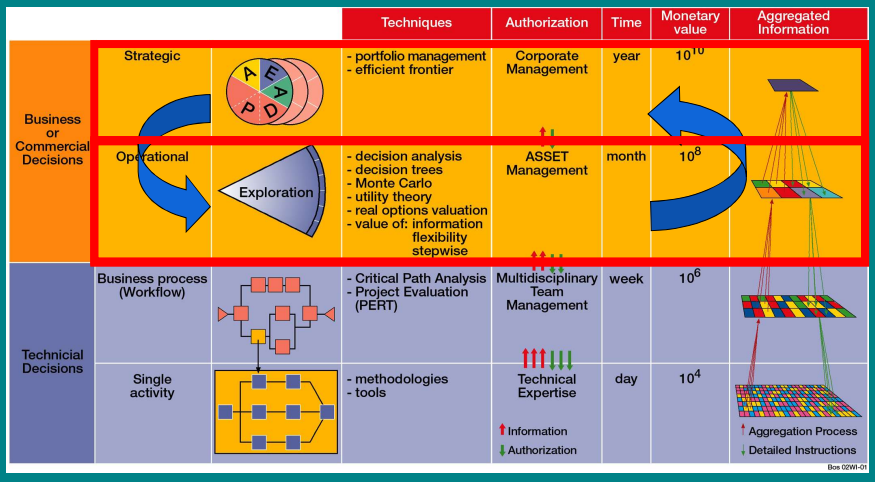


The project and decision gate process



- During operation, new information will be revealed, which will lead to new ideas for improving the asset's value.
- This will lead to *incremental* projects, which should be evaluated based on *incremental* economics.

Decisions and Levels of Aggregation



Hierarchical optimization

- What to optimize at one level, & under which constraints, so as to have a high chance of also being optimal at next higher level?

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Economics is where it all comes together!

- Highest aggregation level of information
- Economists should ideally have a multi-disciplinary attitude and interest to understand value of info received from colleagues
- All E&P planning staff should very well understand value proposition of their company (metrics), and how decisions are made (decision criteria + why)
- Ditto, impact of decisions on life cycle of project, and on portfolio of projects

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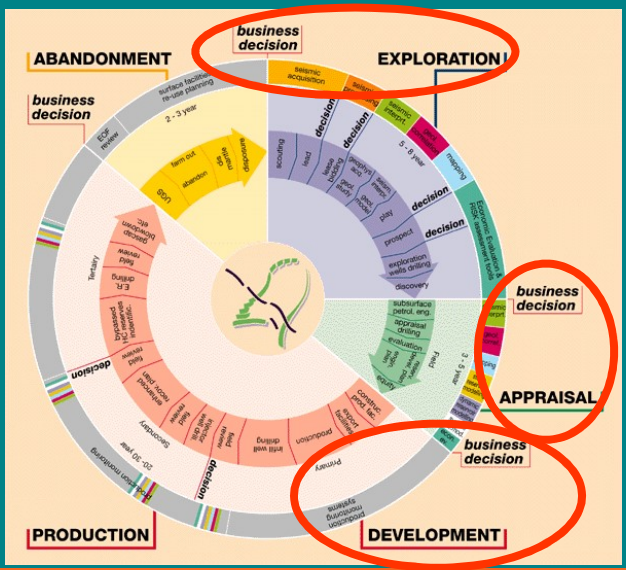
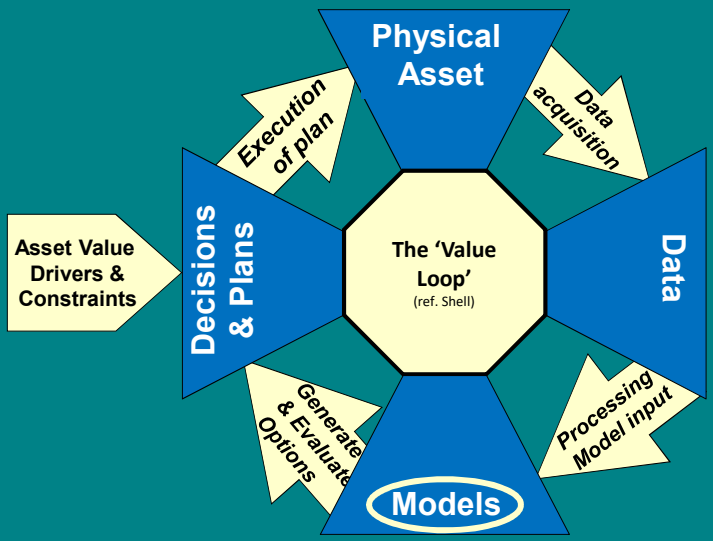
Subsurface Asset Lifecycle

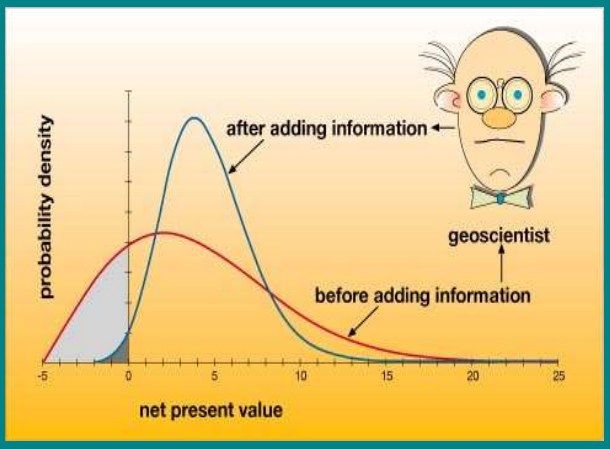


The role of models in creating value



The task of the project team in GTE decision making is to

1. Correctly quantify, using the available models, the uncertainty in the KPIs
2. Create and evaluate decision options to mitigate the downside (e.g. by acquiring new information and/or designing flexibility options)
3. Create and evaluate decision options to chase the upside (e.g. by acquiring new information and/or designing flexibility options)



