



PPSDM Jakarta, November 2nd, 2017

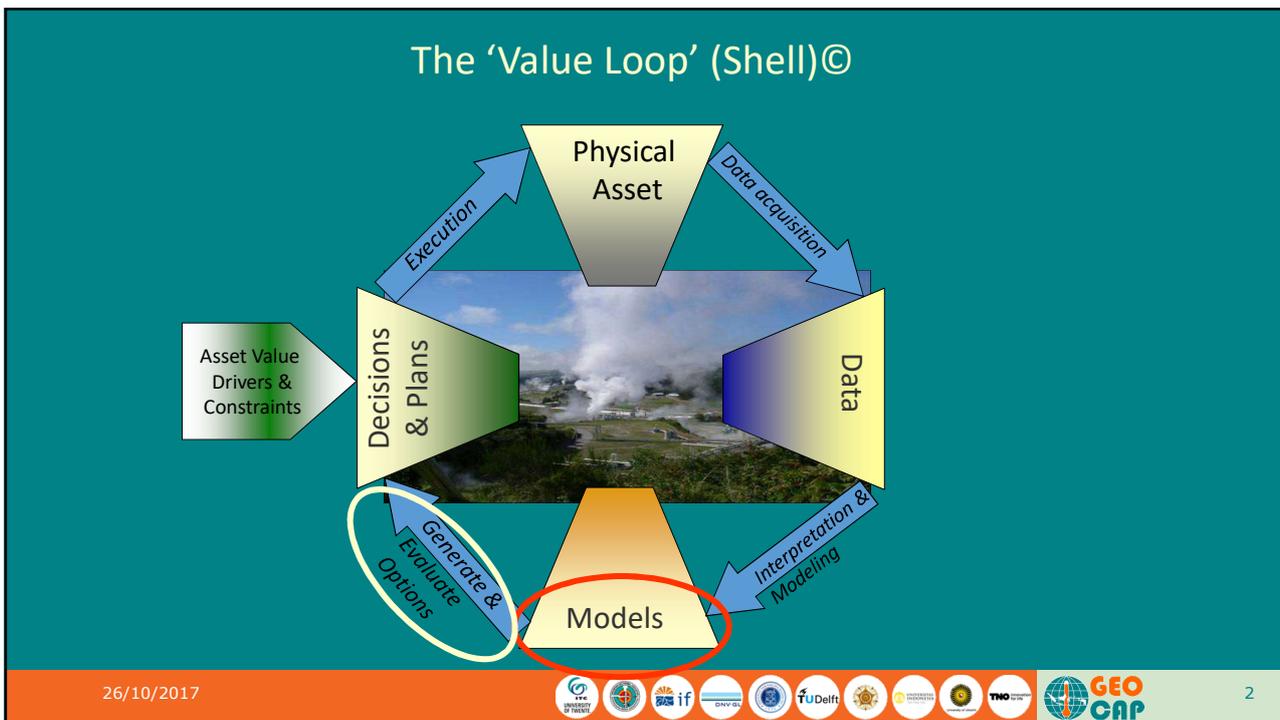
Company decision-making for geothermal projects

(GEOCAP course 1.07)

Topic: Dynamic options, real options

Lecturer - Ir. Christian Bos

Public document (GEOCAP-2016-REP-TNO-1.07-xx)



Common flaws of traditional DCF analysis

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Characteristics of the Investment Decision

- Future cash flows are Uncertain.
- Investment cost is mostly Irreversible.
- There is usually some degree of Managerial Flexibility as to the timing and operation of the project.

