Chapter 10: The Building Blocks Approach

Quantitative Methods for Regulation and Competition

Price-cap or revenue-cap?

- Price cap regulation adjusts the operator's prices according to:
  - Index that reflects the overall rate of inflation in the economy
  - Operator's ability to gain efficiencies relative to the average firm, and
  - Operator's input prices inflation relative to the average firm
- Revenue cap regulation:
  - Same but for revenues rather than prices
  - But regulated firm does not face any quantity risk
  - Appropriate where…
    - quantity demanded largely outside the control of the regulated firm (e.g. electricity transmission and distribution) and
    - costs insensitive to short-term variations in quantity demanded

Revenue-cap or rate of return regulation?

- With *pure price or revenue caps*, the regulator
  - never directly observes the operator's profits

- In practice, distinction between revenue-cap and rate-of-return regulation may be lost
  - price cap regimes base prices on past costs or expected costs
  - regulators make implicit decisions on acceptable real rates of return on capital employed in order to arrive at price limit determinations

- Still, main difference between rate of return and price cap
  - price cap regimes have fixed time periods between price reviews
  - rate of return regulation price reviews are triggered by high or low earnings (relative to the cost of capital)

How to determine P0 and X?

- Use projected efficient operating and investment costs
  - Prices such that revenues cover efficiently incurred operating costs, regulatory depreciation and cost of capital
  - This is known as the “building blocks” approach
- Reasonable and efficient levels of operating and capital expenditure?
  - Identify an attainable cost level by finding a comparable (and efficient) firm, and apply catch-up target
  - Price setting less influenced by own costs (better incentives)
  - May overcome information asymmetry
  - This is known as benchmarking (or yardistick competition)

The Building Blocks Approach

- Discounting the future
- Computing the weighted average cost of Capital
- Computing Allowable Revenues
- Financial modelling: An example

How to value the future?

- A pound today is worth more than one tomorrow!

- Why? Possible to earn interest! If interest is 10% a year…
  - Investing 10 million today gives 11 million year
  - The future value (in a year) of 10 million is 11 million
  - The present value of 11 million in a year is 10 million

Future and Present Values

- Future Value: Amount to which an investment will grow after earning interest

$$FV = £C_0 \times (1+r)^t$$

  - For example, 10 million after two years will be

$$FV = £10m \times (1+0.1)^2 = 12.1m$$

- Present Value: Value today of a future (expected) cash flow

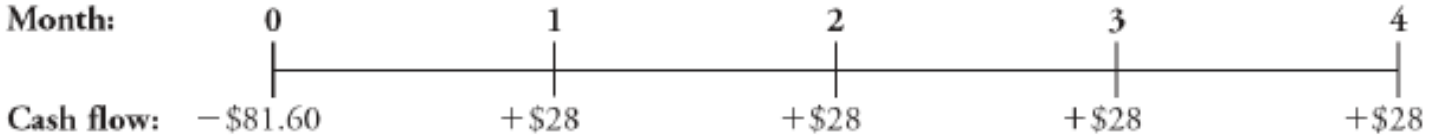
$$PV = \frac{1}{(1+r)^t} \times C_t$$

  - For example, 12.1 million in two years is

$$PV = \frac{1}{(1+0.1)^2} \times 12.1m = 10m$$

Net Present Value

- Cash flows: immediate £81.6 million "outflow" and an "inflow" of £28 million per year for 4 years



- Therefore, if discount rate is $r = 0.10$, the NPV is:

