THE OXFORD INSTITUTE FOR ENERGY STUDIES

A RECOGNIZED INDEPENDENT CENTRE OF THE UNIVERSITY OF OXFORD

UNIVERSITY OF OXFORD

Calculating a Discounted Cashflow (7)

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The Economics of Energy Corporations (2)

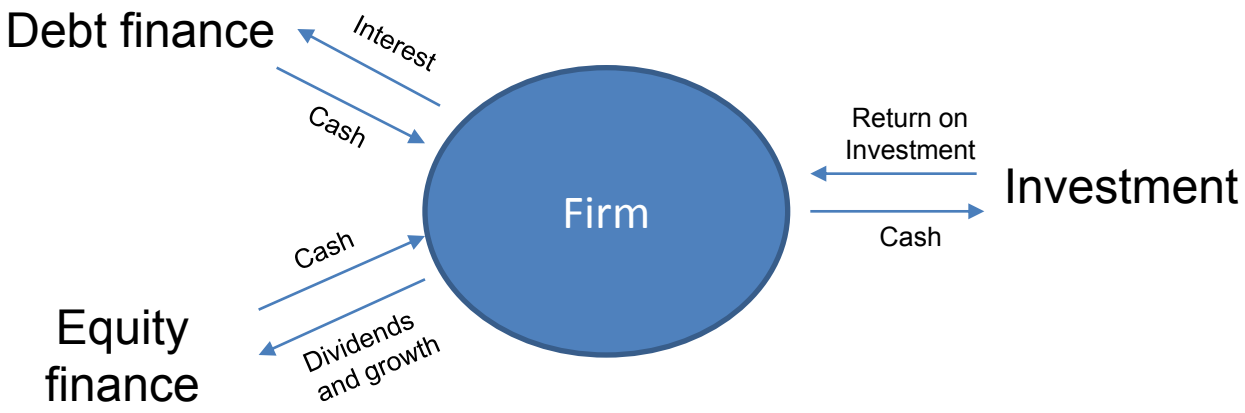
Outline of the course

Overall objective – understand how senior management use economic models to make investment decisions

1. Introduction to key themes in the global energy market
2. Introduction to financial modelling as a management tool
    1. Understanding some key concepts
3. Starting two models for an oil and a gas field – revenues and prices
4. Inputting the costs – capital expenditure
5. Operating costs and paying the government
6. A power plant – a buyer and seller of energy
7. **Calculating a discounted cashflow**
    1. **Why is it important**
    2. **How is it used to make decisions**
8. Testing the investment decisions: running some numbers under different assumptions
9. Answering your questions

The Discount Rate

- A firm is like a pool of cash that has been financed from two sources – debt from banks and equity capital from shareholders
- Both sources of financing demand a return for providing cash
- Companies therefore need to at least recuperate their Weighted Average Cost of Capital from each investment they make



Weighted Average Cost of Capital

- **WACC = [E/V * Re] + [D/V * Rd * (1-Tc)]**

- E = firm's equity, D = firm's debt, V = total value of firm's financing (V = E+D)

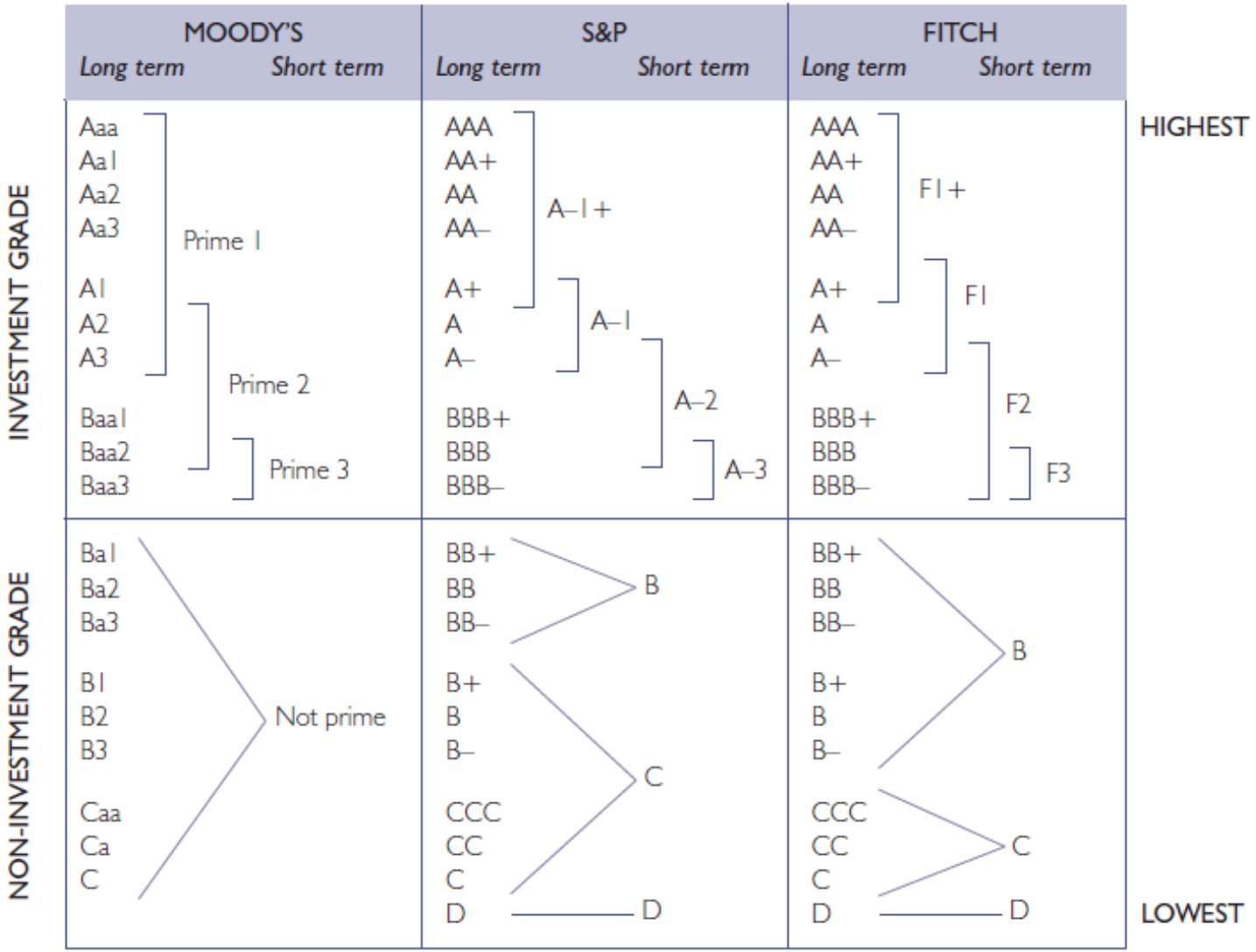
- Re = cost of equity, Rd = cost of debt