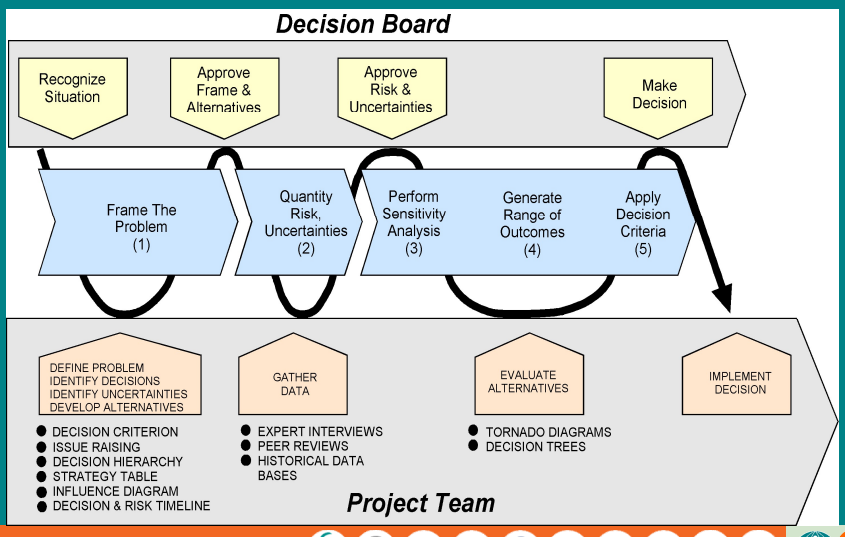
Having quantified uncertainty, then what?

- Exploit the uncertainty to mitigate the downside and chase the upside!
  - ***Use your quantified uncertainty to create new decision options and to optimize your decision-sequence.***
- Actively manage many more what-if scenarios.
  - ***Open up your mind!***
- Update your decision models and options as new information is acquired. See it as measurement & control game: but understand that control means creating new decision options and eliminating those that meanwhile have become invalid.
  - ***Strike your options at the right time (Dynamic & Real Options).***
- Options have value by virtue of uncertainty. Uncertainty is not your foe, it is your friend.
  - ***Manage it, and exploit it to your benefit.***
- Do not simply talk about risk management, thereby focusing on avoiding the downside. Talk about risk and opportunity management, and see it as one integral issue.

D&RA - 5 main steps

1. Frame the problem	2. Set-up quantitat. models	3. Generate range of outcomes	4. Perform Sensitivity Analysis	5. Apply Decision Criteria
•Agree dec. crit. •Agree decisions •Agree scenarios •Construct tree •Prune tree •Agree tree	•Agree models •Populate model •Agree stoch. parameter pdf's & scenario prob. •Agree / est. correlations •Agree KPIs •Agree risk def.	•Est. MC run parameters •Pdf's of KPI's •Quantify risks •Assess impact on portfolio •Est. utility fct, risk tolerance	•Tornado etc •Fine-tune decision altern. • Test robust-ness of decis: - model input - process par - utility fct - dec.sequence •VoI, VoF, ROV	•Describe process •Propose optim. solution + impact on portfolio •Report •Monitor •Update model

The D&RA Process, how mgt & staff create synergy: *team work!*

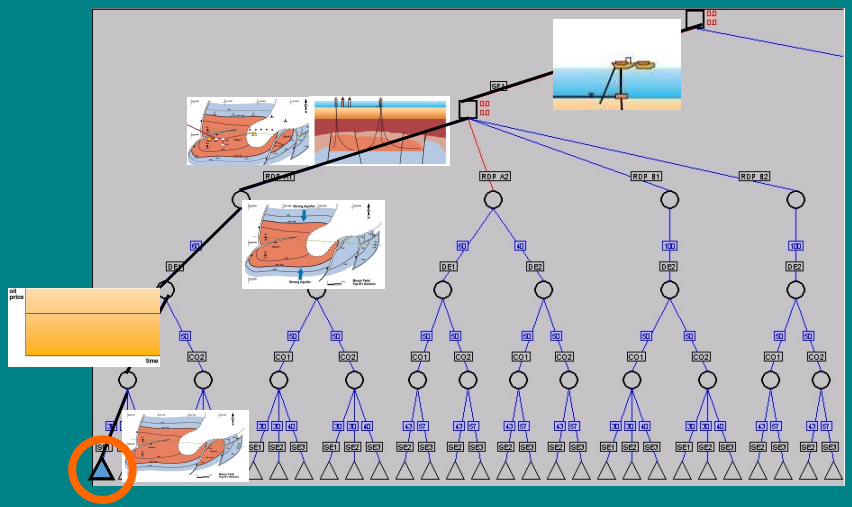


Discussion: Considerations when optimizing "value"

- **Hierarchical optimization**
- **Multi-criteria optimization**
- **Constrained optimization**
- **Optimization under uncertainty: probability of meeting target**
  - **Risk tolerance as optimization constraint**
  - **Scalar optimization + Vector optimization (time-domain)**
    - **Vector cannot be optimized! However, …**
- **Proxy optimization criteria**
- **Fit-for-purpose T2B-models**

Q: What are the value optimization controls?

Decision-Making framework required for valuation ("*No impact? No value!*")



Modelling decisions and uncertainties in a combined framework

Decision-making = value optimization =
hierarchical constrained optimisation under uncertainty given targets

Δvalue = Δprobability of meeting a set of pre-defined time-series targets at the next hierarchical decision-level

KPIs – Key Performance Indicators to be optimized

- **Corporate, e.g.**
  - **EPS, ROACE, ROCE, RRR, Production Income; Quality of Earnings; Production Replacement Ratios, Excluding Acquisitions & Divestments; Finding & Development Costs, Including Acquisitions & Divestments; Discounted Future Net Cash Flow**
- **Asset, e.g.**
  - **KPI maximisation, e.g. NPV (EMV); IRR; P/I; Δproved developed reserves; Δexpected reserves; etc.**
  - **KPI minimisation, e.g. pay-out time POT; Unit Technical cost UTC**
- **Project, e.g.**
  - **Capex minimization within time constraint**
- **Appraisal, e.g.**
  - **Value of Information (ΔEMV)**

