Appendix A

Appendix A

31 MAY 2005

PROFESSIONAL PROJECT MANAGEMENT LTD

3rd FLOOR, SUITE 226/228, CENTRAL CHAMBERS, 109 HOPE STREET, GLASGOW, G2 6LL.
TEL +44(0) 141 221 2235
FAX +44(0) 141 221 2265

OUR REF: CDM/PMACK YOUR REF:

26 May 2005

Infratil Airport Holdings Limited,
Prestwick,
Ayrshire,
KA9 2PL.

Dear Sirs,

GLASGOW PRESTWICK INTERNATIONAL AIRPORT
RAILWAY STATION

I refer to your request for a cost estimate on the construction of a new railway station to the Airport based on current prices.

As you know we were the Project Managers for the existing railway station project but this exercise is been carried out from first principles utilising our detailed knowledge of the site. The following assumptions have been made:-

1. The cost exercise is based on the same location and configuration of the existing railway station. There was no evidence from either the initial study work or the construction phase that there was any benefit in making any change to these fundamental factors.

2. Due to the complex nature of the project and its interface with the railway system it has to be assumed that it would be designed as before with a full design team before proceeding to tender for a main contractor.

3. Costs include for a topographical survey and ground investigation work to reflect the nature of the site.

4. Costs do not include for land purchase and associated legal fees.

Contd/...

5. Costs include for Network Rail charges for Approvals, liaison, possessions and supervision of the work. They also include for works for signal and cable diversions.

Approval/Liaison		£ 40,000
Works		£ 48,000
Possessions		£ 59,000
	Sub-total	£147,000

6. Costs include for the preparation of a Safety Case which is a requirement before the station can become operational.

7. Costs are based on a construction programme of 40 weeks with 26 weekend possessions.

8. Allowance has been made for design, project management and site supervision fees together with compliance with the CDM Regulations.

The breakdown of our estimate of costs is set out below:-

		£
1.	Groundworks, founds and platforms	570,000
2.	Piling	215,000
3.	Steelwork	379,000
4.	Cladding and glazing	485,000
5.	Escalators and lifts	522,000
6.	Services, including lighting	114,000
7.	Signage	5,000
8.	Terminal Finishes	59,000
9.	Metalwork	133,000
10.	Preliminaries 15%	372,000
	Construction costs to sub-total	£2,849,000
	Design fees 12½ %	£ 357,000
	Project management and site supervision 5%	£ 143,000
	Planning Supervisor	£ 5,000
	Topographical Survey	£ 3,000
	Ground Investigation	£ 20,000
	Network Rail charges	£ 147,000
	Safety Case	£ 10,000
	Total	£3,534,000

The costs exclude Value Added Tax.

The above cost compares with the recently opened Gartcosh railway station which has a published cost of £3.5M.

We have undertaken an assessment on the likely lifetime of the components of the station bearing in mind its location which can be classified as a marine environment with severe exposure.

	Component	Life in Years
1.	Groundworks, Founds and Platforms	100
2.	Piling	100
3.	Steelwork	50
4.	Cladding and Glazing	25
5.	Escalators and Lifts	25
6.	Services, including Lighting	20
7.	Signage	15
8.	Terminal Finishes	15
9.	Metalwork	25

We trust the above meets with your requirements and look forward to hearing from you.

Yours faithfully,
PROFESSIONAL PROJECT MANAGEMENT LIMITED

CRAWFORD D. MACCALMAN
CONSULTANT

Appendix B

8 Cost of capital and financial projections

Contents

Introduction

8.1. In this chapter we describe our approach to the cost of capital and provide details of our financial projections for the company.

8.2. The cost of capital needs to reflect the returns that investors (shareholders and lenders) require to be compensated for putting their money into the company and bearing the associated risks. There are three elements to estimating the overall cost of capital:

(a) cost of equity;

(b) cost of debt; and

(c) share of debt in total capital, which we refer to as the debt share.

The company's overall cost of capital is calculated as a weighted average of its cost of equity and its cost of debt and hence is referred to as the weighted average cost of capital (WACC). At present the company's main source of finance is equity and we start with the cost of equity. As discussed below (see paragraph 8. 55), the cost of equity and cost of debt depend on the debt share and we therefore consider the cost of equity and debt at different levels of the debt share.

8.3. As with other UK regulated sectors, water companies' RCV is indexed by the RPI and it is therefore appropriate to consider the real cost of capital.

Cost of equity

8.4. There are two main methods used to estimate a company's cost of equity:

(a) the capital asset pricing model (CAPM) which states that a company's cost of equity is equal to the risk-free rate plus the company's beta times the ERP for the market as a whole (beta measures the riskiness of a company's shares relative to the market);

(b) The dividend discount or growth model (DGM) which states that a company's cost of equity is equal to its dividend yield plus its future dividend growth rate.

A serious difficulty with the DGM is that expected future dividend growth rates depend on past and expected future regulatory decisions making it an unsuitable basis for estimating the regulatory cost of capital. We therefore place the main emphasis on the CAPM, although we do refer to the DGM in paragraphs 8.41 to 8.44. The DGM has not been used by the Commission directly to estimate individual companies' cost of capital nor were DGM-based estimates put to us by the company or the Director (the Director did, however, refer in his published final determination document to the DGM providing a check on the results of the CAPM).

8.5. A further method of estimating the cost of equity is the Arbitrage Pricing Theory (APT). No APT-based estimates were put to us and we did not attempt to make such estimates ourselves as this would have involved disproportionate time and expense. We note also the comment of the Director that 'more sophisticated models, such as the APT, exist but are not yet widely used or understood' and his further comment that such models 'rely on input variables for which independently collated data do not exist over a sufficiently long period, they would be likely to prove impractical and of dubious robustness'.

8.6. We deal in turn with each of the three elements of the CAPM. We then consider the extent to which small companies have a higher cost of capital (small company premium) followed by a brief discussion of the DGM and market to asset ratios.

Real risk-free rate

8.7. Unlike the other elements of the CAPM, the current real risk-free rate is observable from trading in liquid markets. The UK Government has issued index-linked securities (gilts) which are generally considered to have negligible default risk and inflation risk[1] (when inflation is measured by the RPI). The redemption yield on these index-linked gilts provides a direct estimate of the real risk-free rate for different maturities. The Bank of England makes regular estimates of such rates over the whole yield curve which are, in addition, adjusted to a zero coupon basis[2] which helps to deal with tax and other complications.

8.8. Figure 8.1 shows index-linked yields since these securities were first issued in 1982. The yield for medium- (10-year) and long-term (20-year) gilts has, since the summer of 1997, fallen to levels just above and just below 2 per cent respectively—substantially below the average for the whole period of 3.4 per cent and also below all previous figures. The short-term (five-year) yield also remains below the long-term average although it has recovered somewhat during the last 12 months as interest rates have risen. Figure 8.2 shows real yield curves (at six-monthly intervals) over the last three years and again illustrates how yields have declined.

8.9. Equities should clearly be regarded as longer-term investments and medium-/long-term index-linked gilts are a closer substitute for equities than short-term securities. We are concerned with the cost of equity (and hence, in the current context, the risk-free rate) over the next five years, during which the current price control operates. We note, however, that the yield curve also provides information on expected future yields: for example the expected yield on a ten-year gilt in three years' time can be worked out from the current yield on a 13-year gilt and a three-year gilt. However, as discussed below, the shape of the yield curve may reflect liquidity factors.