- Tc = corporate tax rate (firms can claim cost of interest against tax)

Cost of Debt

- How much does it cost to borrow money?
- Government borrowing rate (LIBOR)
  - US$ 1.75%
  - UK£ 0.70%
- Corporate borrowing rate (LIBOR + X%)
  - Depends on loan amount and credit worthiness of borrower
  - Ratings agencies provide assessments used by lenders
- Corporate bond rate (latest Eurobond offering)
  - Gazprom 2017 Eurobond – 4.25%
  - BP 2017 US$ bond – 2.24%
- Interest payments are allowable for tax
  - Cost of debt = Interest rate x (1-tax rate)

Credit ratings impact the cost of debt, as well as investor preceptions



Source: The Association of Corporate Treasurers

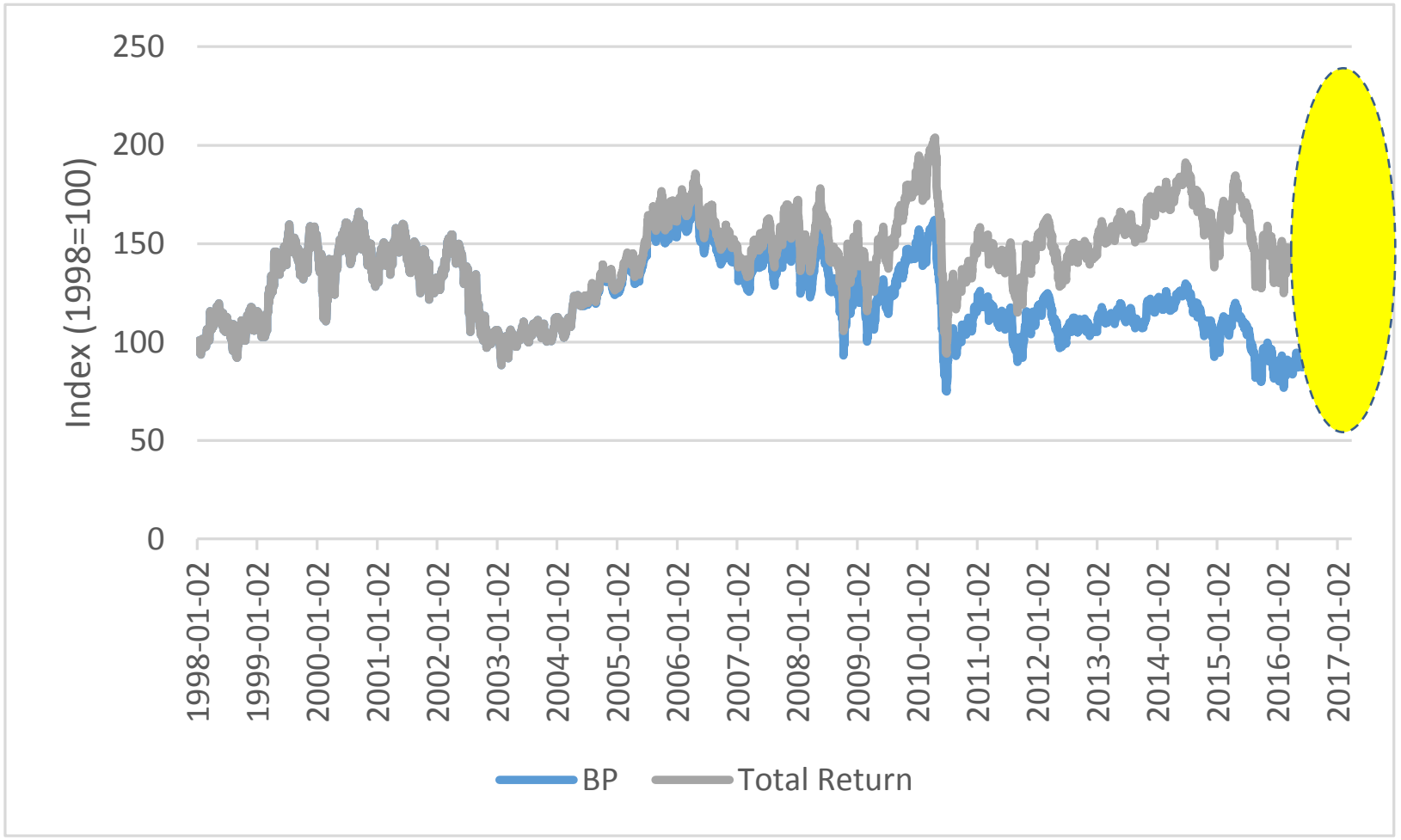
Cost of Equity

- What constitutes a return for a shareholder?
  - Dividends
  - Capital Growth
  - Total Shareholder Return