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DCF Assumptions

- The project is a “now or never” opportunity
- Once the project is undertaken, it will not be affected by any future managerial decision.
- Expected future cash flows are taken as “given” – they are assumed to be certain to happen
- Project has no synergies with other projects the firm may have
- Project risk does not change throughout its life

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Traditional DCF Analysis

- Ignores the option value of investing
- Ignores project uncertainties
- Ignores the value of managerial flexibility
- Generally underestimates the value of projects that have real options
- Can lead to suboptimal capital budgeting decisions

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Dynamic decision tree options

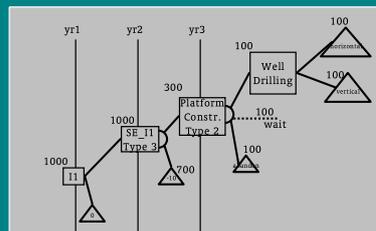
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Dynamic options modelling using automatic "triggers" in time-series

- A "Trigger" could be e.g. the oil price expectation after time-step n until end of project
- Triggers can be combined using Boolean operators, e.g.



sample	option	year 1	year 2	year 3	year 4	year 5	year 6	year 7	year 8	year 9	NPV
1	continue	500									
2	continue	continue	abandon	continue	-10						
3	continue	300									
4	continue	continue	continue	special	800						
5	continue	continue	continue	wait	wait	continue	continue	continue	continue	continue	300
6	continue	continue	continue	abandon	continue	continue	continue	continue	continue	continue	100
7	continue	wait	wait	wait	200						
8	continue	wait	wait	wait	100						
9	continue	200									
10	continue	continue	continue	continue	continue	abandon	continue	continue	continue	continue	30
											252

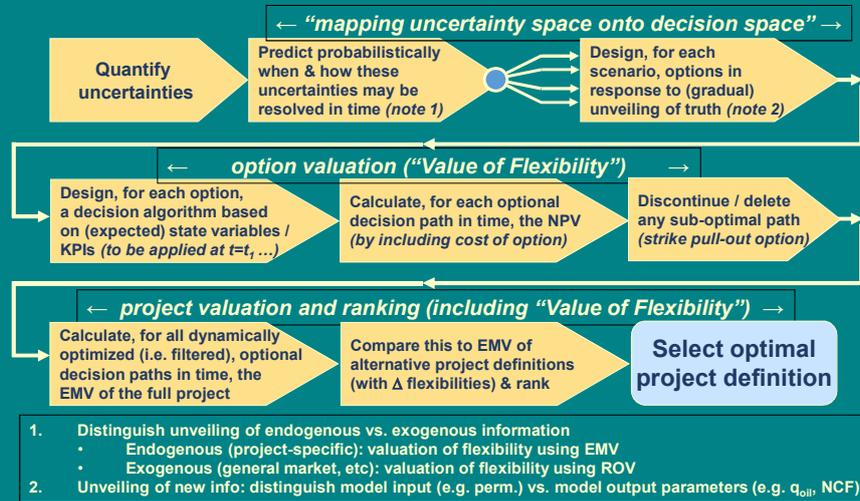
Close-in field **IF**
 $E_{(fut. MWhe price)} < 60$
OR
 $CF_{n, n+5} < 0$
AND
 $Prod_{n, n+5} < 10MW_e$

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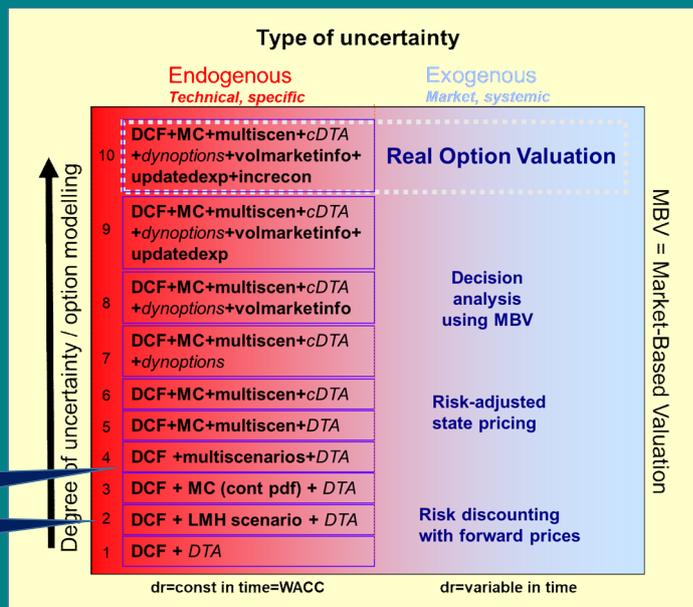
Problem framing: designing and evaluating options in dynamic decision trees



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Taxonomy of methods for the valuation of uncertain future cash flows:

- Constant vs. variable discount rates
- Price volatility can / cannot be modelled
- Focus on endogenous / exogenous uncertainties

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Real options

A method derived from financial option pricing theory to assign a value to flexibility options in response to *new market information* being revealed in time.