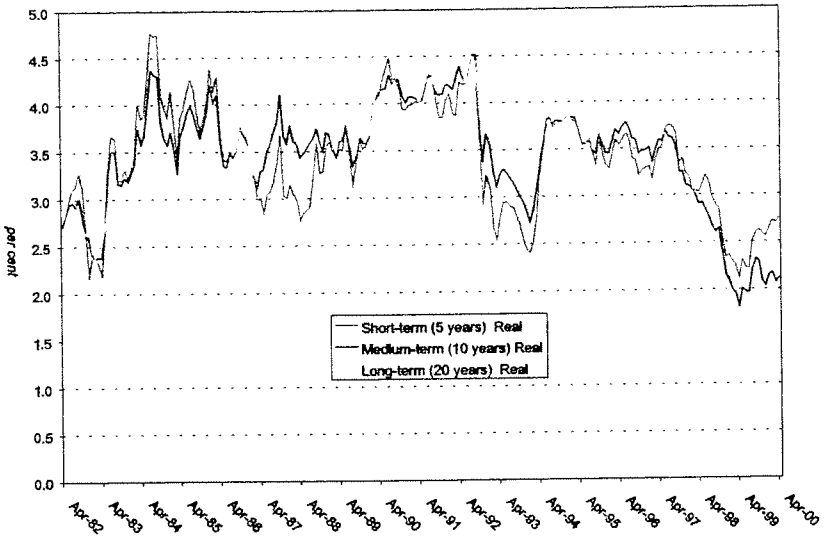
8.10. Two main arguments were put to us suggesting that the risk-free rate should be set at a higher level than implied by current yields on index-linked gilts:

[1]Some inflation risk arises from the RPI indexation being lagged eight months.
[2]A zero coupon/security is one that pays no interest until maturity.

Appx 8.1 F

FIGURE 8.1

Real redemption yields on index-linked gilts*

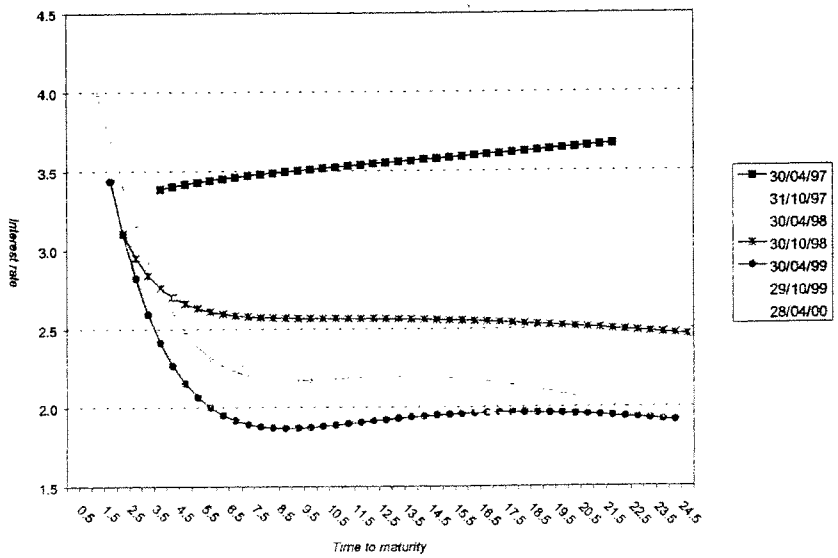


Source: Bank of England.

*Estimated by the Bank of England from a smoothed zero coupon yield curve.

FIGURE 8.2

Real yield curve, April 1997 to April 2000



Source: Bank of England.

(a) It was argued that historical average yields may be more important than current yields as predictors of future yields since yields may revert towards the mean.

(b) It was argued that current yields had been affected by liquidity factors, in particular the Minimum Funding Requirements (MFR) for pension funds.

We consider each of these in turn.

8.11. As regards the first point, no formal evidence of mean reversion in index-linked gilt (or any other bond) yields was put to us. Conventional gilt yields over the past 15 to 20 years (the period when index-linked gilts have been available) have been high relative to even longer periods.[1] Consequently, even if there is long-run mean reversion, it is unclear that the rate to which yields revert is the average yield for the period that index-linked gilts have been available. We therefore see little reason to base a projection of real risk-free rates over the next five years on the historical average of yields over the past 15 years. We accept, however, that markets can be volatile, and it could be unwise to place too much reliance just on the very latest figure if it is substantially different from previous figures. This is not, however, the case at present and we note additionally from Figure 8.1 that long-term yields are lower than short-term yields, which is the opposite situation to previous troughs (but similar to previous peaks).

8.12. In its report on Cellnet and Vodafone,[2] the MMC based its range for the real risk-free rate of 3.5 to 3.8 per cent on regard to both recent and longer-term evidence. However, the Cellnet/Vodafone inquiry was carried out in 1998, at the start of the decline in gilt yields. In this inquiry, we have had to take into account post-1998 evidence and, in particular, the failure of gilt yields to recover to their previous average. Earlier MMC inquiries[3] also used figures in the 3.5 to 3.9 per cent range but at the time this was close to the current rate.

8.13. Turning to the second argument, there appears little doubt that gilt yields have been affected by liquidity factors, including the increasing maturity of UK pension funds and the MFR for mature pension funds, which was introduced in April 1997 just before the decline in longer term gilt yields started. The Bank of England referred in its May 1999 *Inflation Report* to strong demand for bonds, both from pension funds due to the MFR and from insurance companies, leading to upwards pressure on the price of both conventional and index-linked government securities. Low UK Government borrowing in recent years is another factor that may have contributed to this upwards pressure on gilts prices. During the period that gilt yields have fallen, yields on corporate bonds have widened (relative to conventional gilts), again supporting the contention that specific institutional factors have affected gilt yields.

8.14. A recent analysis by Bank of England economists[4] used two methods to try to estimate the extent to which the low yield on UK conventional gilts was due to overvaluation, resulting from increased demand for long-dated gilts from pension funds and life assurance companies together with reduced net debt issuance:

(a) The first method was comparison with yields on World Bank (IBRD) debt, which is guaranteed by its member states and hence should be of similar credit risk to securities issued by those states. This showed that the UK spread[5] had increased by 0.35 to 0.55 per cent relative to the German spread and 0.2 per cent relative to the US spread after September 1998. Prior to September 1998, spreads had been similar for all three countries and the authors note that there was a widening of the spread for all three countries which coincided with the Russian debt crisis and the problems of the US hedge fund Long Term Capital Management. The authors also note that the UK spread widened rapidly after September 1998, whereas the MFR and gilt issuance developments occurred over a longer period.

(b) The second method was comparison of spreads between swap market yields and government security yields. Again this showed that (for a ten-year maturity) UK spreads had increased more than German or US spreads since 1997. At the end of 1999 this suggested UK gilt overvaluation of around 0.8 per cent relative to German and 0.6 per cent relative to US government securities. However, after the end of 1999 the US spread widened rapidly and became almost as large as the UK spread, which the authors note might be associated with expected buy-backs of US government securities.

Both these analyses were concerned with conventional securities of about ten year maturity. We conclude from these analyses that there are indeed specific UK liquidity related issues which have tended to reduce the real yield on longer-dated gilts.

8.15. Index-linked government securities in other countries are currently yielding about 3.3 to 4.0 per cent.[1] Caution is needed in interpreting these figures as the foreign markets for index-linked debt are less mature than the UK and may consequently be less liquid. Moreover, detailed arrangements for index-linking and tax treatment may differ from the UK, as may the construction of the inflation index to which the securities are indexed.

8.16. In assessing the risk-free rate relevant to the cost of equity, it is appropriate to adjust gilt yields for these liquidity factors (since they obviously do not affect the cost of equity). Any such adjustment is inevitably judgemental: based on the evidence available, we consider a risk-free rate of 2.75 to 3.25 per cent appropriate to assessing the cost of equity and we have used the middle of this range, 3 per cent, in our estimates of the cost of capital. This compares with the 2.5 to 3.0 per cent range used by the Director and the 3.5 to 3.8 per cent range proposed by SESW.