- Average cost of equity
  - The minimum acceptable return – the risk free rate
  - The premium for investing in the equity market (the return on the equity market compared to the risk free rate)
  - The specific premium for each company (the Beta) – how different is it to the market
    - Beta value is a measure of specific risk for a company – 1 is the market average
    - BP – 0.99; ExxonMobil - 0.84
    - Sound Energy – 2.83; Chesapeake – 2.68

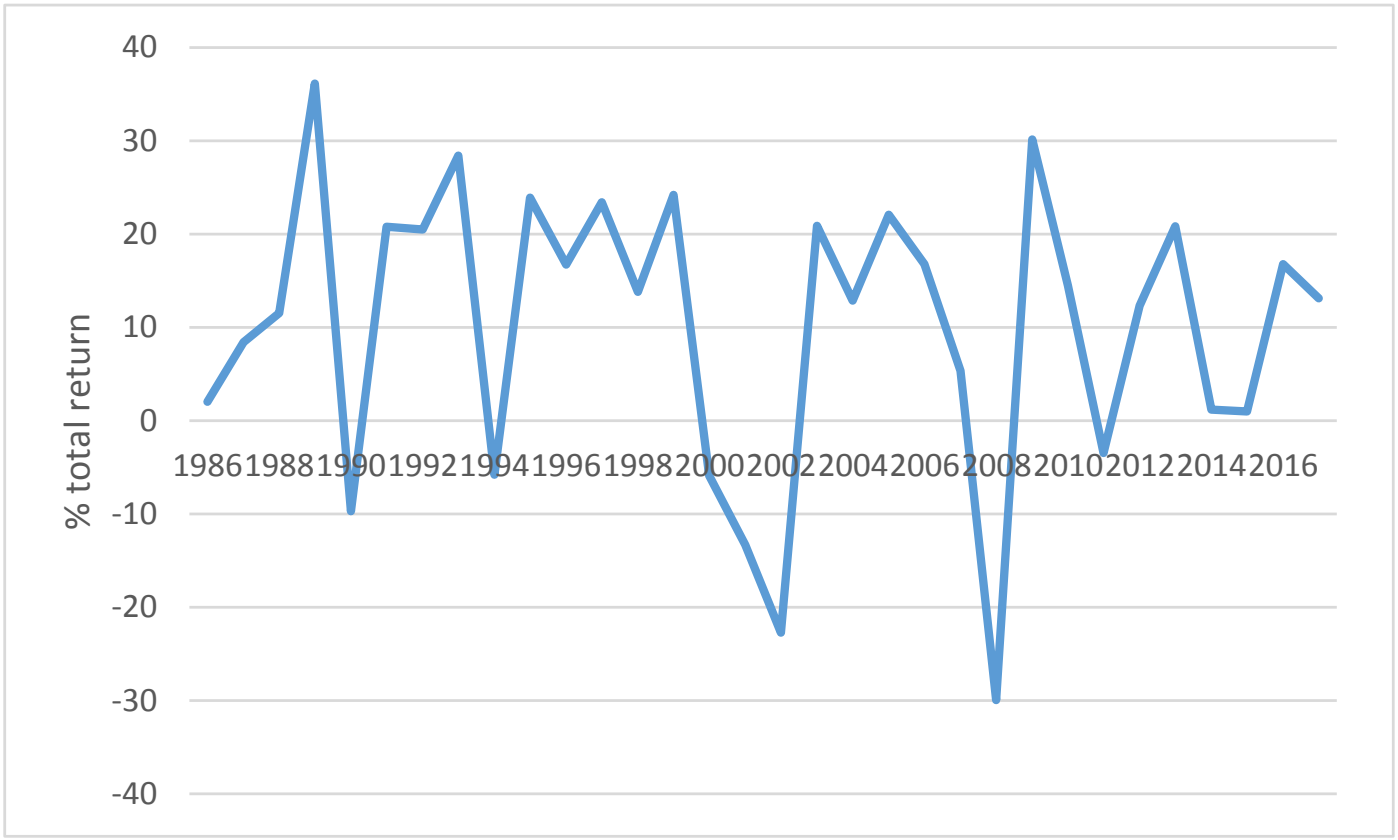
- Risk free rate (LIBOR) + (Beta for a specific company * the equity market premium)

Total return to shareholders



- Almost no gain in share price terms over almost 20 years
- Shareholders doubled their money when dividends and other incentives are included

Total return on FTSE World Index



- Average return over 10 years = 6.86%
- Average return over 5 years = 9.85%
- Average return over 1 year = 12.0%
- Average return over 20 years = 10.53%

The DCF Calculation as a foundation – WACC concept

Weighted average cost of capital is corporate "interest rate"

2.

$$WACC = \frac{E}{D+E}(r_e) + \frac{D}{D+E}(r_d)(1-t)$$

Where:

E = market value of equity

D = market value of debt

r_e = cost of equity

r_d = cost of debt

t = corporate tax rate

WACC is the cost to a company of financing the capital for a project, including debt and equity

Cost of debt = average interest rate for company

Cost of equity is theoretical return to investors in the company

Cost of Equity = Risk free rate + (Beta(Market return – Risk free rate))*

Essentially, how much return would an investor expect relative to putting his money with US Treasury stock, or in the stock market