Project optimization constraints

- Usually, cost-related KPIs
  - **UTC, Maximum exposure, POT, RRR**
- To be used as hurdle rate
  - **E.g. WACC as hurdle rate for IRR, zero for NPV**
- In the probabilistic mind-set, a ***risk-tolerance*** criterion should be added to act as optimization (meta-)constraint:
  - **E.g. "I accept a probability-weighted NPV, if it is <0, of *n* $MM"**
  - **Then any project with a risk > *n* will be rejected.**
- Other constraints:
  - **Manpower, opportunities, HSE, pay-out time**
- Integrated business models attempt to model "constrained KPI optimization process"

Cash Flows

Constructing a project cashflow, sources of information

- Petroleum engineering
  - reserves, nr. wells
  - prod. forecasts electricity-sales
  - development policy
- Drilling engineering (capex)
  - well & completion costs
- Engineering (capex)
  - platforms, pipelines
  - facilities: compression, pumps
- Ops. & Maint. Engineering
  - operating costs (maint., W/O, manpower requirements)
- Human resources
  - Manpower costs (operators, technical staff, support staff)
  - O/H
- Host government
  - Fiscal system (tax rate, royalty rate, royalty in kind, company status: e.g. newcomer, project status: e.g. ring fenced)
  - HSE costs and regulations (abandonment!)
  - Special costs (signature bonus, minimum programme, penalties)
- Corporate Planning
  - Forecast electricity prices
  - Discount rates, hurdle rates
  - Exchange rates
  - Inflation forecast
  - Market factors
  - Political risk, social obligations
  - etc.

Cash-in, cash-out

- **Revenue items (cash-in)**

Production (MWh / yr)
Electricity price ($/MWh)
Electricity sales (MWh)
Tariffs received
Farming out payments
Other
Total revenue

- **Expenditure items (cash-out)**

Capex
Opex:
fixed (assets < 1yr)
fixed (not related to prod)
variable (related to prod)
Govt take:
Royalty
Tax
Other
Total expenditure

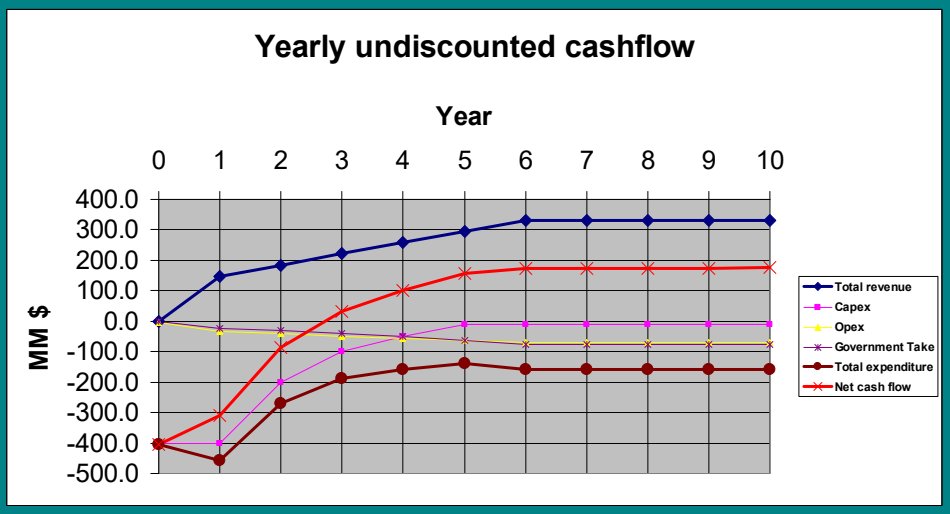
Capex (Capital expenditure)

- *Exploration costs*
  - **Surveys, processing, interpretation**
- *Drilling Costs*
  - **New wells**
  - **Completion**
  - **Hook-up**
- *Engineering costs*
  - **Platforms, surface locations (drainage, dykes, ground prep.)**
  - **Pipelines**
  - **Compression, pumps**
  - **Production stations, Power stations**
  - **Gathering stations, export terminals**
  - **Roads**
  - **Costs for construction of offices, housing**
  - **etc.**

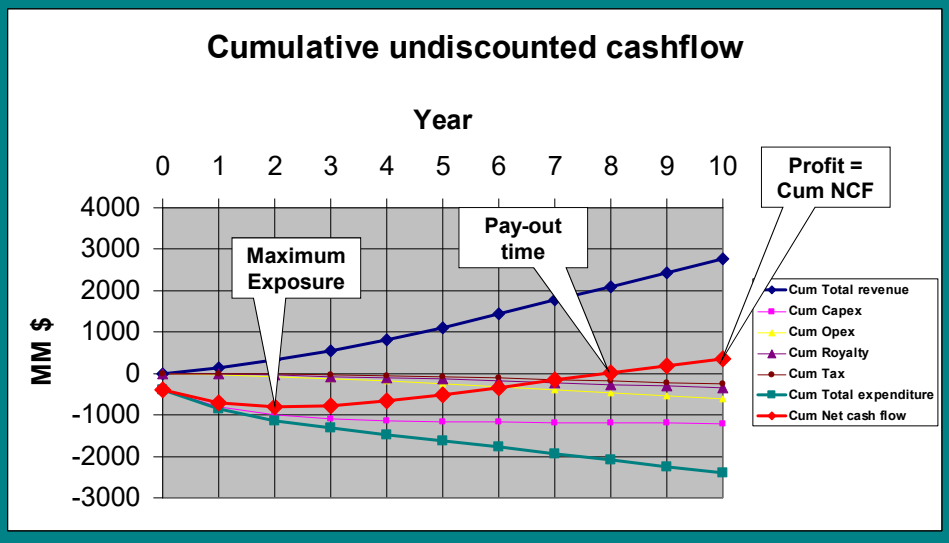
Opex (Operating expenditure)

- *Production Costs* (35%; proportional to production)
  - **lifting, treatment, workovers, injection**
- *Maintenance Costs* (17%; proportional to capex)
  - **inspection, preventative maintenance, remedial maintenance**
- *Evacuation Costs* (23%; proportional to production)
  - **pump fuel and losses, tanker rentals, tariffs, terminal operations**
- *Insurance Premiums* (21%; 0.5 - 4% of capex)
  - **depending on vulnerability**
- *Overheads* (4%)
  - **administration, camp costs, head office overheads**