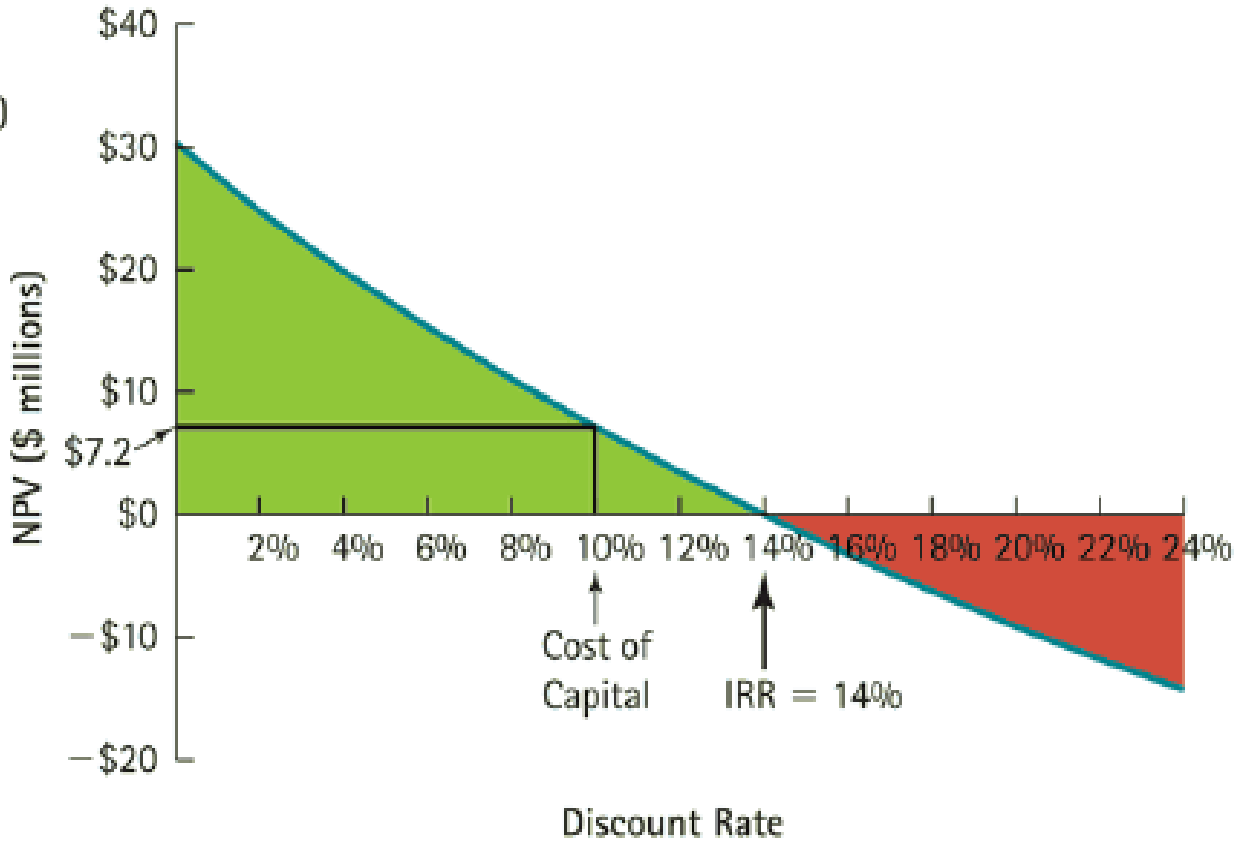
$$NPV = -81.6 + \frac{28}{(1+0.1)^1} + \frac{28}{(1+0.1)^2} + \frac{28}{(1+0.1)^3} + \frac{28}{(1+0.1)^4}$$

- Discount rate depends on the riskiness of the cash flows
  - Higher risk implies greater discount and lower present value

Panel (a)

Discount Rate	NPV ($ millions)
0%	$30.4
2%	$25.0
4%	$20.0
6%	$15.4
8%	$11.1
10%	$7.2
12%	$3.4
14%	$0.0
16%	−$3.3
18%	−$6.3
20%	−$9.1
22%	−$11.8
24%	−$14.3

Panel (b)



Asset value's rate of return

- Consider an asset that does not generate revenues or costs:

1. Value in two subsequent periods:
   - C_0: 80m and C_1: 96.8m
   - Return: r = (96.8 – 80)/80 = 0.21 or 21%
2. Value in two non-subsequent periods:
   - C_0: 80m and C_2: 96.8m, return: ?
   - Numerical method: find *r* such that Net Present Value (NPV) = 0