WACC Calculation

BP

- Debt/Equity – 30:70
- Equity Market return – 10.53%
- Risk free rate – 1.75%
- Cost of Equity
- 1.75 + (0.99 x (10.53 – 1.75)) = 1.75 + 8.69 = 10.44

- Cost of Debt – 2.24% x (1-0.2) = 1.79%

- WACC calculation

  (10.44*0.7)+(1.79*0.3)

  =7.31% + 0.54%

  =7.85%

WACC Calculation

Sound Energy

- Debt/Equity – 50:50
- Equity Market return – 10.53%
- Risk free rate – 1.75%
- Cost of Equity
- 1.75 + (2.83 x (10.53 – 1.75)) = 1.75 + 25.85 = 26.60

- Cost of Debt – 5.75% (LIBOR+4%) x (1-0.2) = 4.60%

- WACC calculation

  (26.60*0.5)+(4.60*0.5)

  =13.3% + 2.3%

  =15.6%

WACC Questions

- Calculate the WACC based on the following assumptions:

- General
  - Risk-free rate – 1.5%
  - Equity market return – 8%
  - Corporate tax rate – 25%

- Specific
  - Company 1: Beta – 0.85, Interest rate on Debt – 3.5%, Share of Equity – 40%
  - Company 2: Beta – 1.75, Interest rate on Debt – 5%, Share of Equity – 30%
  - Company 3: Beta – 3.0, Interest rate on Debt – 7.5%, Share of Equity – 70%

- Double the Beta of Company 1. What happens to the WACC?
  - Do the same for company 3. What happens?

- In general, what is the optimal financing strategy for reducing WACC?
  - Can you think why it may or may not be possible to achieve this?

Terminal Value Calculation (1)

- Two methodologies
  - Perpetual Growth Method
  - Exit Multiple Method

- Perpetual Growth Method
  - TV = [FCFn x (1+g)] / (WACC-g)

  - TV = terminal value
  - G = perpetual growth rate of FCF
  - WACC = Weighted average cost of capital

- Generally used in academia rather than business
  - Need to assume “G”

Terminal Value Calculation (2)

- Exit Multiple Method
  - Preferred by industry as it compares a value of a business or asset with an observation in the market
  - The multiple tends to be the average for the industry or a peer group
  - The EV/EBITDA multiple is the most common

- The Exit Multiple Formula
  - TV=Financial Metric (EBITDA) x Trading Multiple (EV/EBITDA)

- Assume Terminal Value in final year +1, then discount with rest of cashflow model

Terminal Value Calculation (3)

- Looking for multiples

Comparative multiples-based valuations

	P/E			EV/EBITDA		
	2017E	2018E	2019E	2017E	2018E	2019E
Russia and FSU						
Gazprom	4.3	3.6	3.4	3.5	2.8	2.8
Lukoil	8.6	5.9	6.2	4.2	3.3	3.4
Novatek	15.0	14.4	9.8	12.3	10.9	11.0
Gazprom Neft	4.9	3.9	4.3	4.4	3.9	4.4
Surgutneftegaz	7.9	4.0	4.8	neg.	neg.	neg.
Tatneft	10.1	8.3	8.1	6.3	5.3	5.2
Rosneft	13.8	8.0	5.2	7.0	5.7	5.0
Transneft	5.8	6.1	5.5	3.9	3.7	3.4
Bashneft	2.6	4.5	3.9	3.5	3.0	2.7
Emerging markets						
Sinopec	12.6	11.4	10.7	4.6	4.2	3.9
CNOOC	14.5	10.4	10.3	5.1	4.3	4.2
PetroChina	61.5	35.1	30.1	6.7	6.0	5.7
Petrobras	20.7	11.7	8.7	6.1	5.1	4.5
ONGC	12.9	10.0	8.6	7.2	5.0	4.3
Developed markets						
Royal Dutch Shell	17.9	14.8	13.6	8.2	5.7	5.4
BP	22.6	15.5	14.2	6.1	5.3	4.9
Chevron	34.2	17.6	18.0	8.9	6.4	6.0
ConocoPhillips	96.2	23.2	22.1	20.7	6.9	6.4
Eni	25.2	17.4	16.8	4.8	4.0	3.8
ExxonMobil	22.1	16.6	17.6	9.6	7.7	7.8
Statoil	17.7	16.5	15.5	4.0	3.6	3.3
Total	14.0	12.6	12.0	6.4	5.3	5.0

Note: Based on prices as of February 5, 2018. Bloomberg consensus estimates are used for foreign companies and Sberbank CIB Investment Research estimates for Russian and FSU companies.

Source: Bloomberg, Sberbank CIB Investment Research

Average: 4.9 (Oil only)