Cashflow, yearly



Cashflow, cumulative



Fiscal Regimes

Host Government Take (1)

- The contracts that govern the relationship between geothermal companies and governments take several forms. Examples:
  - **Concession Agreement**
  - **Production Sharing Agreement (PSA)**
  - **Technical Service Agreement (TSA)**

Host Government Take (2)

- The revenues accruing to govt under Concession Agreement can take 3 forms:
  - ***Royalties*: % of revenues from hydrocarbons sales to partly indemnify govt (as owner of resource) for removal of depletable asset**
  - ***Taxation*: basis = profit made by company (= revenues - costs, with costs in line with fiscal conditions).**
  - ***Duties and levies* associated with importing equipment or buying equipment or services locally. Import duties and sales tax (Value Added Tax) are examples of this form of Government Take.**

Taxation

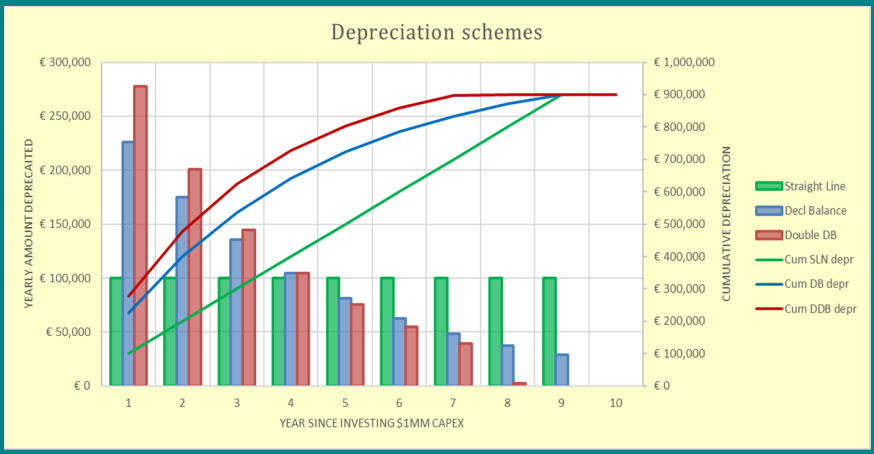
- Taxes calculated on yearly basis, using information from annual report
- Equations:
  - **royalty = royalty rate (%) * e-sales (MWh) * e-price ($/MWh)**
  - **fiscal costs = royalty + opex + capital allowance ($)**
  - **taxable income = revenues - fiscal costs ($)**
  - **tax payable = taxable income ($) * tax rate (%)**
- In concession system: $Tax = taxrate \times (annualrevenues - opex - depreciation - uplift - royalty)$
  - **uplift = to compensate oil companies for deferment of fiscal relief on the capex due to the depreciation mechanism (non-standard)**

Depreciation (capital allowance)

- Depreciation is NOT a cashflow item! It controls to some extent the cashflow as it is used to calculate fiscal income and tax. Four common methods:

1. Straight Line Capital Allowance
   - **capex of one year depreciated by fixed % the following years**
2. Declining Balance Method
   - **total unrecovered capex of one year depreciated by fixed %**
   - **faster depreciation than SLCA**
   - **at end of project life residual in last year accepted in full as allowance**
   - **Also: double declining method, even faster depreciation**
3. Depletion Method
   - **In E&P oil&gas, related to remaining reserves to obtain constant allowance per bbl produced. Usually too complex as ultimate recovery not constant in time**
4. Depreciation "at will"

Depreciation schemes in Indonesia:
DB and DDB



- $1 million CAPEX
- See XL functions DB and DDB
- If DDB rate 2, DDB=DB

1000000	capex
100000	salvage
9	lifetime (yrs)
12	#months in yr1
2.5	rate DDB

DB and DDB formulas

DB: the fixed-declining balance method computes depreciation at a fixed rate. DB uses the following formulas to calculate depreciation for a period:

(cost - total depreciation from prior periods) * rate

where:

rate = 1 - ((salvage / cost) ^ (1 / life)), rounded to three decimal places

Depreciation for the first and last periods is a special case. For the first period, DB uses this formula:

cost * rate * month / 12

For the last period, DB uses this formula:

((cost - total depreciation from prior periods) * rate * (12 - month)) / 12

DDB: double-declining balance method computes depreciation at an accelerated rate.

Production Sharing Agreement (PSA) - 1

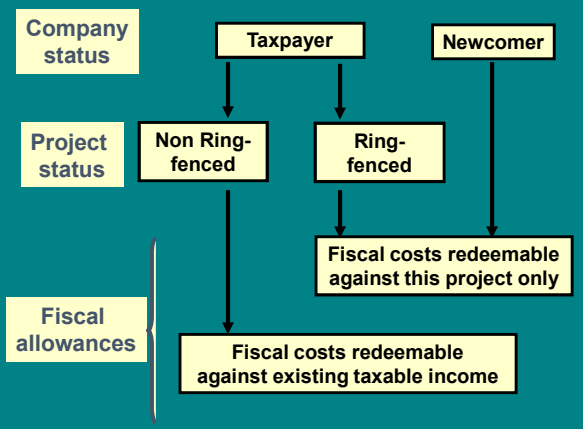
- Ownership of resource remains with the Govt who employs Oil Co as a "contractor" and pays him out of production (PS)
- PSC covers exploration phase of fixed # years: contractor must carry out minimum work programme. This money is entirely at contractor's risk.
- "Premiums" to be paid, e.g. signature bonus, road construction, education, etc. (usually not deductible against any production tax).
- If discovery is commercial, production licence is awarded. Once production, contractor is paid "in kind" (i.e. in oil or gas).
- Payments are split into *Cost Recovery* and *Profit Share*.