Equity risk premium

8.17. The ERP represents the additional return that investors require to compensate for the additional risk associated with investing in equities rather than risk-free securities. It is not directly measurable from market data because the future payout from equities (unlike bonds) is uncertain.

8.18. There are two main methods used to estimate the ERP:

(a) historical average of the excess of the realized equity return over the risk-free rate; and

(b) survey and other evidence of investors' current expectations of the ERP.

Whichever method is used, the objective is to estimate investors' expectations of the ERP over the next five years. We consider each of the methods in turn.

8.19. If it is assumed that the ERP is constant over time and that, on average, investors' expectations are realized, the current (and future) ERP can be estimated from a historical average of the difference between past equity returns and risk-free rates. Given that equity returns are volatile, it is standard practice in the finance literature to take a historical average over a very long period. As noted above, equities are longer-term investments and it would therefore appear appropriate to use a longer holding period such as ten years.

8.20. Figure 8.3 shows ex-post equity risk premia (based on a ten-year holding period) relative to both conventional gilts[2] and to Treasury Bills.[3] Each point on the chart shows the return over the previous ten years on equities less the return over that period on gilts (or Treasury Bills). Treasury Bills have been included as well as gilts on the grounds that returns on Treasury Bills are less affected by unanticipated inflation. For the years on the chart affected by increasing inflation (for example, 1970 to 1980), the premium relative to gilts does tend to be higher than relative to Treasury Bills, perhaps

[1] The compound real rate of return on conventional gilts was 8.4 per cent over 1980 to 2000, and 9.3 per cent over 1990 to 2000, compared with only 1.3 per cent for the whole of the twentieth century. E Dimson, P Marsh and M Staunton, *The Millennium Book, A Century of Investment Returns*, London: ABN-AMRO and London Business School, 2000 (ABN–AMRO/LBS study).

[2] *Cellnet and Vodafone: reports on references under section 13 of the Telecommunications Act 1984 on the charges made by Cellnet and Vodafone for terminating calls from fixed-line networks*, The Stationery Office, ISBN 0 11 515459 0, January 1999.

[3] *Northern Ireland Electricity plc: a report on a reference made under Article 15 of the Electricity (Northern Ireland) Order 1992*, The Stationery Office, ISBN 0 337 112436, April 1997. *BAA plc: a report on the economic regulation of the London airports companies (Heathrow Airport Ltd, Gatwick Airport Ltd and Stansted Airport Ltd)*, HMSO, MMC4, July 1996. *Scottish Hydro-Electricity plc: a report on a reference under section 12 of the Electricity Act 1989*, HMSO, ISBN 0 11 701932, June 1995. *Gas: Volume 1 of reports under the Fair Trading Act 1973 on the supply within Great Britain of gas through pipes to tariff and non-tariff customers, and the supply within Great Britain of the conveyance or storage of gas by public gas supplies*, HMSO, IC2314, August 1993.

[4] M Brooke, A Clare and I Lekkos, 'A comparison of long bond yields in the UK, USA and Germany', *Bank of England Quarterly Bulletin*, May 2000.

[5] The spread is defined as IBRD bond yield minus government security yield.

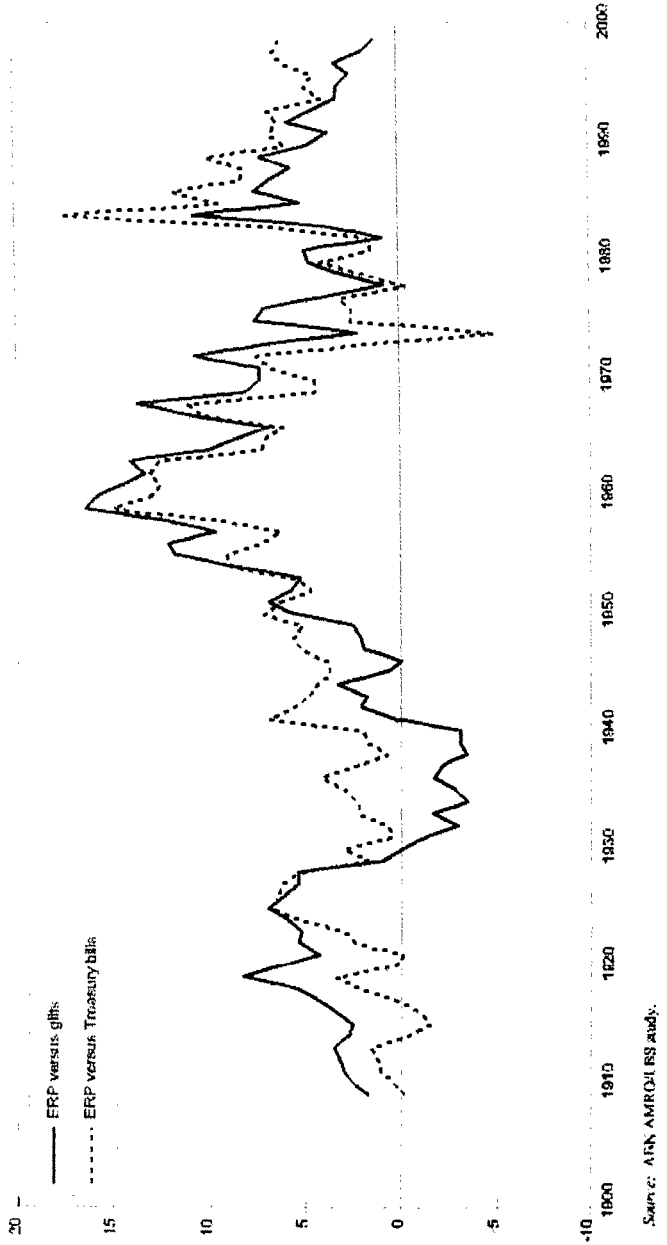
[1] Barclays Capital, *The Global Inflation-Linked Monthly*, July 2000. Redemption yields on over five-year maturity index-linked bonds issued by the Governments of the USA, France, Sweden and Canada were in the range 3.7 per cent to 4.1 per cent. Index-linked bonds issued by the Government of Australia yielded 3.3 to 3.4 per cent.

[2] Irredeemable stocks up to 1954, conventional gilts with mean maturity of 20 years after that.

[3] Treasury Bills are short-dated gilts: the return on Treasury Bills reflects current interest rates.

FIGURE 8.3

Rolling UK equity risk premia (ten-year holiday period) relative to Treasury bills and to gilts



Source: ABN-AMRO/LBS study.

reflecting unanticipated inflation. On the other hand, for years affected by deflation or decelerating inflation, the premium relative to gilts tends to be lower than relative to Treasury Bills. Year-to-year fluctuations in the ex-post premium are likely to reflect unanticipated changes in equity prices and hence information on the historical ex-ante premium can only be obtained by considering long-term averages.

8.21. Table 8.1 shows the average equity premium for the twentieth century. The historical average depends both on whether the premium is computed relative to gilts or Treasury Bills and on the statistical method of averaging that is used. Under the assumptions set out above (that the risk premium is constant over time and that on average investors expectations are realized), the arithmetic mean seems more relevant (see Appendix 8.2).

TABLE 8.1 **Historical averages for the ERP (annual rate), 1900 to 2000**

per cent

	Geometric mean	*Arithmetic mean of one-year returns*
Return on equities	5.9	7.8
Return on gilts	1.3	2.2
Return on Treasury Bills	1.0	1.2
ERP: relative to gilts	4.6	5.8
ERP: relative to Treasury Bills	4.9	8.6

Source: ABN-AMRO/LBS study.