Average: 5.9

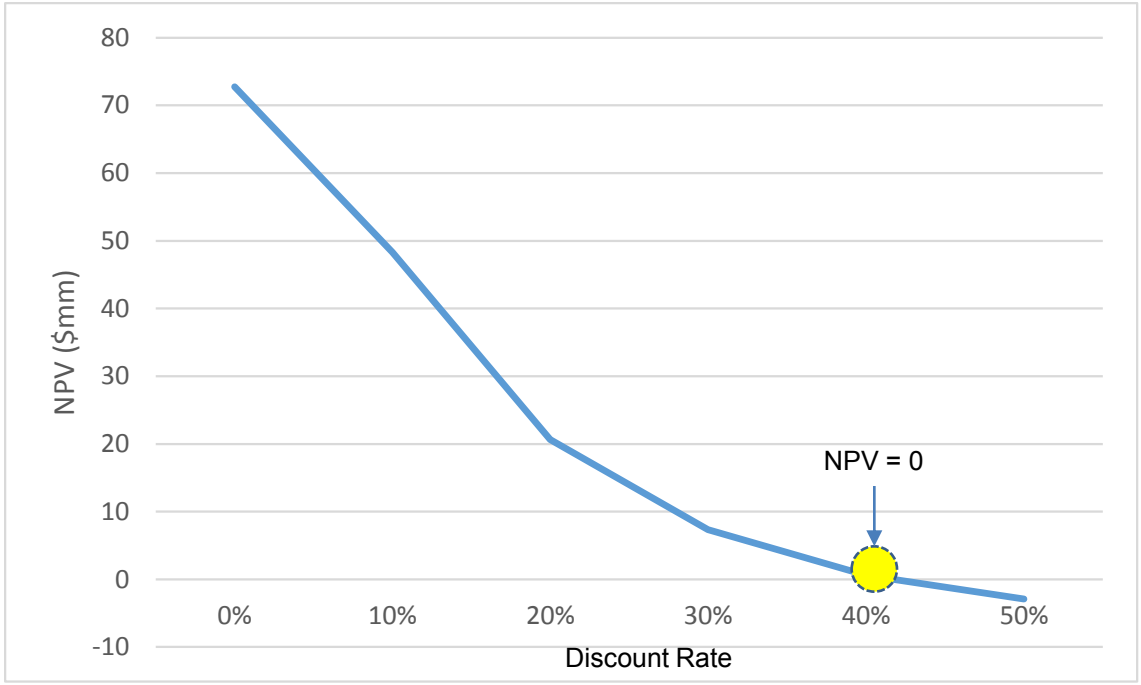
Average: 8.6

Internal Rate of Return

- To calculate a NPV, we have to use a discount rate
- This rate is set by calculating the cost of capital, based on the expected rate of return expected by debt and equity investors
- But how high could this expected rate go before the NPV equals zero?
- This figure tells us the Internal Rate of Return (IRR) of the project
  - When the NPV is zero, it means that all the capital is repaid plus a certain level of return
  - As long as the IRR is higher than our discount rate, then the project will have a positive NPV and as reasonable rate of return

Establishing the IRR of a project cashflow

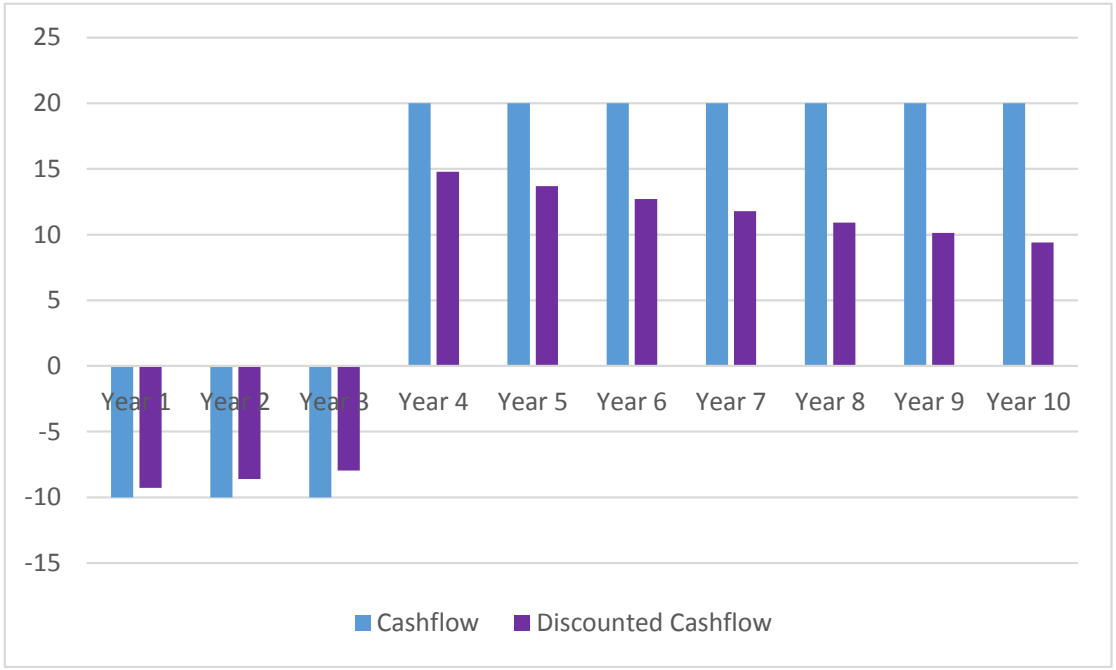
	Today	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Cashflow	0	-10	-10	-10	20	20	20	20	20	20	20
Discount factor	1	1.08	1.16	1.25	1.35	1.46	1.57	1.70	1.83	1.97	2.13
Discounted Cashflow	0	-9.27	-8.60	-7.97	14.78	13.71	12.71	11.78	10.93	10.13	9.39
Total Value	57.59										
Discount Rate	7.85%										
IRR	41%										



Payback

- How long does it take to recover the initial investment
- Measured in years (usually) but can be months for very rapid projects
- Can be calculated in simple or discounted terms
  - In other words either taking into account the time value of money or not

Calculating Payback



- US$30mm invested over three years
- Simple payback – US$30mm recovered after 1.5 years
- Discounted payback - $26mm recovered after 2 years