Production Sharing Agreement (PSA) - 2

- Allowable (i.e. tax deductible) costs include exploration, development and opex
- Rate of cost recovery is normally constrained by a maximum % of production to be used for cost recovery (e.g. 40 or 50%)
- Exploration & operating costs are usually allowed to be recovered immediately (subject to above production limit)
- Development costs generally are only allowed to be recovered over a fixed time period (say, 5 years)
- Remainder of production, after cost recovery, is called *profit oil*
- Profit oil is shared between the Govt & Oil co.
- E.g. fixed split, (85:15% for Govt: Contractor)
- Other forms exist (e.g. sliding scale with *production tranches* for the profit oil, some countries have up to 8 tranches)

Treatment of company & project (ring-fencing)

- Ring-fencing can have significant impact on project economics! How?
- Often very detrimental to the company and beneficial to the government



Difference Cashflow vs. Net Income

- Net income: also called "Profit" or "Earnings"
- What is difference?
- Cashflow = revenue - expenditure
  = revenue - opex - royalty - tax - capex
- Net income = revenue - opex - royalty - tax - depreciation
  - abandonment provision
- Remember: depreciation and provisions are no CF-items!

Cash Flow XL exercise

NCF spreadsheet: cash-in & cash-out items

Revenue items (MM $)	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Production (Mbbl/d)		20,00	25,00	30,00	35,00	40,00
Oil price ($/bbl)	22,00	22,00	22,00	22,00	22,00	22,00
HC sales	0,00	160,60	200,75	240,90	281,05	321,20
Tariffs received						
Farming out payments						
Other						
Total revenue	0,00	160,60	200,75	240,90	281,05	321,20

Expenditure items (MM $)	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Capex	300,00	200,00	150,00	100,00	50,00	10,00
Opex:						
fixed (assets < 1yr)	0,00	1,00	1,00	1,00	1,00	1,00
fixed (not related to prod)	4,00	4,00	4,00	4,00	4,00	4,00
variable (related to prod)		21,90	27,38	32,85	38,33	43,80
Govt take:						
Royalty		20,08	25,09	30,11	35,13	40,15
Tax		3,82	3,72	6,42	11,93	19,67
Other						
Total expenditure	304,00	250,79	211,19	174,39	140,38	118,62
Net cash flow (MM $)	(304,00)	(90,19)	(10,44)	66,52	140,67	202,58

Discounted Cash Flows

Discounting, why?

- Lending: Time value of money: money today is worth more than money tomorrow. Reasons:
  - **interest (would be accrued)**
  - **risk (something may happen!)**
- External financing: Cost of capital (loans, equity)
  - **Capital Asset Pricing Model, this includes systemic risk**
  - **Some companies also discount for project risk**
  - **And some for opportunity cost of capital**

Economists apply discount factor smaller than 1 to deferred receipts or payments. Analogous to the perspective concept in drawing and painting: objects further away look smaller and less significant.

Discounting: summing time-series

- If money today is worth more than money tomorrow, then time-steps of a time-series (cash-flows) cannot be simply added
  - Apples & pears!
  - Cashflows in different years have to be expressed in same quantity to allow summation
  - All money to be converted to a reference year
    - Usually, the first year of a project (start of investment schedule)
  - Conversion factor is discount factor, calculated from discount rate

Discounting, how? (1)

- Assume discount rate to be constant in time
- Set discount rate either at
  - **Cost of capital for company + risk component for project (not recommended)**
  - **WACC = Cost of capital (usually recommended)**
    - **Use CAPM to determine WACC = Weighted Avg Cost of Capital**

- The basic concept is to translate all future amounts of money onto either receipts or payments of money today, called Present Value (PV). These PV's should grow to the future amount over the given time period when put on a savings account with the desired discount rate as interest:

$$future\ amount = present\ value \times (1 + discount\ rate)^{time\ period}$$
$$present\ value = future\ amount \,/\, (1 + discount\ rate)^{time\ period}$$

Discounting, how? (2)

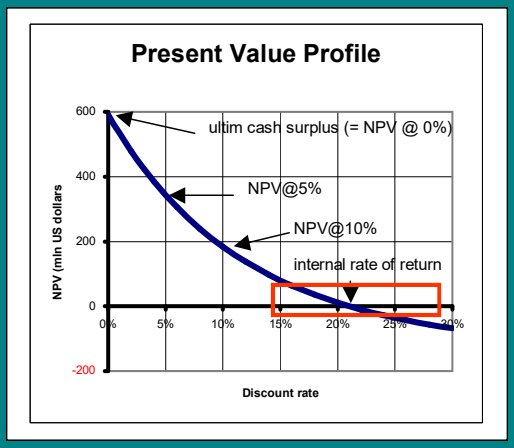
- **If an entire cashflow, being a series of successive payments or receipts, is to be discounted, the PV of the cashflow amounts to the sum of the PV's of the individual elements of the cashflow from the reference date, the date of the decision to be taken (i = 0) until abandonment (i = n). As this PV normally refers to the cashflow "net of tax", it is commonly referred to as the Net Present Value, NPV:**

$$NPV\ (Cashflow) = \sum_{i=0}^{i=n} Cashflow\ (i) / (1 + discount\ rate)^{i}$$

- **This implies that NPV only has meaning only when the Reference Date and the Discount Rate are known.**

Discount rates affect project economics

- NPV decreases significantly with higher discount rates
- By definition, NPV=0 at DiscRate=IRR
  - or: IRR = dr @ which NPV=0
- NPV<0 if DiscRate>IRR