8.22. The figures shown in Table 8.1 are lower than the figures that are often quoted[1] because the ABN-AMRO/LBS study discovered upwards survivorship bias[2] in previous estimates of the return on equity for the first half of the century and because earlier figures often ignored the 1900 to 1919 period. The ABN-AMRO/LBS study also showed the UK historical average equity premium was slightly below the average for 11 other countries.

8.23. As a predictor of the current risk premium, the historical average may be overstated if returns on gilts and Treasury Bills have been depressed by factors such as unanticipated inflation and exchange controls, which were in place for most of the twentieth century and restricted UK investors from obtaining higher returns in other countries.[3] Additionally it is often argued that investors in the second half of the twentieth century enjoyed higher than expected returns and thus that the historical average overstates the true ERP at the beginning of the period.[4] Evidence from the USA suggests that the ERP in the nineteenth century was no higher, and possibly lower, than that in the first half of the twentieth century[5] and thus supports the suggestion that the second half of the twentieth century was a period of unusually high risk premium.

8.24. The main argument against using historical data is that the ERP might now be lower than in the past, for instance due to diminished risk of the underlying cash flows associated with equity investment or increased appetite for risk among investors. Equity valuations, as measured by P/E ratios, dividend yields and Tobin's q (the ratio of total market capitalization to replacement cost of assets less debt) are much higher than in the past[6] and this is consistent with the ERP being lower than in the past. Alternative explanations of current high equity valuations, which could be consistent with the current equity premium remaining at its historical average, include that the market is overvalued[7] and that future profits and dividends are expected to increase rapidly. Whichever explanation is correct, current high equity valuations have contributed to the high historical equity premium for the second half of the twentieth century.

[1] For example, a submission to us by Thames Water quoted an arithmetic mean risk premium of 7.6 per cent relative to gilts and 9.2 per cent relative to Treasury Bills.

[2] Previous indices had overstated returns as they had been calculated for companies that were subsequently incorporated into a large-company index and had excluded companies that had not survived.

[3] This point is made for example in T Jenkinson, 'Real Interest Rates and the Cost of Capital', *Oxford Review of Economic Policy*, Volume 15 No 2 (1999).

[4] This point is made for example in E Dimson, P Marsh and M Staunton, 'Risk and return in the 20th and 21st centuries', *Business Strategy Review*, Volume 12, Issue 2 (2000).

[5] J J Siegel, *Stocks for the Long Run*, McGraw-Hill (1998).

[6] This is documented in relation to the USA (eg in Andrew Smithers and Stephen Wright, *Valuing Wall Street*, McGraw-Hill, 2000). There is less evidence for the UK in relation to P/E ratios and Tobin's q but there nevertheless seems little doubt that valuations are high relative to the past, albeit probably not to the same extent as for the USA.

[7] This is argued (for the USA) in the book by Smithers and Wright (op cit) another recent book by Robert Shiller (*Irrational Exuberance*, Princeton Universtiy Press, 2000) and elsewhere including a January 1999 article in the *National Institute Economic Review* by Sushil Wadhwani, 'The US Stock Market and the Global Economic Crisis'.

8.25. We turn now to the second method mentioned in paragraph 8.18: survey and other evidence of investors' current views. In his published final determination document, the Director referred to a 1998 survey by Price Waterhouse, which found a range for the ERP of 2.7 to 4.5 per cent; recent research published by equity analysts at a broad range of investment banks showing a range of 2 to 4 per cent and to a January 1999 survey by National Economics Research Associates (NERA) (of six utility analysts), which suggested an average premium of 3 to 4 per cent.[1] In reaching his conclusion that the ERP was 3 to 4 per cent, the Director also relied on his own consultations within the City.

8.26. In its June 2000 draft proposals for electricity transmission price control, Ofgem quoted some other evidence, including a September 1998 report on electricity companies by Merrill Lynch which, Ofgem said, noted that some fund managers had started to use estimates of the ERP as low as 2 to 3 per cent, and an October 1997 report on the cost of capital (confirmed in a report issued earlier this year) by SBC Warburgs which, Ofgem said, had used 3.5 per cent as an estimate of the ERP.

8.27. We are also aware of other similar evidence. A 1997 report on Strategic Asset Management by Mercury Asset Management stated that many estimates of the expected annualized real return fall between 5 and 7 per cent, implying an ERP of 2 to 4 per cent on the basis of our risk-free rate of 3 per cent. A recent paper by a group of actuaries[2] assumed future real returns on UK equities of 4.5 per cent, implying an ERP of only 1.5 per cent on the basis of our risk-free rate of 3 per cent.

8.28. The survey and other evidence discussed above leads to quite a wide range of figures. This evidence may be subject to biases which are difficult to quantify and assess: fund managers may have the incentive to quote lower figures to make their achievements look better but, on the other hand, if they know the use made of the evidence, they have the incentive to quote higher figures since they benefit directly from a higher cost of capital for regulated companies. Probably for this latter reason, the evidence tends not to be derived from rigorously structured surveys.

8.29. There remains much uncertainty about the ERP and we continue to attach weight to both the historical evidence and the evidence on current market expectations. Despite the uncertainty, it is necessary to choose a best estimate of the ERP in order to calculate the cost of equity under the CAPM. Our best estimate is 4 per cent, which is somewhat below the historical average but above the current estimates of market expectations. This compares with the middle of the Director's range which was 3.5 per cent and the 4.5 per cent figure proposed by MKW.

8.30. Our best estimate of 4 per cent is within the range of 3.5 to 5 per cent quoted in two previous MMC reports (Cellnet/Vodafone, 1999, and NIE, 1997).[3] However, it is 0.25 per cent below the middle of that range (4.25 per cent) which was the figure implicitly used to calculate the cost of capital in those inquiries. Dr Jenkinson, on behalf of MKW, the other company that referred its determination to us, argued that stability in regulatory decisions was very important and that there was no evidence that justified such a change. We agree that stability in regulatory decisions is very important and therefore we have been very cautious in reducing the ERP used in the cost of capital below that used by the MMC. Nevertheless, we believe that a small reduction in the ERP is justified by evidence that long-term historical averages are lower than previously thought (see paragraph 8.22) and also by continued high equity valuations: the longer that equity valuations remain high, the more confidence it is possible to have that the ERP is lower than the historical average.

Beta

8.31. As with the ERP, beta is not measurable directly from market data. However, statistical estimates of beta are made by regression analysis (total returns from holding a particular share or

[1]He also referred to a 1998 study by SRU for Yorkshire Water and a study, which we discuss below under the Dividend Growth Model, by Credit Lyonnais Securities Europe (CLSE) of 89 institutional investors, *Risk and return in the UK water sector—an independent survey of institutional investors*, 19 October 1998. The CLSE survey showed expected real dividend growth for the market as a whole of 3.9 per cent which, combined with CLSE's estimated dividend yield for the market in 1998 of 3.0 per cent, suggests a cost of equity (using the DGM) of 6.9 per cent and hence an ERP using our 3 per cent risk-free rate of 3.9 per cent.

[2]P M C Meredith, N P Horsfall, J M Harrison, K Kneller, J M Knight and R F Murphy, *Pensions and Low Inflation*, The Staple Inn Actuarial Society, 2000.

[3]Ranges were also quoted in three earlier MMC regulatory reports: BAA (1996), 4 to 5 per cent; Scottish Hydro (1995), 3.5 to 4.5 per cent; British Gas (1993), illustrative rates of 3.37 and 3.5 per cent. (See footnote to paragraph 8.12.)

portfolio of shares are regressed against total returns from the market portfolio). Table 8.2 shows estimates of beta for the water sector from two sources:

(a) estimates made by OXERA from daily share price data: these are available since 1995; and

(b) estimates made by LBS on the basis of 60 months' data.