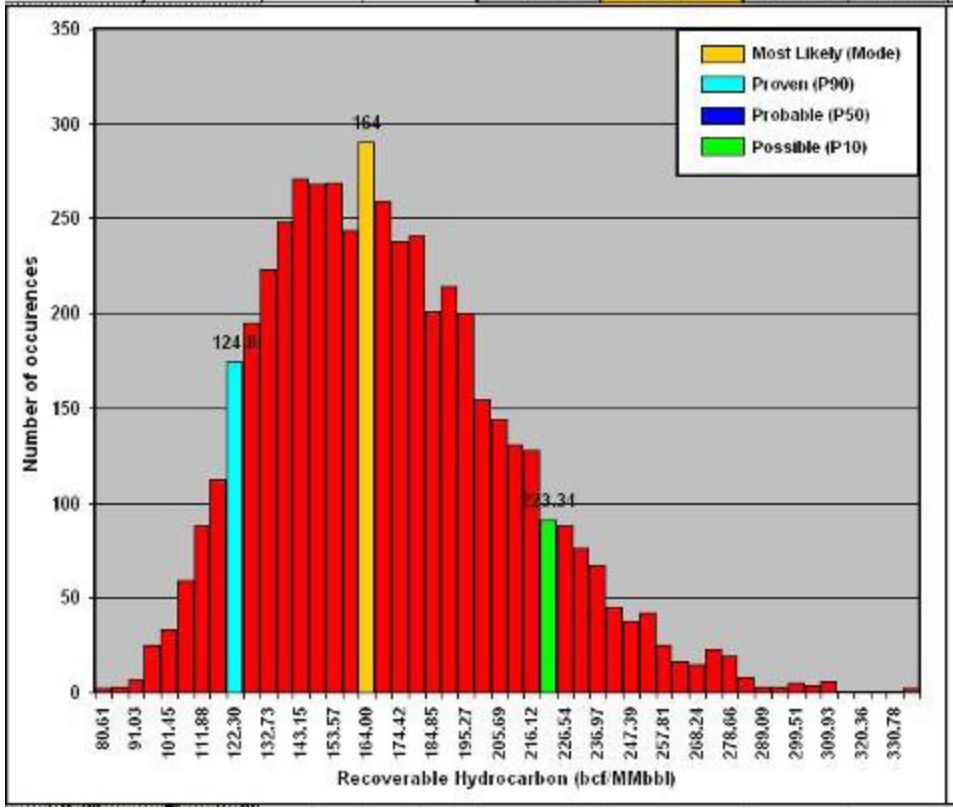
Analysis to Support the Decision to drill an exploration well

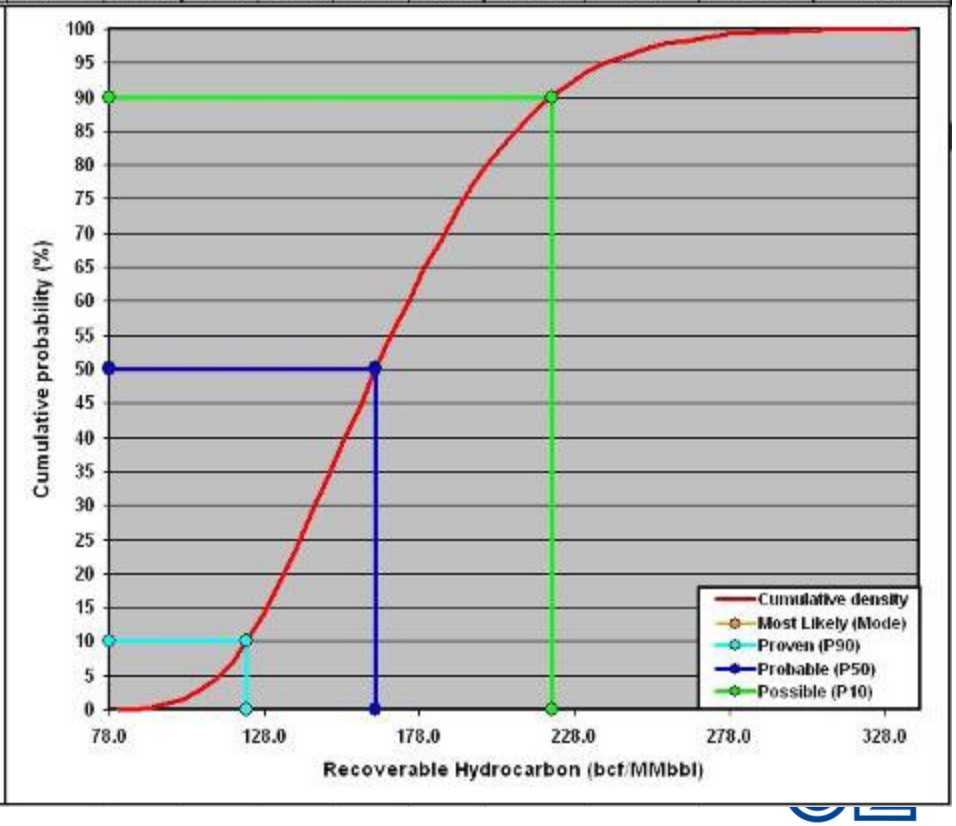
- **Geologists/Geophysicists:**
  - Interpret Seismic data and assess reservoir size probability distribution.
  - Assess the probability of source, reservoir and trap.
- **Reservoir Engineer:**
  - Assess the recoverable reserves and reservoir properties for the 90%,50% and 10% cases.
  - Assess the number of production wells required.
  - Develop annual production profile for the life of the field.
- **Facilities Engineer:**
  - Creates conceptual design for min, mean and max cases with costing and cost phasing.
- **Petroleum Economist:**
  - Models the cashflow of the three reserve cases including tax or Production sharing effects. Derives the Net Present Value of Cashflows, the Internal rate of return and other metrics.
  - Integrates the NPV's over the reserve distribution range to derive the Expected Present value.
  - Performs decision tree analysis based on the probability of the exploration well being successful.
  - Presents the investment case to management.