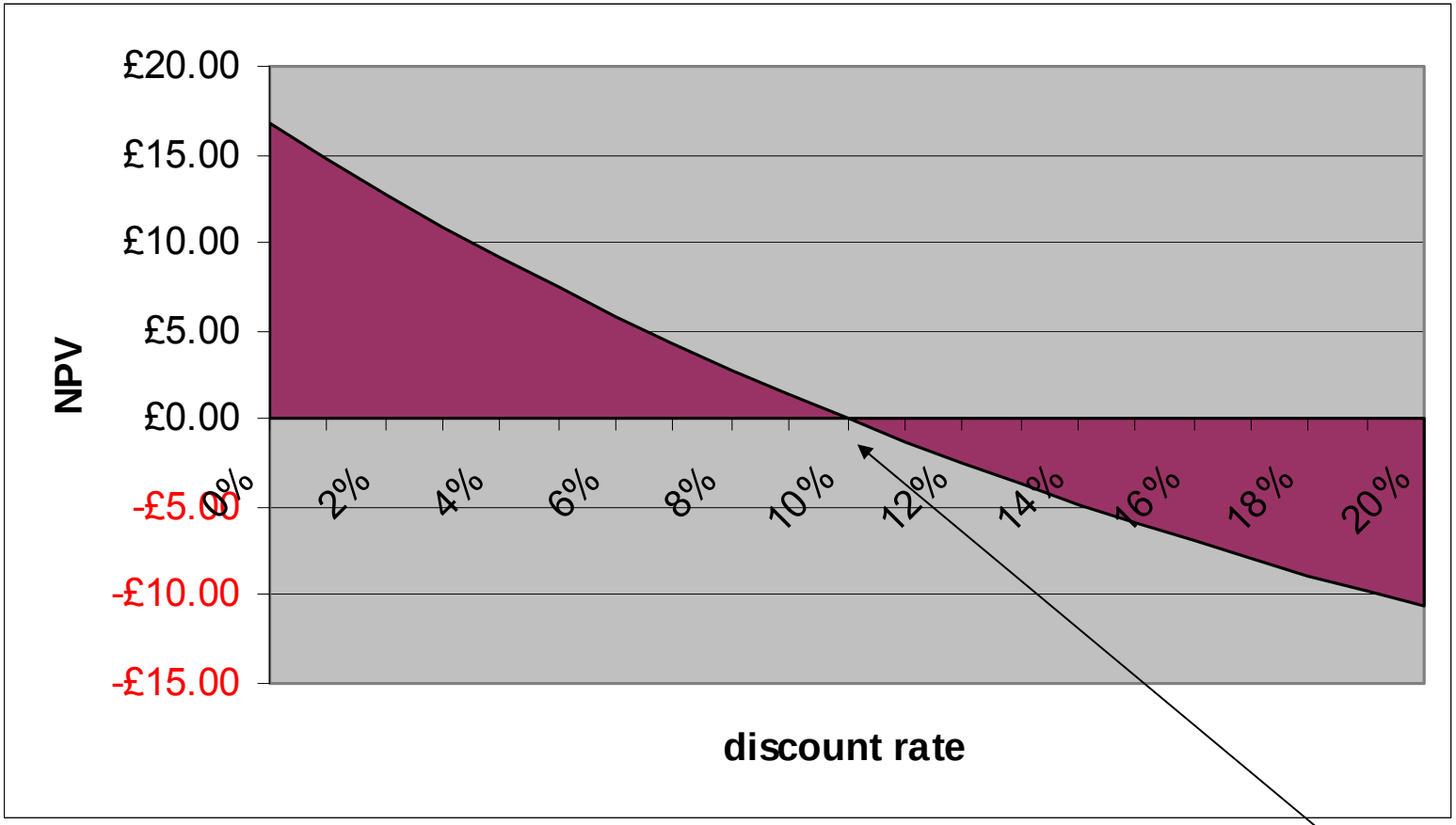
$$NPV = -80 + \frac{96.8}{(1+r)^2} = 0 \quad \text{or} \quad r = 0.10 = 10\%$$

   - In other words,

$$80(1+0.1)(1+0.1) = 96.8$$

   - What is the rate of return in the first examples?