TABLE 8.2 **Estimates of equity beta for the water sector**

	Daily data (OXERA)	*Monthly data (LBS)*
1995	0.70	
1996	0.58	
1997	0.63	
1998	0.21	
1999	0.28	
Year to May 2000	0.39	
Whole period	0.38	0.47*

Source: *The Utilities Journal*, May 2000 (for OXERA estimates), *Risk Measurement Service*, Second Quarter 2000 (for LBS estimates).

*60 months to January 2000.

LBS estimates for the water sector are available for a longer period and these are shown in Appendix 8.1 together with LBS estimates of betas for ESH and other small water companies based on monthly data (it would not be sensible to calculate betas from daily data for small water companies since trading is infrequent). All estimates of beta relate to the quoted company rather than the regulated business alone.

8.32. In relation to beta, three main issues arise:

(a) How much weight should be put on estimates of beta for the water sector and how much on estimates for ESH?

(b) How much weight should be put on the latest estimate of beta and how much, if any, on earlier estimates?

(c) Since, under the CAPM, equity beta depends on debt share, how should the equity beta be adjusted for changes in the relative importance of debt in total capital?

The last of these is essentially a technical issue and we adopt the approach of choosing an asset beta (the beta that would apply to the company if it had no debt) and then calculating equity betas under different assumptions about the debt share. Based on a debt share for the water sector of about 20 per cent and taking into account both monthly and daily beta estimates for the whole period and also the daily beta estimate for the year to May 2000 (which is in any case similar to the daily beta estimate for the whole period), Table 8.2 suggests an asset beta in the range 0.30 to 0.45.

8.33. We also consider that little weight should be attached to estimates of beta for small companies such as ESH due to the infrequency of trading and the statistical fragility of the estimates in Appendix 8.1; we discuss below the issue of whether a small company premium should be included in the cost of equity. We consider that statistical estimates of beta are subject to large margins of error and that, in projecting beta for the next five years, we should therefore have some regard to earlier higher betas as well as the more recent figures. We have also taken into account that statistical estimates of beta for electricity and gas companies are somewhat higher than for the water sector despite the CLSE survey suggesting that these companies are regarded by institutional investors as lower risk than water companies. In the light of these factors, we have assumed an asset beta somewhat above the level implied by recent statistical estimates even though we have also taken into account that statistical estimates of beta reflect all the activities of the quoted companies including possibly higher-risk non-regulated activities.

8.34. We therefore assume an asset beta of 0.5 for the water sector over the next five years implying an equity beta of about 1.0 for a 50 per cent debt share (see Table 8.4). This compares with the Director's assumption of an equity beta of 0.7 to 0.8 at around 50 per cent debt share. Our assumed asset beta of 0.5 compares to SESW's assumption of an asset beta of 0.6.

Small company equity premium

8.35. ESH, of which the principal subsidiary is SESW, is quoted on the London Stock Exchange but has a market capitalization of under £100million, making it a relatively small company.

8.36. There are a number of reasons why small companies may have a higher cost of equity:

(a) Small companies are higher risk.

(b) There is less public information available about small companies, causing investors interested in small companies to incur additional information costs which would need to be compensated by higher returns.

(c) Trading in small company shares is less liquid, leading to higher transactions costs and also potentially making small company shares less attractive to institutions.

We consider these in turn.

8.37. Statistical estimates of beta do not suggest that small companies are higher risk: the LBS-estimated beta for the FT-SE Small Cap index is 0.81 (for the 60 months to April 2000) indicating lower risk than for the FT-SE All Share index (which has a beta of 1.0). Moreover, the data in Appendix 8.1 do not suggest that small water companies have higher beta than the water sector as a whole. Over the long term (30 to 45 years), returns on companies accounting for the smallest 10 per cent of the London Stock exchange's market capitalization have exceeded returns on all shares by 2 to 3 per cent[1] but, as shown in Figure 8.4, this has not been the case more recently. Academic studies have found some evidence (which is fairly weak for the UK) that investments in the smallest companies earned higher returns than investments in larger companies.[2] This might reflect higher risk that has not been captured by statistical estimates of beta, for example due to a lack of information on such companies, the point to which we now turn.

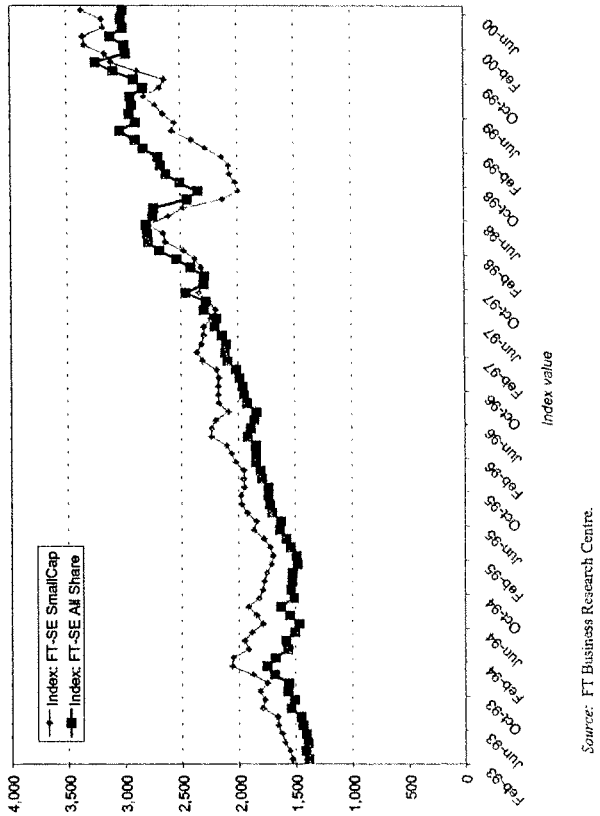
8.38. We are aware that small companies are regarded by investors as difficult to value; that many small companies in the manufacturing and service sectors have been taken private by their managements while managers of other such small companies feel that their businesses are not understood by the market; and that these developments may reflect the difficulty and expense of collecting and disseminating information on small companies. However, small water companies are much less difficult to value than other small companies due to their having a RCV and, furthermore, a great deal of information about all water companies, including the small ones, is published by Ofwat. We do not therefore consider that the information problems associated with small companies generally justify a small company equity premium for small water companies.

8.39. The lower liquidity of the market in ESH shares is reflected in a bid/ask spread of about 6 per cent,[3] compared with about 0.5 per cent for large water companies. Thus if the shares are held on average for about five years[4] the additional transactions costs would be equivalent to about 1 per cent a year: returns on the share would consequently need to be 1 per cent a year higher to compensate investors for the extra costs.

[1]Hoare Govett Small Companies Index, quoted in *The water industry cost of capital and the small company effect*, a paper prepared for Sutton and East Surrey Water, London Economics, August 1998.
[2]David Miles and Allan Timmermann, 'Variation in expected stock returns: evidence on the pricing of equities from a cross-section of UK companies' *Economica*, August 1996. The study used data for May 1979 to April 1991 and found that the mean return on the smallest decile of companies was significantly higher than on other companies at the 10 per cent level (but not the 5 per cent level).
[3]UK-iNvest.com.
[4]The discussion in paragraph 8.19 assumed an illustrative holding period for equities of ten years. However, this related to holdings of equities (as opposed to other assets) generally and it is appropriate to assume a shorter holding period for shares in an individual company.

FIGURE 8.4

FT-SE SmallCap and All Share indices



Source: FT Business Research Centre.