Create a theoretical cashflow based on assumptions known to date

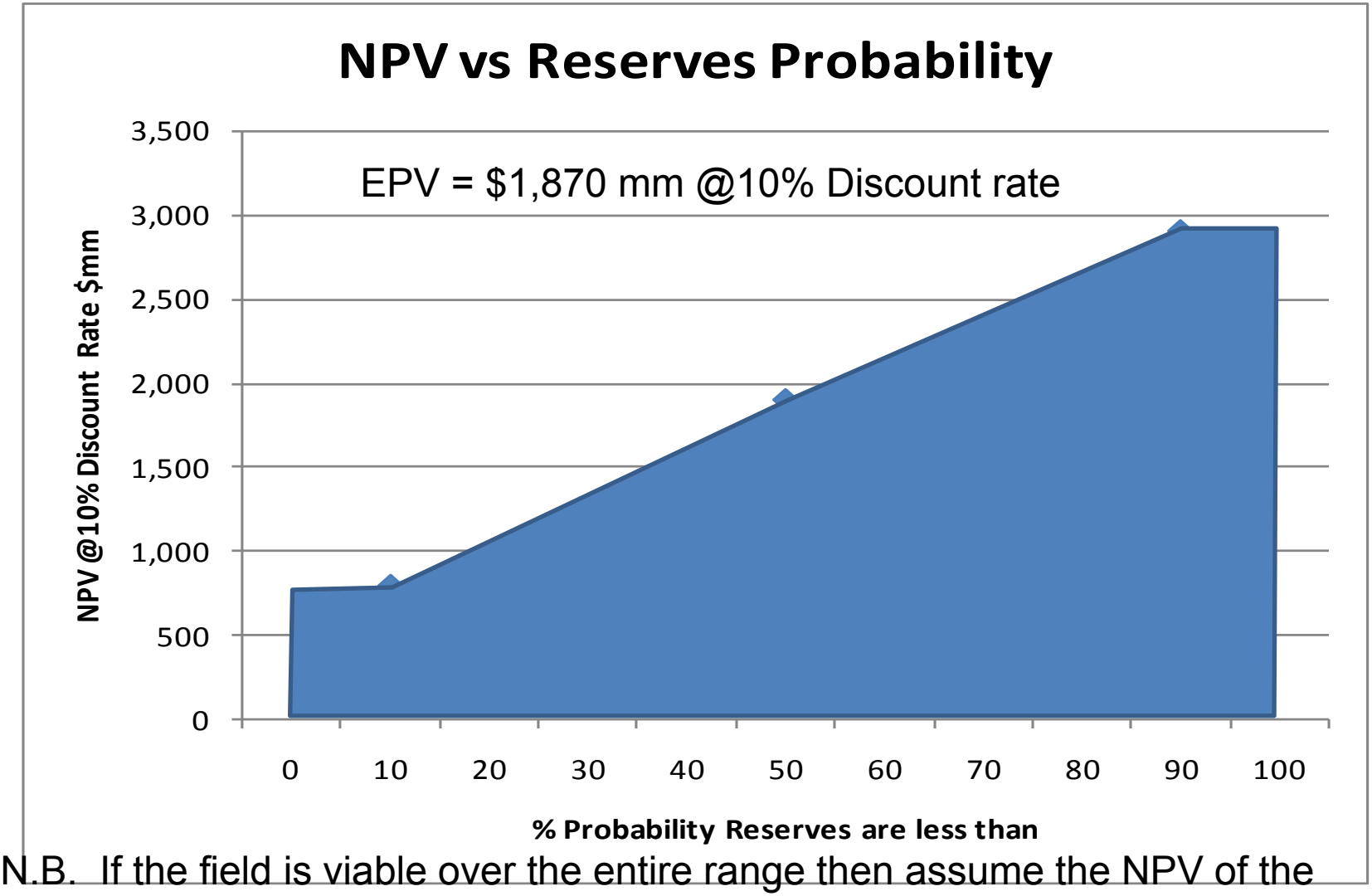
Monte Carlo reserve simulation: results and input parameter summary

Prospect Name	Modelling and structural parameters			Statistics	Recoverable hydrocarbon (bcf/MMbbl)	Volumetric parameters				Petrophysical parameters				PVT parameters			Field development parameters
	Number of Iterations	Reservoir Type	Trap Type			OWC/GWC depth (m)	Reservoir thickness (m)	Reservoir area (km^2)	GRV (10^8 m^3)	Φ (%)	Sw (%)	S_{hc} (%)	Area N/G	Reservoir Pressure (MPa)	Reservoir Temperature (°C)	Expansion Factor (Sm^3/Rm^3)	Recovery factor
M11-1 Preliminary results	5000	GAS	Simple Layer	Minimum	78.13	2800.01	18.25	8.002	148.12	9.52	20.15	60.30	1.00	46.08	97.00	322.00	0.604
				Most Likely	164.00	2803.41	25.29	8.070	224.85	12.23	30.15	69.85	1.00	46.08	97.00	322.00	0.704
				Maximum	338.45	2849.96	39.77	11.171	412.92	14.09	39.70	79.85	1.00	46.08	97.00	322.00	0.849
				P90	124.80	2804.86	21.79	8.158	193.22	10.66	24.55	64.52	1.00	46.08	97.00	322.00	0.650
				P50	166.48	2824.61	27.01	8.947	245.14	12.02	29.97	70.03	1.00	46.08	97.00	322.00	0.714
				P10	223.34	2844.68	34.13	10.192	315.06	13.19	35.48	75.45	1.00	46.08	97.00	322.00	0.790





At exploration stage add risk to calculate an Expected Present Value (integration over range of reserves uncertainty)