Example 2


£20.00
£15.00
£10.00
£5.00
£0.00
-£5.00
-£10.00
-£15.00
NPV
0%
2%
4%
6%
8%
10%
12%
14%
16%
18%
20%
discount rate
Rate of return: 10%

Introducing revenues

- No revenues:
  - AV_0: 80m and AV_2: 96.8m

$$NPV = -80 + \frac{96.8}{(1+r)^2} = 0 \quad \text{or} \quad r = 10\%$$

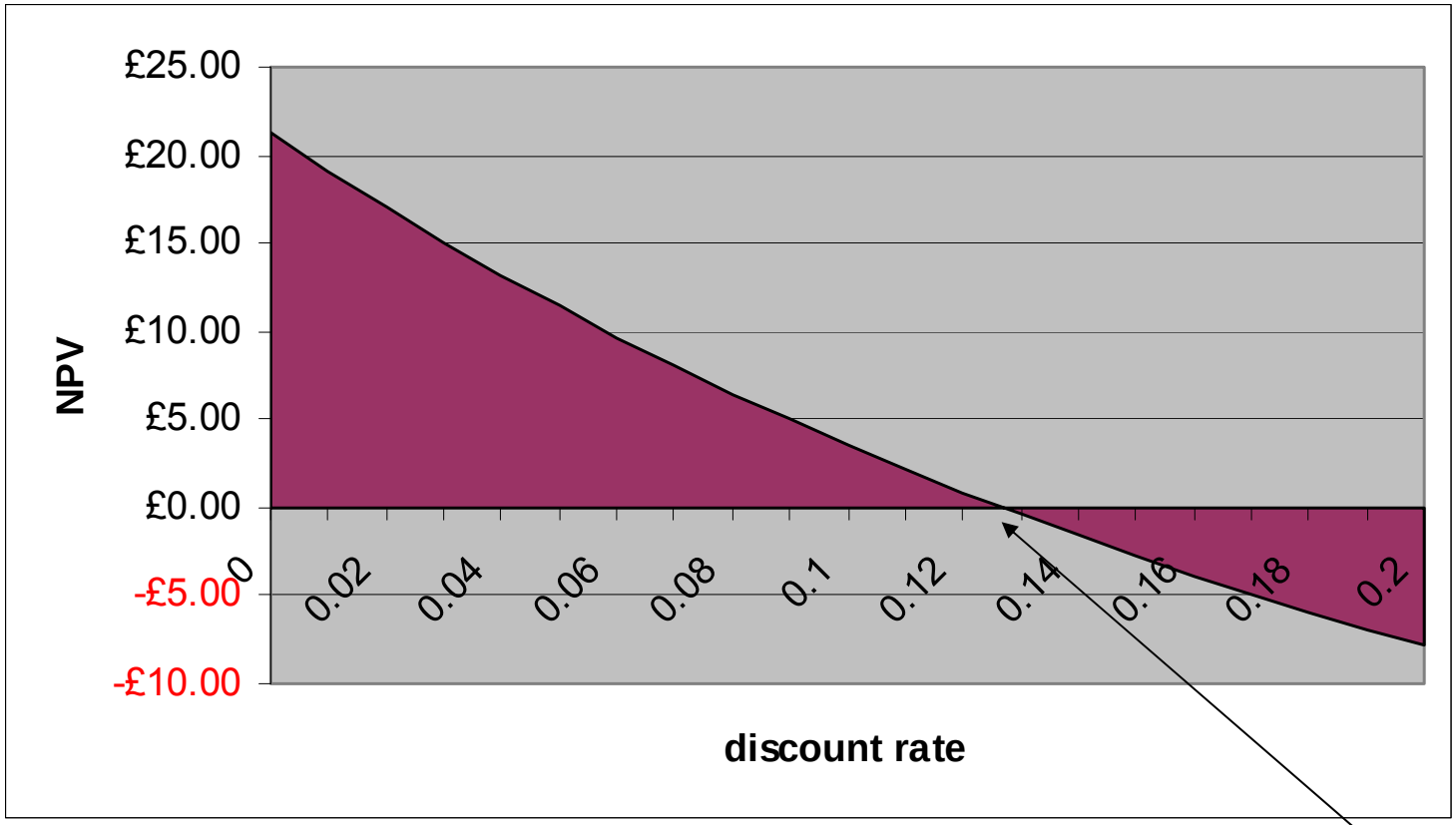
- Constant revenues:
  - AV_0: 80m, AV_2: 96.8m, R_1: 2m, R_2: 2m

$$NPV = -80 + \frac{2}{(1+r)^1} + \frac{2}{(1+r)^2} + \frac{96.8}{(1+r)^2} = 0 \quad \text{or} \quad r = 12.4\%$$