This bid/ask spread relates to a relatively small transaction size and the additional small company costs for a larger transaction, such as might be made by a pension fund or insurance company may be even greater. On the other hand, holding periods may be longer than five years because less liquid shares with higher bid/ask spreads would tend to be more attractive to investors intending to hold for longer periods.

8.40. On balance, we judge that the lower liquidity of trading in ESH's shares requires a small company premium of 1 per cent a year.

Dividend growth model

8.41. As noted above, in its simplest form the DGM states that the cost of equity is equal to the dividend yield plus the future dividend growth rate. The dividend yield is directly observable but the future dividend growth rate is not observable. An additional complication is that investors may not expect the same dividend growth rate for all future periods. In the short term, the outlook for some water companies may be for dividend cuts in response to the Director's P0 price reductions in 2000/01 that were accepted by all but the two companies which referred their determinations to us.

8.42. Results from the CLSE survey of institutional investors[1] showed that investors expected water companies' dividend yield to be 30 to 70 per cent above the market average and expected dividend growth of 3.2 per cent. CLSE estimated the dividend yield for 1998 at 3.0 per cent[2] and suggested that the results implied a real cost of equity of 7.1 to 8.3 per cent. A puzzling feature of these results is that the CLSE survey also showed expected growth for the market as a whole of 3.9 per cent, implying a cost of equity for the market as whole of 6.9 per cent and thus that water companies are perceived as higher risk than the market as a whole. This seems implausible and contrary to other results of the CLSE survey. We have noted above our concerns about possible unreliability in survey evidence. An additional concern in relation to the CLSE survey is whether responses on dividend growth rates fully reflect expected long-run growth rates.

8.43. The market dividend yield is currently 2.1 per cent: if the CLSE responses on relative dividend yields and dividend growth rates are applied to the current market dividend yield, the resulting cost of equity is 5.9 to 6.9 per cent.

8.44. The CLSE survey also suggested a debt share of about 50 per cent. On the basis of a 50 per cent debt share, Table 8.4 shows that our assumed cost of equity (excluding small company equity premium) is 6.8 per cent. This is below CLSE's range but consistent with the recalculation in the previous paragraph.

Market to asset ratios

8.45. Other things being equal, if a regulated company earns exactly the cost of capital on its RCV, its market capitalization should be equal to its RCV adjusted for debt and non-regulated activities (representing a market to asset ratio (MAR) of one). Under five-year RPI–X regulation, MARs will also reflect the market's expectations of the company's performance against the regulator's projections of opex and capex. SESW argued that the MAR was one of the most important indications of the reasonableness of the Director's determination: ESH's MAR had fallen well below 1 and this indicated that the Director's determination had been inadequate.

8.46. Data on MARs for large water companies at a recent date is shown in Table 8.3. We have not included ESH as its share price is likely to be affected by uncertainty resulting from our inquiry nor have we included other small water companies due to the illiquidity of their trading.

[1]See footnote to paragraph 8.25.
[2]This appears to represent the gross dividend yield at the time; given that changes in the tax treatment of dividends had already been announced, institutional investors may have responded on the basis of net dividend yield which would have been 0.6 per cent lower.

TABLE 8.3 **MARs for large water companies***

Company	%
Anglian Water	72
Hyder	50
Kelda Group	96
Pennon	66
Severn Trent	71
Thames Water	84
United Utilities	91

Source: Merrill Lynch.

*11 April 2000.

8.47. As share prices tend to be volatile and there is uncertainty about the market value of unregulated activities, caution is needed in interpreting MARs. In particular, MARs need to be considered over a period of time rather than at a single point in time. Since the publication of *Prospects for Prices* in late 1998 (when the Director indicated his intention of implementing substantial P0 reductions), MARs have been both above and below 1 (although the general trend has been down). Consequently we do not think that it can necessarily be concluded from the data on recent MARs that the cost of capital is above the level assumed by the Director. As noted below, our estimate of the cost of capital is nevertheless slightly higher than that of the Director.

Asymmetric risk

8.48. Some water companies suggested to us that the existence of regulatory and political risk created an asymmetric risk of lower profits, that this was not reflected in beta and hence justified an additional risk premium. However, regulated companies are not the only ones facing asymmetric risks (suggesting that some allowance will be included for asymmetric risks in the ERP). Moreover, regulated water companies benefit from an asymmetric safety net in the form of the shipwreck clause (see paragraph 4.17). As noted in paragraph 8.47, MARs have not been consistently below 1 since the main features of the Director's determinations became apparent in late 1998 and this would suggest that no specific allowance for asymmetric risk is needed in the cost of capital. This was also the conclusion of the MMC in its Cellnet/Vodafone[1] inquiry and of the Director.

Cost of debt

8.49. There are a number of ways that regulated companies can borrow, including issuing index-linked bonds, conventional bonds and borrowing from banks. The cost of debt should include both interest payments and fees; the evidence put to us suggested that, for small companies such as SESW, borrowing from banks was the cheapest method due to the lower level of fees.

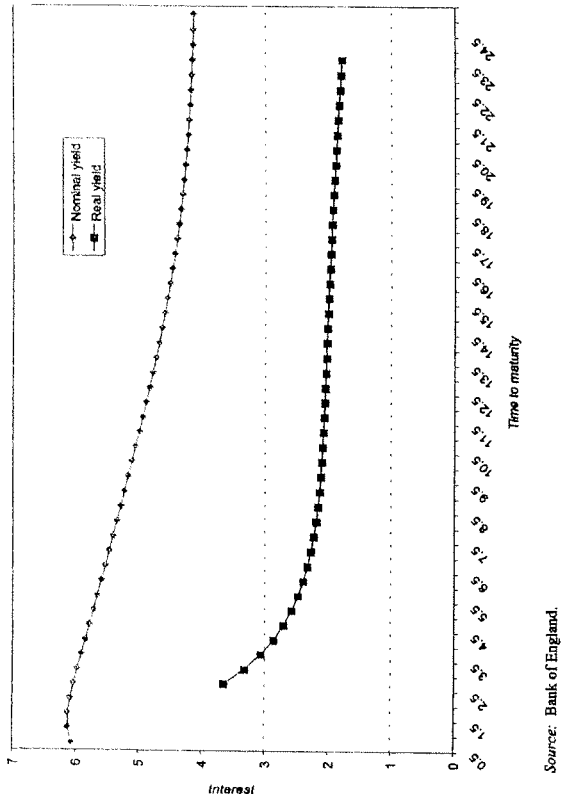
8.50. The evidence put to us by both companies that referred their determinations to us indicated that fees and margin over LIBOR[2] for such borrowing would come to about [✂] per cent for a debt share of 25 per cent and [✂] per cent for a debt share of 50 per cent.

8.51. In order to estimate the cost of debt we also need to make an assumption about the level of LIBOR over the next five years. Figure 8.2 shows that the index-linked gilt yield for a five-year maturity is about 2.6 per cent. However, Figure 8.5 shows that the yield on conventional gilts is about 5.7 per cent, implying an expected inflation rate of 3 per cent. We note that if the expected inflation rate were 2.5 per cent, the implied real yield on conventional gilts would be 3.1 per cent. Taking all these factors into account we judge an appropriate assumption about real interest rates (LIBOR) over the next five years to be 3 per cent.

[1]See footnote to paragraph 8.12.
[2]London InterBank Offer Rate.

FIGURE 8.5

Real and nominal yield curves, 28 April 2000



Source: Bank of England.