Prerequisite: market-price volatility must exist and must be 'modellable'.

→ Not applicable to GTE in Indonesia

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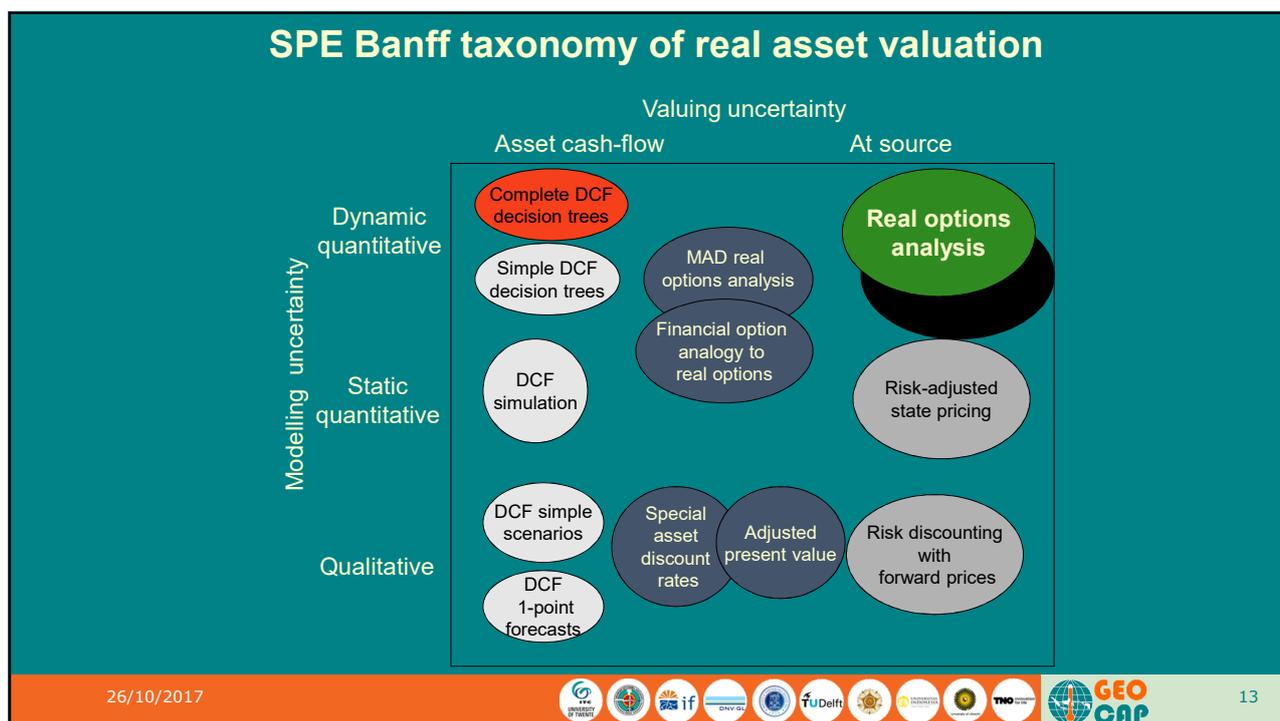
ROV uses variable discount rates

- Risk of project reduces as project proceeds in time
- Discount rate represents market or systemic risk
- Q: shouldn't then discount rate be reduced as project proceeds?
- Real options valuation uses variable discounting over time

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What is a Real Option?