N.B. If the field is viable over the entire range then assume the NPV of the 50% case equals the EPV

Decision Tree Analysis

Cost of Exploration Well =$50mm

Probability of finding hydrocarbon = 20%

0.2 *(1870 – 50) = 364

0.8 *(– 50) = -40

$324 mm

Probability of not finding hydrocarbon = 80%

Dry Well

EPV $1,870mm

Probability of oil case =100%

Oil Case

Min NPV $800mm

Mean NPV $1,870mm

Max NPV $2,900mm

EPV $1,870mm

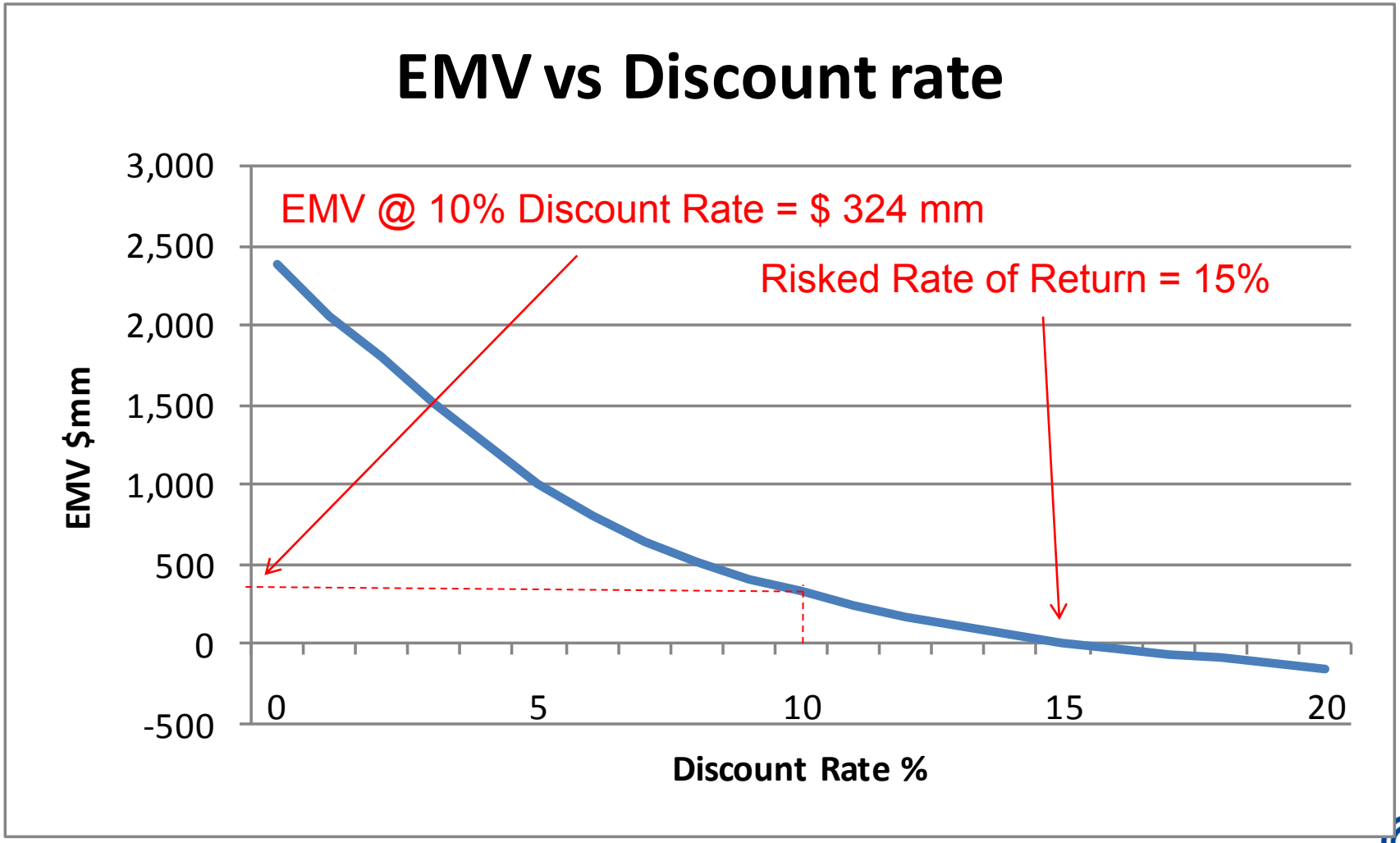
Probability of gas case = 0%

Gas Case

(not evaluated)

This is called the Expected Monetary Value (EMV) at the discount rate used.

Risked Rate of Return



Exploration Proposal

‘It is recommend that the company drill an exploration well on the prospect at a cost of $50mm.

The probability of discovering oil is 20% (in in 5). The mean discovery case has a recoverable reserves level of 900 million barrels of oil and a NPV @ 10% discount rate of $1,900mm.

Risked exploration economics indicate an Expected Monetary value of $324mm @ 10% discount rate and a Risked Rate of Return of 15%.’

Decisions on incremental investments

- I have discovered something new about the field
- I need to make an investment to enhance production
- Should I go ahead?
- How to adapt model?

The Development Decision

Congratulations – you discovered oil at a level just above the mean reserves case.

The exploration well, in addition to confirming a discovery, has provided useful information on reservoir quality, well flow rate and oil quality.

Your share price has soared but you now need to drill four appraisal wells to narrow the uncertainty on the reserves range, work out what it will cost to develop the discovery and what the economics of the project are before you go to the banks and your shareholders to raise more capital.

Reacting to a momentous event

- I have developed an oil field and spent many billions of US$
- Production has started
- The oil price collapses by 50% 2 years into the project
- How do I decide whether to continue or not?