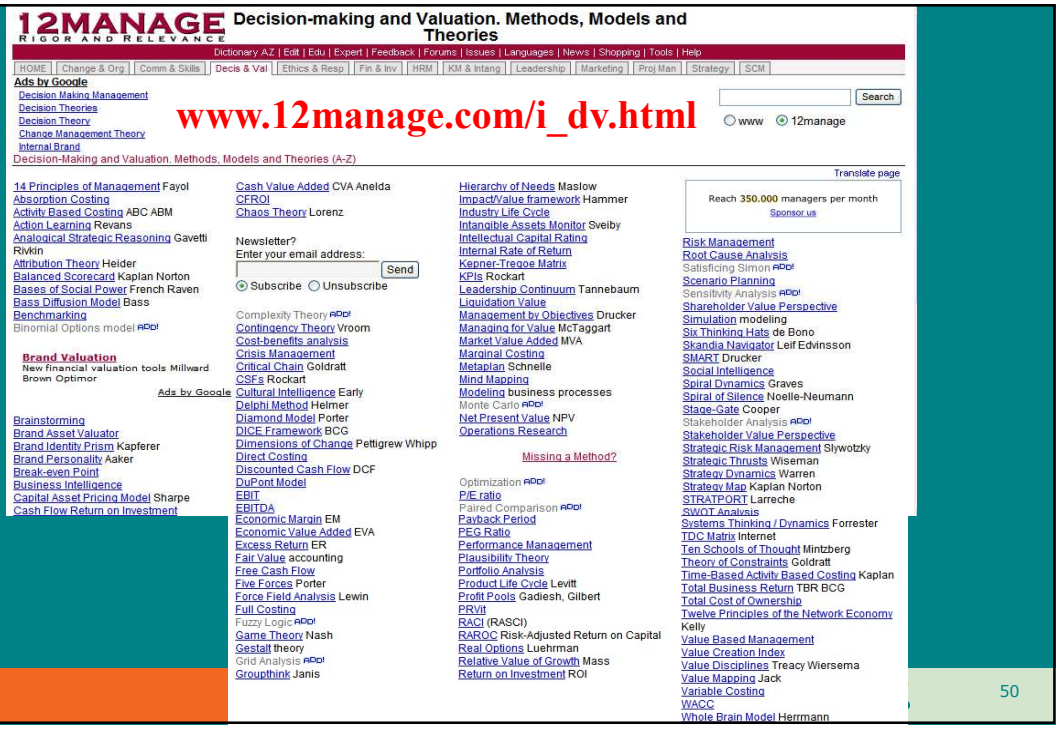


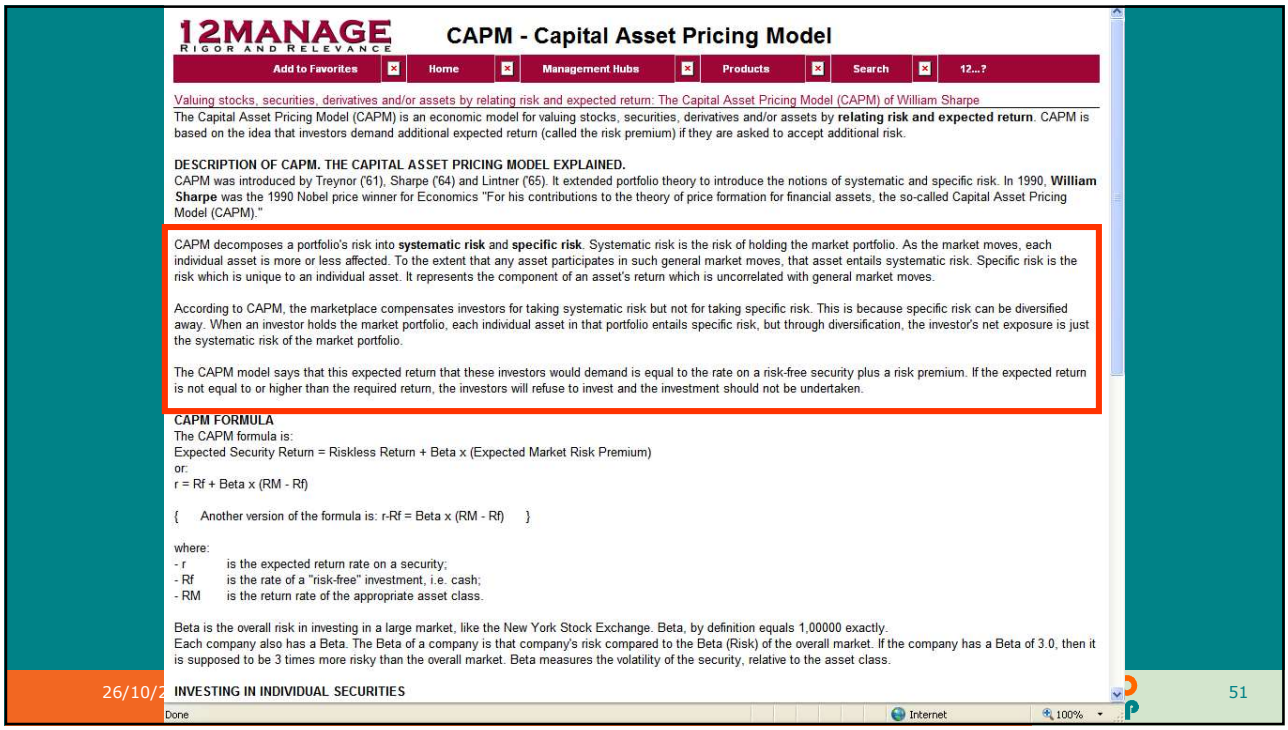
What is difference discount rate vs. discount factor?

DCF XL exercise

Capital Asset Pricing Model

- decomposing systematic risk / specific risk
- determining Weighted Average Cost of Capital
- relation to discount rate





12MANAGE
RIGOR AND RELEVANCE

CAPM - Capital Asset Pricing Model

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Valuing stocks, securities, derivatives and/or assets by relating risk and expected return: The Capital Asset Pricing Model (CAPM) of William Sharpe

The Capital Asset Pricing Model (CAPM) is an economic model for valuing stocks, securities, derivatives and/or assets by **relating risk and expected return**. CAPM is based on the idea that investors demand additional expected return (called the risk premium) if they are asked to accept additional risk.

DESCRIPTION OF CAPM. THE CAPITAL ASSET PRICING MODEL EXPLAINED.

CAPM was introduced by Treynor ('61), Sharpe ('64) and Lintner ('65). It extended portfolio theory to introduce the notions of systematic and specific risk. In 1990, **William Sharpe** was the 1990 Nobel price winner for Economics "For his contributions to the theory of price formation for financial assets, the so-called Capital Asset Pricing Model (CAPM)."

CAPM decomposes a portfolio's risk into **systematic risk** and **specific risk**. Systematic risk is the risk of holding the market portfolio. As the market moves, each individual asset is more or less affected. To the extent that any asset participates in such general market moves, that asset entails systematic risk. Specific risk is the risk which is unique to an individual asset. It represents the component of an asset's return which is uncorrelated with general market moves.

According to CAPM, the marketplace compensates investors for taking systematic risk but not for taking specific risk. This is because specific risk can be diversified away. When an investor holds the market portfolio, each individual asset in that portfolio entails specific risk, but through diversification, the investor's net exposure is just the systematic risk of the market portfolio.