- Increasing revenues:
  - AV_0: 80m, AV_2: 96.8m, R_1: 2m, R_2: 2.5m

$$NPV = -80 + \frac{2}{(1+r)^1} + \frac{2.5}{(1+r)^2} + \frac{96.8}{(1+r)^2} = 0 \quad \text{or} \quad r = 12.7\%$$

Example 2 with revenues



Rate of return: 12.4%

Introducing costs

- Revenues, costs and asset values:

  AV_0: 80m, AV_2: 96.8m, R_1: 2m, R_2: 2.5m, C_1: 1m, C_2: 1.2m

$$NPV = -80 + \frac{2}{(1+r)^1} - \frac{1}{(1+r)^1} + \frac{2.5}{(1+r)^2} - \frac{1.2}{(1+r)^2} + \frac{96.8}{(1+r)^2} = 0 \quad \text{or} \quad r = 11.36\%$$

- If *r* is known, set revenues so that rate of return is *r*

$$NPV = -80 + \frac{R_1}{(1.1136)^1} - \frac{1}{(1.1136)^1} + \frac{R_2}{(1.1136)^2} - \frac{1.2}{(1.1136)^2} + \frac{96.8}{(1.1136)^2} = 0$$

  - Different options available

$$e.g.\ R_1 = 2 \text{ and } R_2 = 2.5 \quad \text{but also } R_1 = 1.5 \text{ and } R_2 \approx 3.05$$

Summary

- Revenues over time can be fixed by initial value plus yearly increase
- Rate of return increases if…
  - Future asset value is higher (e.g. less depreciation)
  - Costs are lower
  - Revenues are higher

- What is the appropriate rate of return?
- What is the appropriate revenue sliding scale?
- By how much costs are expected to increase?

The weighted average cost of capital

Weighted Average Cost of Capital

- Return that “an average” investor would have earned if she invested in any other firm with a comparable level of risk (opportunity cost of capital)
- Cost of capital is the cost of debt (e.g. bonds) and equity (e.g. common stocks) weighted by their market values

$$r = d\frac{D}{D+E} + k\frac{E}{D+E}$$

where d is the cost of debt, k the cost of equity and D the value of debt outstanding and E the value of equity outstanding

The proportion of debt over total value (E+D) is called gearing

Cost of debt, d

- Repayments due to interest on debt issued
- Possible to estimate from current debt outstanding

- Cost of debt…
  - lower than cost of equity since debt payments are senior to (paid before) equity payments
  - depends on the risk-free rate (government debt) and the risk premium of the debt (related to the company rating assigned by credit rating agencies)

Cost of equity, k

- k depends on the state of stock markets

- There are two types of methods:
  - Accounting methods, for example the dividend growth model
  - Econometric methods, based on Capital Asset Pricing Model (CAPM) and Arbitrage Pricing Theory (APT), which are based on financial market micro-models

Dividend growth model

- Share price determined by the PV of dividend stream:

$$P = \frac{D_1}{(1+k)^1} + \frac{D_2}{(1+k)^2} + \ldots + \frac{D_i}{(1+k)^i} + \ldots$$

where P is current share price, D_i expected dividends in year i and k is the opportunity cost of equity (discount rate used by investors)

- If dividends are expected to grow at a constant rate g, then

$$k = \frac{D_1}{P} + g$$

  - For example, if dividend yield (D_1/P) is 8% and dividends are expected to grow at 7% then cost of equity capital is 15%

Capital Asset Pricing Model

- Risk-averse investors…
  - can reduce the all portfolio variance by diversifying,..
  - except for market or systematic risk…
  - resulting in a cost premium
- Beta (β) measures…
  - relative risk of company's equity with respect to market risk
- The cost of equity is determined by such risk premium