8.52. The implied real cost of new debt for SESW assuming a 50 per cent debt share would be 4.9 per cent. This may be considerably higher than the real cost of new debt to larger regulated companies: for example, a company that was able to issue 20-year bonds for margin and fees of 2.3 per cent over index-linked gilts would incur a real cost of only 4 per cent (since the real yield on index-linked gilts is about 1.7 per cent).[1]

Debt share

8.53. We have assessed the cost of capital under two assumptions about debt share: 25 and 50 per cent. We have made initial financial projections on the basis of the debt share implied by the company's initial balance sheet together with the assumption that no additional equity is raised for example, by rights issues. We have then considered whether the resulting projections are consistent with our assumptions on cost of capital, in particular whether deterioration of financial ratios could trigger increased financing costs which would not be consistent with our assumed cost of debt. Our financial projections are summarized in Table 8.5.

8.54. During the course of our inquiry, Kelda plc, the owner of Yorkshire Water, proposed a radical restructuring of its business involving divestment of its regulated water business to a mutually owned company financed by debt. The Director issued a consultation paper on the issues raised and in particular on whether new licence conditions were required to strengthen management independence and accountability and encourage efficient procurement through competitive tendering. Kelda's proposals implied a much higher level of debt than the 50 per cent maximum suggested in paragraph 8.53 but it seemed to us that it remained uncertain whether they could be implemented and, even if they could be, whether they could be applied to small companies such as ESH. We did not therefore consider a very high debt case. Near the end of our inquiry, the Director issued a preliminary assessment of Kelda's proposal, indicating it was not acceptable to him.

Weighted average cost of capital

8.55. Table 8.4 shows our estimates of the WACC based on the above assumptions. For a 25 per cent debt share we estimate the WACC to be 6.1 per cent; and for a 50 per cent debt share we estimate the WACC to be 6.4 per cent. The WACC increases with the debt share because an increased debt share increases the riskiness and hence cost of both equity and debt and this more than offsets the effect of debt being cheaper than equity. These figures are based on a simple average of the cost of equity and debt and ignore tax savings due to increased debt. Our financial projections treat tax as a cost of the business and therefore we have not adjusted the WACC for tax. An alternative approach, used previously by the MMC, is to adjust the cost of equity for the tax that has to be paid by the company (and which cannot be recovered by shareholders): this is known as the pre-tax cost of capital. When the pre-tax cost of capital is used to compute the company's required revenue, tax is excluded from the company's costs. Appendix 8.3 explains further the different measures of WACC.

[1]The effect of any relevant institutional factors such as the MFR will be reflected in the corporate bond margin over gilts and it is therefore not appropriate to adjust the gilt yield for such factors in considering the real cost of debt.

TABLE 8.4 **Weighted average cost of capital**

per cent

	25% debt share	*50% debt share*
Assumptions		
Risk-free rate	3.0	3.0
ERP	4.0	4.0
Asset beta*	0.5	0.5
Debt share	25.0	50.0
Effective corporate tax rate	20.0	20.0
Cost of equity		
Equity beta*	0.7	1.0
Cost of equity (post-tax)	5.8	8.8
Small company equity premium	1.0	1.0
Adjusted cost of equity (post-tax)	6.6	7.8
Cost of debt		
Real interest rate	3.0	3.0
Debt premium	1.5	1.9
Cost of new debt	4.5	4.9
Total cost of debt	4.5	4.9
WACC		
Gross WACC (gross of the debt tax shield)	6.1	6.4
Tax-adjusted WACC		
Net WACC (net of the debt tax shield)	5.9	6.9
Pre-tax WACC	7.3	7.3

Source: CC.

Beta is quoted as a number not a percentage. Equity beta has been calculated as the average of the equity beta under Modigliani Miller assumption about capital market equilibrium, calculated as (Asset beta)(1+(1–Tax)*(Debt/Equity)) and the equity beta under Miller assumption, calculated as (Asset beta)*(1+Debt/Equity).

8.56. Table 8.4 also shows, for comparability purposes, two measures of a tax-adjusted WACC (see Appendix 8.3) which we have calculated using an average effective tax rate of 20 per cent (this is approximately the rate implied by our financial modelling):

(a) Our assumed WACC net of the debt tax shield is 5.9 per cent: this compares to the 5.5 per cent net WACC assumed for small companies by the Director. However, the Director's calculations of the tax shield were based on the marginal tax rate of 30 per cent and, if our WACC is adjusted to this basis, it reduces from 5.9 to 5.6 per cent.

(b) Our assumed pre-tax WACC is 7.3 per cent.

Table 8.4 suggests the tax-adjusted WACC is not sensitive to the level of debt share.[1]

8.57. The initial balance sheet described in paragraph 8.54 implies an average debt share for the five years of about 25 per cent and we have therefore assumed a WACC of 6.1 per cent in our financial projections.

Financial projections

8.58. We have projected the NPV of the revenue required by SESW on the basis of this WACC and the following assumptions:

(a) levels of opex set out in Chapter 7;

[1]However, our financial modelling suggests that the effective tax rate falls with increased debt whereas Table 8.4 assumes the effective tax rate is the same for different levels of debt. More precise calculations would show the pre-tax WACC (and hence implied K) decreasing somewhat as the debt share rises.

(b) levels of capex set out in Chapter 6 and the trends in capex prices relative to the RPI set out in Appendix 8.4;

(c) an initial RCV at 31 March 2000 of £86.9million at 1997/98 prices;

(d) the depreciation profile and asset lives for future capex discussed in Appendix 8.5;

(e) infrastructure renewals charge calculated by averaging real infrastructure renewals expenditure over the 15 years, 1995/96 to 2009/10, and unwinding any accrual or prepayment at the end of 1994/95 over the same 15 years;

(f) initial tax balances submitted by the company, the allocation of capex to asset life categories set out in Appendix 8.5 and a tax rate of 30 per cent. We also assumed (as did the Director) that infrastructure renewals expenditure continues to be fully tax deductible ie treated as operating expenditure in computing taxable profits. By contrast, SESW assumed in its projections that, from 2001/02, the tax treatment would change and that infrastructure renewals expenditure would instead receive the same tax allowances as other long life assets;

(g) an increase of 2.5 per cent a year in the RPI (based on the Bank of England's target); and

(h) full allowance for the Director's rolling incentive allowances for capital and operating expenditure efficiencies. These enable companies to retain the benefit of out-performance against previous projections for five years. Such adjustments (and in particular the expectation that similar adjustments will be made at the next Periodic Review) ensure that the incentive for companies to improve efficiency towards the end of each five-year period is not diminished.

8.59. We projected revenue assuming optional metering at 2.5 per cent of the 1999/2000 base of unmeasured households in each of the five years 2000/01 to 2004/05. In line with the company's assumption in its submission to us, we assumed the average consumption of unmeasured households switching to measured supply was 105m^3 per year (about 58 per cent of the 1999/2000 average for all unmeasured households). As regards other aspects of revenue (including volumes and number of connections) and receipts from grants and contributions, we found the company's projections were similar to those of the Director. Accordingly, we projected these other aspects of revenue on the basis of the company's assumptions in its submission, adjusted where appropriate for the actual 1999/2000 figures.[1] We modelled the operation of the tariff basket using the London Economics (LE) financial model which was also used by SESW and many other water companies.

8.60. We then calculated the level of K in years 2001/02 to 2004/05 that would equate the NPV of projected revenue to required revenue. We did not adjust K to offset the effect on prices of the refurbishment of Woodmansterne treatment works (see paragraph 6.48) being included in RCV.[2] We assumed the level of Po determined by the Director, as the company had already implemented this from April 2000. The NPV of our projected required revenue implied higher Ks than those in the Director's determination and we spread the adjustment over 2001/02 to 2002/03 with the larger part in the first of these years. Our methodology for calculating K is set out in Appendix 8.6 and the detail of our calculations is shown in Appendix 8.7.