- A RO situation is when one has managerial flexibility to respond to **exogenous** information being revealed in time.
 - Exogenous – not project-specific. Example: oil price, casing price, rig rate, etc.
 - Exogenous information cannot be actively acquired! One can only sit and wait until the information comes toward you.
 - Generic knowledge on this exogenous information may however exist, e.g. pdf's, volatility, etc.
 - Endogenous – project-specific

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What are real options?

An option is the right but not the obligation to take an action (at a cost, called the exercise price) for a predetermined period of time (called the maturity of the option). Options capture the element of flexibility in decision-making

Financial option
The option is contingent on the uncertain value of a financial security e.g. a CBOE call

Real option
The option is contingent on the uncertain value of a real asset e.g. an irreversible investment

Source: Adapted from Myers [1977] © Alexander Van de Putte, PhD

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Types of uncertainty in economic literature

According to Dixit and Pindyck [1994] there are two types of uncertainty: economic and technical uncertainty*

Two types of uncertainty

Economic uncertainty

- Depends on factors exogenous to the project (e.g. market prices and the volatility of sales).
- Correlated with the general movements of the economy.
- Can influence managers to postpone the implementation of a project.

Technical uncertainty

- Depends on factors endogenous to the project (e.g. the quantity of copper contained in a copper mine).
- Not correlated with the general movements of the economy.
- Can influence managers to anticipate the start of a project in order to collect additional information.
- Can only be resolved by actually undertaking and completing the project.

* Note that economic uncertainty is sometimes called future uncertainty, while technical uncertainty is often called present uncertainty. © Alexander Van de Putte, PhD

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Optimal valuation metric selection

- The selection of the most appropriate valuation metric will largely depend on the type (technical versus economic) and degree of uncertainty.

Types of uncertainty

Economic uncertainty

- Depends on factors exogenous to the project (e.g. the volatility of the oil price).
- Correlated with the general movements of the economy.
- Can influence managers to postpone the implementation of a project.

Technical uncertainty

- Depends on factors endogenous to the project (e.g. the quantity of oil contained in an oil field).
- Can influence managers to anticipate the start of a project in order to collect additional information.
- Can only be resolved by actually undertaking and completing the project.

		Degree of technical uncertainty	
		Low	High
Degree of economic uncertainty	High	Real Option Valuation (RO) 2	Combination of RO and DTA 4
	Low	Discounted Cash Flow (DCF) Analysis 1	Decision Tree Analysis (DTA) 3

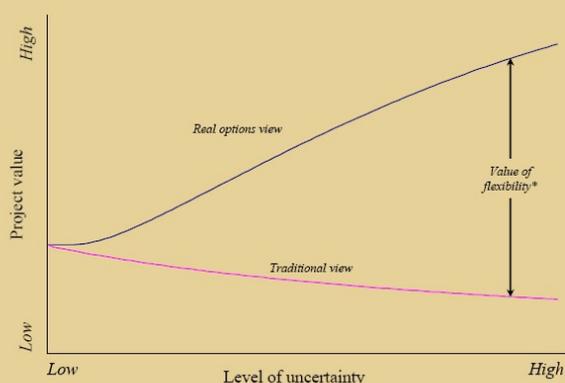
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Uncertainty leads to higher project value in real option situations



Source: Adapted from Amram and Kulatilaka [1999]; calculated using DCF method for the traditional view and Black & Scholes model for the real options view.
* assuming that management has the flexibility to address the uncertainty

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What is Real Option Valuation?

- An approach to valuation that relies on option pricing theory to assign a value to project flexibility.
 - Black & Scholes model (Nobel prize laureates)
- Real Options values the managerial flexibility embedded in many projects and which is disregarded by traditional DCF methods.
 - Only the managerial flexibility to respond to exogenous (systematic) information being revealed in time (e.g. if MWh_e market price is volatile)
 - Not applicable to project-specific (technical) info! Then use DTA (static / dynamic DT options)
- Real options approach is intended to supplement, not replace, capital budgeting analyses based on DCF methodologies.