$$k = E(r_e) = r_f + \beta(r_m - r_f)$$

Risk free interest rate

Market Index Risk Premium

Finding beta: run a regression

$$(r_i - r_f) = \beta_i (r_m - r_f) + e_i$$

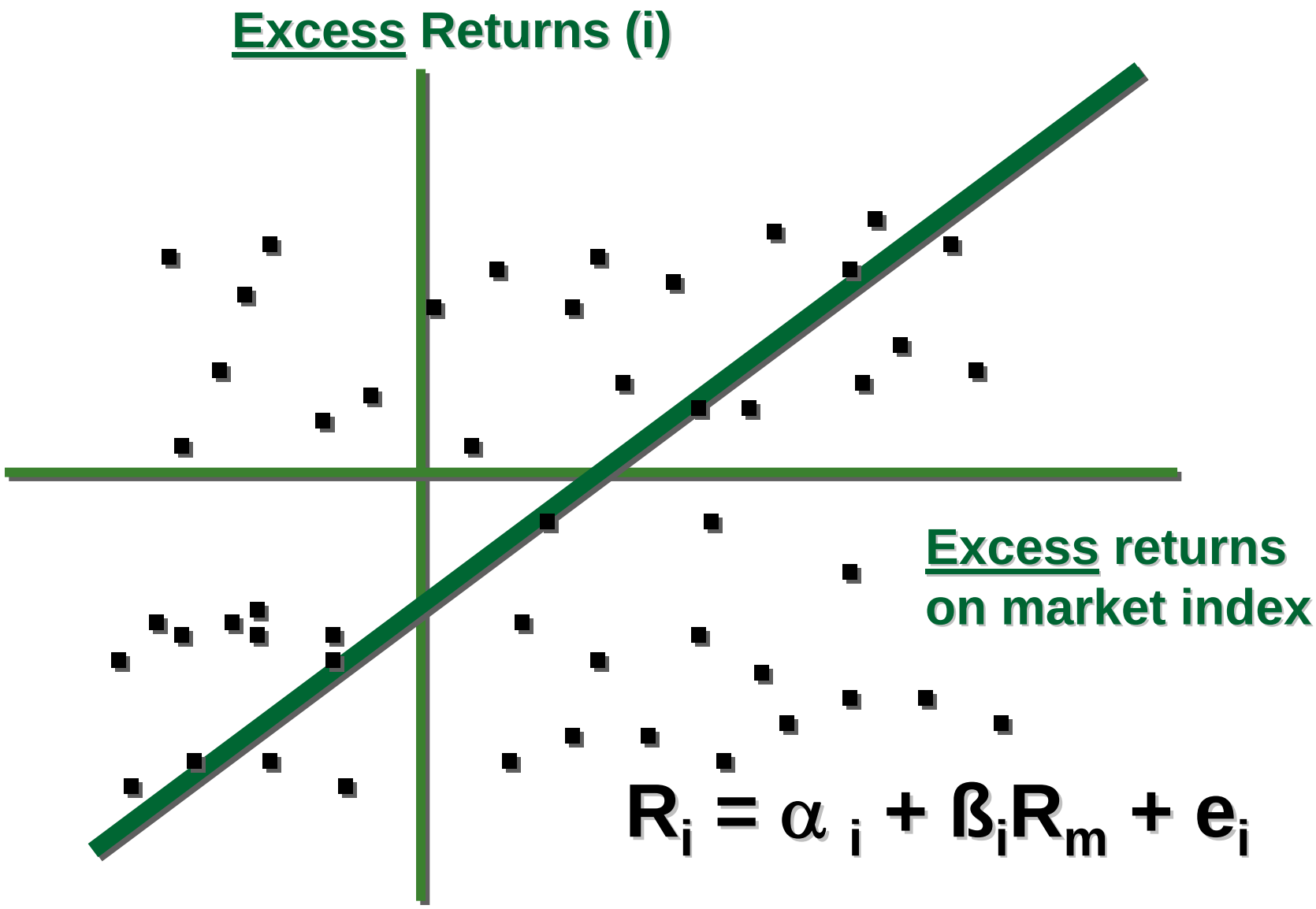
Stock i Risk Premium

Market Index Risk Premium

$ß_i(r_m - r_f)$ = the component of return due to movements in the market index

e_i = firm specific component, not due to market movements

Estimating the Model by OLS



Example: Transmission (Ofgem, 2006)

	Updated Proposals	Final Proposals
Risk free rate	2.30%	2.50%
Debt premium	1.10%	1.25%
Cost of debt	3.40%	3.75%
Cost of equity	7.00%	7.00%
Gearing	60%	60%
WACC (vanilla)	4.84%	4.40%

Computing Allowable Revenues

Determining the price

- Price controlled revenues enough to cover expected efficient costs (including operating and capital expenditures)

$$p\,q = C$$

  - p represents price
  - q quantity provided
  - C the firm's costs
- Or if more than one service is provided,

$$p_1 q_1 + \ldots + p_n q_n = C$$

- But, which costs? How to add up revenues and costs for different years? How do we provide a "fair" return on capital?