The CAPM model says that this expected return that these investors would demand is equal to the rate on a risk-free security plus a risk premium. If the expected return is not equal to or higher than the required return, the investors will refuse to invest and the investment should not be undertaken.

CAPM FORMULA

The CAPM formula is:
Expected Security Return = Riskless Return + Beta x (Expected Market Risk Premium)
or:
r = Rf + Beta x (RM - Rf)

{ Another version of the formula is: r-Rf = Beta x (RM - Rf) }

where:
- r is the expected return rate on a security;
- Rf is the rate of a "risk-free" investment, i.e. cash;
- RM is the return rate of the appropriate asset class.

Beta is the overall risk in investing in a large market, like the New York Stock Exchange. Beta, by definition equals 1,00000 exactly.
Each company also has a Beta. The Beta of a company is that company's risk compared to the Beta (Risk) of the overall market. If the company has a Beta of 3.0, then it is supposed to be 3 times more risky than the overall market. Beta measures the volatility of the security, relative to the asset class.

INVESTING IN INDIVIDUAL SECURITIES

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Decomposing risk into systematic risk and specific risk

- Systematic risk
  - Other name: exogenous risk
  - As the market moves, each individual asset is affected in ± the same way.
  - Systematic risk features in WACC
  - Example systematic risk factor: CO_2 price, Δcapex (market), political risk, country risk
- Specific risk
  - Other name: endogenous risk
  - Component of risk that is not affected by market moves and that is specific to the project.
  - Markets assume that specific risk can be diversified away by the portfolio of the company
    - Therefore, specific risk is not part of the WACC !
  - Example specific risk factor: HIIP, technical reserves, Δcapex (due to scope changes)

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Why decomposing risk?

- Different valuation
  - WACC only reflects systematic risk, not project-specific risk
  - Markets perceive the two types of risk differently
- Systematic risk
  - Valuation of this risk implied when using WACC as discount rate
  - Valuation of Managerial flexibility options to address systematic ("exogenous") info being revealed in time: Real Option Valuation
- Specific risk
  - Markets assume the company can diversify this away in its portfolio of projects: not to be implied in discount rate to assess individual projects
  - Rather, specific risk to be assessed explicitly, using Decision Tree Analysis (DTA, static & dynamic decision options) and probabilistic methods

Consequence of CAPM

- Investing in individual stocks is useless, because one can duplicate the risk and reward characteristics of any security by using the right mix of cash with the appropriate asset class.
- Diehard followers of CAPM avoid securities and instead build portfolios merely out of low-cost index funds.

CAPM assumptions

ASSUMPTIONS OF THE CAPITAL ASSET PRICING MODEL
Note! The Capital Asset Pricing Model is a ceteris paribus model. It is only valid within a special set of assumptions. These are:

- Investors are risk averse individuals who maximize the expected utility of their end of period wealth. Implication: The model is a one period model.
- Investors have homogenous expectations (beliefs) about asset returns. Implication: all investors perceive identical opportunity sets. This is, everyone have the same information at the same time.
- Asset returns are distributed by the normal distribution.
- There exists a risk free asset and investors may borrow or lend unlimited amounts of this asset at a constant rate: the risk free rate.
- There is a definite number of assets and their quantities are fixed within the one period world.
- All assets are perfectly divisible and priced in a perfectly competitive marked. Implication: e.g. human capital is non-existing (it is not divisible and it can't be owned as an asset).
- Asset markets are frictionless and information is costless and simultaneously available to all investors. Implication: the borrowing rate equals the lending rate.
- There are no market imperfections such as taxes, regulations, or restrictions on short selling.

The assumptions mentioned above are normally not all valid and met. However, CAPM anyway remains one of the most used investments models to determine risk and return.

Book: William F. Sharpe - Portfolio Theory and Capital Markets - Search at Amazon
Book: Harry M. Markowitz - Mean-Variance Analysis in Portfolio Choice and Capital Markets - Search at Amazon
Book: Mary Jackson - Advanced modelling in finance using Excel and VBA - Search at Amazon

Cost of Capital (1)

- A company initially obtains its capital from 2 sources, each with different costs of capital
  - **from issuing equity shares to stockholders**
  - **from the bank as loans**
- The cost of capital (coc) of the company is the weighted sum of the coc of both sources and is referred to as WACC (Weighted Average Cost of Capital):

$$WACC = gearing\,ratio \times coc(loans) + (1 - gearing\,ratio) \times coc(equity)$$

  - **Gearing ratio represents the outstanding long-term loans of the company as a fraction of its total assets.**
  - **Cost of loans is basically the interest rate of the bank, corrected for any tax rebate on interest payments:**

$$coc\ (loans\ ) = Interest\ \times (1 - tax\ rate\ )$$

Cost of Capital (2)

- WACC (Weighted Average Cost of Capital):

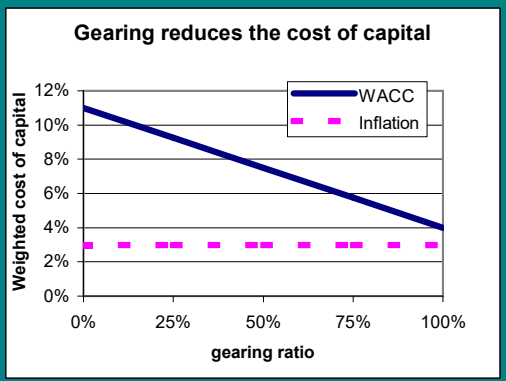
$$WACC = gearing\,ratio \times coc(loans) + (1 - gearing\,ratio) \times coc(equity)$$

- **Cost of equity is** $coc\,(equity\ ) = risk\ \ free\ rate\ + beta\ \times average\ \ equity\ \ risk\ \ premium$

- ***beta*** **is ratio of the volatilities of the stocks in a certain sector divided by the average volatility of stocks.**
  - **For the oil sector on the New York Stock Exchange (NYSE) beta is about 75% (average).**
- **The "average equity risk premium" is some 8%**
- **The "risk free rate" is some 2% above inflation.**
  - **With inflation at 3% this results in a coc(equity) of some 11%, or 8% above inflation.**

WACC

- The interest on loans depends on the financial strength of the borrower
  - **For larger companies some 3% above inflation, i.e. 6% nominal.**
  - **Correction for the tax rebate results in a coc(loans) of 4%.**
- Calculate WACC for oil co's: depends on gearing ratio of companies.