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An option is a right, not an obligation, to take future action

- Call option is a right
 - to buy share on the stock market later for price agreed earlier
- Put option is a right
 - to sell share on the stock market later for price agreed earlier
- Waiting to invest option:
 - Wait with investment until market is ready for the product
- Growth option:
 - Early entry allows benefiting from follow-up projects
- Flexibility option:
 - Flexibility allows quick adaptation to future changes
- Exit option:
 - right to abort a project if is disappointing
- Learning option:
 - trying out the market on small scale with right to expand later

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Oldest(?) application of Options (quoted by Aristoteles)

- Thales the Melesian bought the right (not obligation!) to rent, in 6 months time, olive presses at the usual rate from their owners (call option)
 - Thales foresaw a good olive harvest
 - When it came presses were in high demand
 - Thales let the farmers use his presses at a high rate
 - He paid the press owner the agreed rate and made a profit
 - With a poor harvest he would only have lost the (modest) price of the option
- Alternatively the press owner could have bought the right (not the obligation!) to rent Thales his presses at the usual rate (put option) in 6 month time
 - If he foresaw a disappointing harvest with lesser than usual rates
 - He would not exercise the option if the harvest was good

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Financial Options jargon

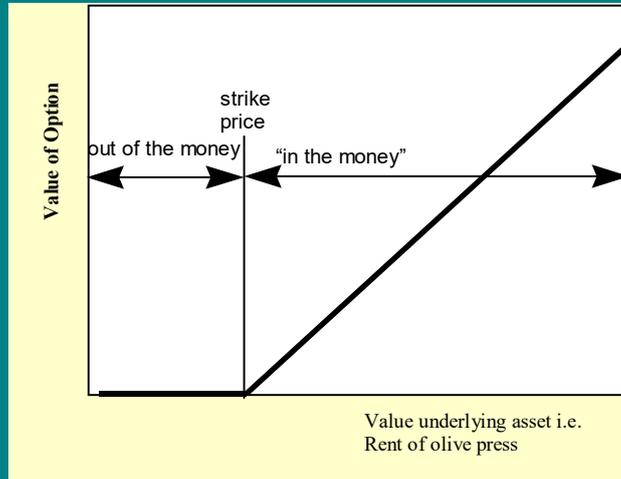
- exercise price or strike price
 - the pre agreed price (Thales' rental fee)
- maturity date
 - date when the option can be exercised

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Thales' profit versus the rental price

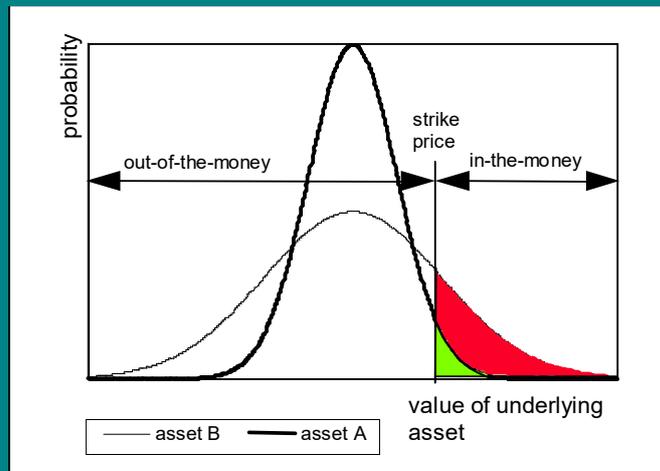


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Effect of uncertainty of the value of a call option



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Key Issues

- Modeling Project Flexibility to respond to exogenous (market) information being revealed in time
 - What options are associated with a project?
 - How can we model these options?

- Valuing Risky Cash Flows
 - What are the uncertain cash flows worth?
 - How should we forecast cash flows?
 - What discount rate should we use?

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Summary

- Most of the Real Options literature deals with mathematically challenging continuous time models.

- A Decision Analysis approach that combines the use of decision trees with risk neutral probabilities is more intuitive for practitioners and may provide a practical alternative to traditional Real Option valuation.

- This method can be readily applied using commercially available off the shelf software.

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