Operating Expenditures (Opex)

- "Expenditures from running the business" including
  - Administrative expenses and overhead, salaries, marketing costs
  - Research and development expenditures
  - Depreciation and amortisation

- Regulator able to observe current level of operating costs from the regulatory accounts
- Rules of the process specify pro-forma profit and loss, balance sheet and cash-flow statements and accounting guidelines
- Regulated business should be ring-fenced from other businesses to ensure that flows between businesses are transparent
- Regulator needs to estimate the efficient level of operating costs

Capital Expenditures (Capex)

- "Cash required for investment activities"
  - Purchases of new property, plant, and equipment

- How to estimate future capital expenditure?
  - Engineers' reports
  - Benchmarking against other businesses
  - Submission of business plans

Approaches to setting initial RAB value

- Accounting based
  - HCA, CCA, Replacement costs
- Market based
  - Market Capitalisation, Sale price
- Model based
  - MEA, DCF, DORC, Deprival rule

Accounting based approaches

- Historic cost accounting
  - assets are valued at their original purchase cost and are depreciated over their accounting lives
- Current cost accounting
  - assets are valued at original purchase cost but value on books is updated by general inflation every year
- Replacement costs
  - assets are valued by inflating historic costs by an index specific to those assets or the industry considered

Market-based approaches

- Market Capitalisation:
  - Company valued using stock market valuation (share-price x number of shares) plus net debt
- Initial sales price:
  - based on the initial sales price at privatisation
  - E.g. electricity: initial share price adjusted by 15% (for under-pricing) plus net debt is added

Model based approaches

- Modern Equivalent Asset
  - Assets are valued at the cost of buying a new asset that would perform the same function
  - Or at the recoverable value of the existing asset if they are not worth replacing
- Discounted Cash-flow:
  - The valuation of the company is based on the net present value (NPV) of the future stream of profits
- Depreciated Optimised Replacement Cost
  - Modern engineering equivalent or the optimal configuration is used to determine the standard replacement cost and then assets are depreciated

Example: Gas distribution

Table 1:Regulatory Asset Values for Gas Distribution (£ Millions, 2000 prices)

Regional Network	RAVs at 1st April 2002	RAVs at 1st April 2007
Scotland	670	707
North England	1,072	1,108
North West	1,137	1,134
East England	1,865	1,791
West Midlands	903	909
Wales and West	915	947
London	1,024	1,000
South England	1,789	1,785
Total	9,376	9,382

Rolling forward the asset base

- After starting point, forecast RAV changes during price control period
  - Investment in the system
  - Depreciation of existing components
  - Inflation
- Important for certainty, fairness etc that once a starting point has been established, it is not changed
- Issues:
  - Only expenditure justifiably incurred on an efficient basis
  - Depreciation related to life or rate of use?
    - Straight-line method: equal amounts of depreciation
    - Reducing balance method: decreasing amounts of depreciation
  - Re-valued using RPI or industry-specific index?

Financial modelling:
An Example

Price controlled revenues

- Objective:
  - Given cost efficient expenditures and appropriate measure of RAV, find $R_1,\ldots, R_5$ such that

$$\frac{R_1}{(1+r_{WACC})^1}-\frac{Opex_1+Capex_1}{(1+r_{WACC})^1}+\ldots+\frac{R_5}{(1+r_{WACC})^5}-\frac{Opex_5+Capex_5}{(1+r_{WACC})^5}-RAB_0+\frac{RAB_5}{(1+r_{WACC})^5}=0$$

Example: NGG TO (Ofgem 2006)