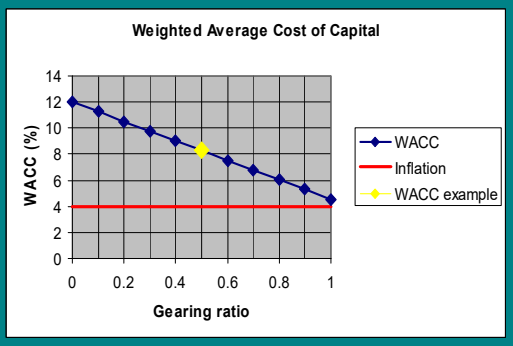


- **Highly geared companies will have lower discount rate than companies with little or no long-term loans.**
- **One of reasons why companies use different discount rates as investment criteria.**

WACC example (very large company)

Gearing ratio	
Outstanding LT loans (MM $)	5000
Assets (MM $)	10000
Gearing ratio	0.50
CoC(loans)	
inflation	4.0
size of company XS-S-M-L-XL-XXL	XXL
interest rate bank (%)	7.00
tax rate (%)	35.00
CoC(loans)	4.55
CoC(equity)	
risk-free rate	6.0
beta (%)	75
avg equity risk premium (%)	8.0
CoC(equity)	12.0
WACC example	8.3

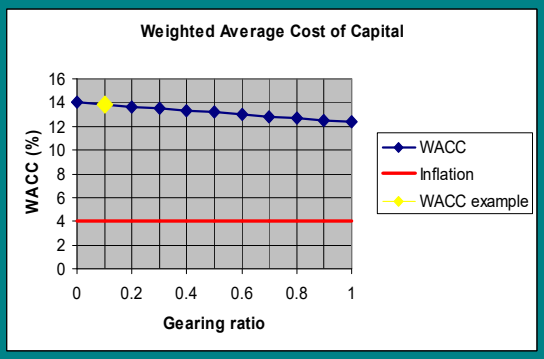
- LT debt, assets from Annual Report
- Discount factor = WACC + risk component for project



WACC example

Gearing ratio	
Outstanding LT loans (MM $)	17.512
Assets (MM $)	174.062
Gearing ratio	0.10
CoC(loans)	
inflation	4.0
size of company XS-S-M-L-XL-XXL	XS
interest rate bank (%)	19.00
tax rate (%)	35.00
CoC(loans)	12.35
CoC(equity)	
risk-free rate	6.0
beta (%)	100
avg equity risk premium (%)	8.0
CoC(equity)	14.0
WACC example	13.8

- LT debt, assets from Annual Report of a company that is not stock listed, no β: CAPM does not apply!



Project discount rate example, small vs. large company (same project)

Small co. IRR project hurdle rate (*hurdle rate = optimization constraint*)	Large co. IRR project hurdle rate
• IRR= WACC + risk comp.	• IRR= 8.3 + risk component

• IRR= 13.8 + risk component
• Risk component depends on individual project *and* portfolio / corporate considerations:
  • **Cum. prob. of KPI < threshold x avg. KPI < thr. (Risk < risk tolerance)**
  • **Potential impact on portfolio, e.g. max. exposure of project**
	• Risk component depends on individual project *and* portfolio considerations:
	  • **Project risk : smaller than small co. (DR is smaller**
	  • **Max. exposure of project has much lower potential impact on company's total portfolio (perhaps negligible)**

• IRR hurdle = 13.8 + say 11.2 = 25%	• IRR hurdle = 8.3 + say 4.2 = 12.5%

Project discount rate example, large, self-financing company

- If in a large capital-constrained company with plenty opportunities the capital is NOT raised from equity or loans, a more appropriate discount rate would be the rate of return of alternative investment opportunities
  - **Alternative opportunity is foregone by undertaking the proposed project**
- "Opportunity cost of capital"
- In such cases, this may be more appropriate than WACC
- Simply recovering the cost of capital is not sufficient for the long-term survival of the company

Project performance / decision indicators (metrics)

- NPV - Net Present Value (or PVCS: PV Cumulative Cash Surplus)
- IRR - Internal Rate of Return (or "Earning Power"): the discount factor at which the NPV of project = 0
- ME - Maximum Exposure: deepest cashflow sink
- VIR (VIR discounted) - Discounted Value (Profit) to Investment Ratio: PV Cash Surplus / PV Capex = NPV / PV Capex
- UTC - Unit Technical Cost @ % (PV cost / PV MWh): discounted Cumulative Expenditure / discounted cumulative production
- BEP - Break even oil price: the oil price at which NPV=0 for the given discount factor
- Pay-out time - the number of years at which PVCS=0 and starts becoming >0.

- *Note: value optimisation = selecting the decision alternative that maximizes one KPI under the constraint(s) of some other KPI's hurdle rates. Theoretically, also weighted multi-criteria can be optimized.*

Company performance indicators

- ROCE - Return On Capital Employed
  - *Earnings / (depreciated investments + equity + debt)*
- ROACE - Return On Average Capital Employed
  - *Using averages over rolling time window*
- EPS - Earnings Per Share
  - *Profit / # shares (Profit = revenue - opex - royalty - tax - depreciation - provisions)*
- EBITDA - Earnings Before Interest, Taxes, Depreciation and Amortization
- ROE - Return on Equity
- R/P - Reserves depletion rate (# years)
- PRR - Production Replacement ratio (new discoveries + revisions + acquisitions)

Company metrics (Prudential)

I. Adjusted Production Costs
II. Depreciation, Depletion & Amortization Expenses
III. Production Income
IV. Quality of Earnings
V. Cash Flow
VI. Production Replacement Ratios, excluding acquisitions and divestments
VII. Finding & Development Costs, including acquisitions and divestments
VIII. Discounted Future Net Cash Flow
IX. Upstream Returns

CAPM + WACC exercise