All prices are £m in 2004/05 terms

	Licensee = NGGT TO	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12
		£m	£m	£m	£m	£m	£m
	Regulatory Asset Value (RAV)						
1	Opening asset value		2,928.9	3,296.1	3,396.5	3,335.7	3,268.3
2	Total capital expenditure		464.3	206.3	48.3	41.3	36.9
3	Depreciation		-97.1	-105.9	-109.1	-108.7	-108.1
4	Closing asset value		3,296.1	3,396.5	3,335.7	3,268.3	3,197.1
5	Present value of opening/closing RAV		2,928.9				2,524.2
6	5 year movement in PV of RAV						404.8
	Allowed items						
7	Operating costs (excluding pensions)		137.8	136.5	137.2	136.4	138.2
8	Capital expenditure		464.3	206.3	48.3	41.3	36.9
9	Pensions allowance		38.3	37.7	37.1	37.0	36.6
10	Tax allowance		36.1	31.4	35.9	41.1	45.2
11	Total of allowed items		676.4	411.9	258.4	255.7	256.9
12	Present value of allowed items		660.6	383.7	229.6	216.7	207.7
13	5 year movement in PV of RAV						404.8
14	Total present value over 5 years						2,103.2
	Revenue						
15	Revenue index		1.000	1.000	1.000	1.000	1.000
16	Discounted revenue index		0.977	0.932	0.889	0.848	0.808
17	Price control revenue		472.3	472.3	472.3	472.3	472.3
18	Present value of PC revenue		461.3	440.0	419.7	400.3	381.8
19	Total present value over 5 years						2,103.2
20	IFI revenue (0.4% of line 17)		1.9	1.9	1.9	1.9	1.9
21	Total price control revenue		474.2	474.2	474.2	474.2	474.2

Discounted at WACC = 5%

X = 0

Example: NGET TO (Ofgem 2006)

All prices are £m in 2004/05 terms

	Licensee = NGET TO	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12
		£m	£m	£m	£m	£m	£m
	Regulatory Asset Value (RAV)						
1	Opening asset value		5,415.6	5,634.2	5,761.3	5,931.6	6,187.4
2	Total capital expenditure		601.3	524.9	581.1	655.6	677.9
3	Depreciation		-382.7	-397.8	-410.9	-399.8	-416.1
4	Closing asset value		5,634.2	5,761.3	5,931.6	6,187.4	6,449.2
5	Present value of opening/closing RAV		5,415.6				5,041.1
6	5 year movement in PV of RAV						374.5
	Allowed items						
7	Operating costs (excluding pensions)		266.0	259.7	254.3	254.0	254.9
8	Capital expenditure		601.3	524.9	581.1	655.6	677.9
9	Pensions allowance		38.5	37.8	37.4	37.3	36.9
10	Tax allowance		101.1	105.6	110.4	110.2	108.1
11	Total of allowed items		1,006.9	928.1	983.2	1,057.1	1,077.7
12	Present value of allowed items		982.4	861.9	869.3	889.7	863.4
13	5 year movement in PV of RAV						374.5
14	Total present value over 5 years						4,841.3
	Revenue						
15	Revenue index		1.000	1.020	1.040	1.061	1.082
16	Discounted revenue index		0.976	0.947	0.920	0.893	0.867
17	**Base price control revenue**	**924.9**	**985.5**	**1,005.2**	**1,025.3**	**1,045.8**	**1,066.7**
18	Excluded service revenue	58.2	58.4	64.3	71.9	75.8	76.1
19	Total TO revenues	983.1	1,043.9	1,069.5	1,097.2	1,121.6	1,142.8
20	Present value of total revenue		1,018.5	993.3	970.0	943.9	915.6
21	Total present value over 5 years						4,841.3
22	IFI revenue forecast		3.9	4.0	4.1	4.2	4.3
23	Price control extension reconciliation		0.7	0.0	0.0	0.0	0.0
24	Total price control revenue		1,048.5	1,073.5	1,101.3	1,125.8	1,147.1

Discounted at WACC=5%

X = 2%

Computations

- Movement in the RAV:
  - Closing value (line 4) becomes next year's opening value (line 1)
- Difference between present values of opening and closing (line 6)
- Allowed levels of costs and associated items (lines 7 to 14)
- Allowed revenues (line 17):
  - Index, increasing by 2% (line 15), discounted at wacc (line 16)
  - Distribute allowed costs (line 14) except for excluded services revenue (line 18), according to the revenue indices
- Discounted revenue (line 21) = total allowed costs (line 14)

- NPV=0 if r=wacc ensures that investors obtain return equal to wacc

Further Reading

Wright, Mason and Miles (2003): “A study into certain aspects of the cost of capital for regulated utilities in the UK”