8.61. We sent an initial draft of our projections (including details of the assumptions) to the company and Ofwat on 26 June 2000 and discussed the results at hearings with both the company and Ofwat. Our final projections (shown in Table 8.5) reflect also subsequent discussion with the company and with Ofwat.

[1]There was one exception to this: SESW projected rechargeable works revenue of £0.69 million for 2000/2001 to 2004/05 reflecting its expected level of revenue in 1999/2000. We projected rechargeable works revenue of £0.98 reflecting revenue received (at 1997/98 prices) in 1998/99. We did this because rechargeable works revenue recovers costs incurred and the base year for operating expenditure projections was 1998/99 (see Chapter 7). Our projection was put to SESW as part of the draft projections (see paragraph 8.61) and the company made no comment.

[2]At a late stage of the inquiry, the Director suggested that the approach to modelling should be to include Woodmansterne in the RCV and to increase the size of the Po reduction by 1.5 per cent after targeting the cost of capital.

8.62. Table 8.5 summarizes financial projections for our determination of K. Return on capital in 2000/01 is below the cost of capital reflecting the Director's Po reduction (which is larger than required by our findings), the costs of this inquiry which fall in 2000/01 and also the impact of the opex incentive allowance which is largest in 2000/01. The effect of our determination is to increase return above the cost of capital for the remaining years, 2001/02 to 2004/05, so that the company earns a return equal to the cost of capital for the five years as a whole.

TABLE 8.5 **Financial projections**

£ million, 1997/98 prices

	2000/01	*2001/02*	*2002/03*	*2003/04*	*2004/05*	*Total*	*Average*
Opex and revenue							
Opex (after efficiencies):							
Base opex							
Quality enhancement							
Enhanced service level							
Supply/demand balance							
Total							
Opex incentive allowance							
CCD	*Figures omitted. See note on page iv.*						
Infrastructure renewals charge							
Return on capital (pre-tax)							
Total revenue							
K (%)	–17.0	3.8	2.1	0.0	0.0		
Capex (after efficiencies, before real capex prices)							
Infrastructure renewals expenditure							
Base—non-infrastructure							
Quality enhancement							
Enhanced service level							
Supply/demand balance (net of contributions)							
Total							
RCV							
RCV (end year)							
RCV (average)	*Figures omitted. See note on page iv.*						
Rate of return							
Accounting pre-tax return on RCV (%)*							
Accounting post-tax return on RCV (%)*							
Adjusted post-tax return on RCV (%)*†							
Effective tax rate (regulatory‡) (%)							
Financial ratios							
HCA interest cover (times)							
HCA gearing (%)							
HCA ordinary dividend cover (times)							
Ordinary dividend (£m)							
Net debt as % of RCV (end year)							
Net debt (end year)							

Source: CC.

*Treats opex incentive allowance as a cost.
†See Appendix 8.6.
‡Tax charge used in computing post-tax rate of return divided by return on capital plus opex incentive allowance less net interest paid less exceptional items.

Comparison with projections of the Director and the company

8.63. The Director's projections for his determination are summarized at Appendix 8.8 and the company's projections for its statement of case to us (which differed in a number of respects from its draft BP submitted to Ofwat) at Appendix 8.9. Table 8.6 compares our determination of K with that of the Director and with the company's proposals.

TABLE 8.6 **Comparison of Ks**

	2000/01	*2001/02*	*2002/03*	*2003/04*	*2004/05*
CC	–17.0	3.8	2.1	0.0	0.0
The Director	–17.0	–5.0	–2.4	0.0	0.0
SESW (7% metering)	3.0	–1.2	5.0	5.8	6.6

Source: CC.

8.64. Table 8.7 shows our analysis of the factors contributing to the difference between our determination and that of the Director. We have analysed these differences, using our financial model, as follows:

(a) We have calculated the NPV[1] of the revenue generated by the Director's determination and the level of Po adjustment that would generate that NPV if K for years 2 to 5 was zero. We have described this as the notional Po adjustment.

(b) We then calculated the notional Po adjustment if the NPV of projected revenue is equal to the NPV of required revenue at our assumed cost of capital of 6.1 per cent, but maintaining the Director's other assumptions. For consistency we also altered the initial balance sheet to that in our own projections. The effect of this is to increase notional Po by about 2 per cent, reflecting primarily our not including the Director's 1.5 per cent reduction in Po associated with Woodmansterne treatment works.

(c) We then calculated the impact on notional Po of replacing the Director's assumptions, one by one, with those in our own projections.

The results of this exercise may depend to some extent on the order in which the assumptions are varied and may also depend on the details of the financial modelling. Table 8.7 shows that the main reasons that our determination has a smaller Po adjustment than that of the Director are: the absence in our determination of a broad equivalence adjustment, our projection of higher opex and capex as well as our removing the 1.5 per cent adjustment for Woodmansterne (see subparagraph *(a)* above).

TABLE 8.7 **Effect on notional Po of differences between CC assumptions and those of the Director and company**

per cent

	Director's projections	*Company's projections*
Notional Po for Director's and company's projections	–21.3	8.2
Effect on Po of:		
Cost of capital	2.0	–6.6
Broad equivalence	2.6	0.0
Opex	2.4	–1.4
Capex (net of capital contributions)	1.1	–6.7
Revenue (including meter optants)	–0.3	–3.9
Other*	0.0	–3.1
Notional Po for CC projections	–13.5	–13.5

Source: CC calculations.

*Includes calculation of infrastructure renewals charge, asset lives and allocations and other tax assumptions.

8.65. Table 8.7 also shows our similar analysis of the factors contributing to the difference between our determination and the company's proposed K. The main reasons for differences are lower capex, lower cost of capital, lower meter optants plus the impact of removing the company's assumption of a change in the tax treatment of infrastructure renewals expenditure.

[1]All NPVs were calculated assuming the WACC of 6.1 per cent (see Table 8.4).

Appendix C

Appendix C

4. Cost of capital and financial indicators

Introduction

4.1 The calculation of the Weighted Average Cost of Capital (WACC) is used to determine the allowed rate of return on the Regualtory Asset Base. It depends on estimates of the cost of debt finance, the cost of equity finance and an assumed level of gearing (the proportion of debt and equity):

- cost of debt: the cost of debt is made up of two components – the risk free rate and a company specific debt premium. OFWAT and OFGEM have also made a separate allowance for the cost of embedded fixed rate debt (i.e. long-term debt which the companies entered into when interest rates were significantly higher than current market rates); and

- cost of equity: the previous Regulator, as with other regulators, calculated the cost of equity using the Capital Asset Pricing Model (CAPM). Under this approach, the cost of equity is calculated from the risk free rate plus the equity risk premium (which reflects the risk associated with equity in general) multiplied by a company specific beta (which reflects the risks associated with Railtrack shares that cannot be diversified by holding a large portfolio of shares).

4.2 Consistency with the approach and assumptions adopted by other regulators and over time should help to minimise unnecessary uncertainty among investors about the returns which an efficient Railtrack can be expected to earn. The joint statement published on 8 October 1999 by the five regulators for water, telecommunications, rail, gas and electricity set out the arrangements for joint working including the working group on price control and the cost of capital. Given the current absence of a right of appeal for Railtrack to the Competition Commission, the Regulator believes that it is particularly important for him to have regard to relevant precedents (although he has given his support to Railtrack being given a right of appeal to the Competition Commission).

4.3 The Regulator considers that the most recent cases are likely to represent the most relevant precedents and he has therefore taken account of the approaches adopted by OFWAT and OFGEM in their respective reviews of the regional

electricity companies and the water and sewerage companies. He is aware that these other companies have argued that the approach adopted by their regulator is inconsistent with what the MMC has previously done (particularly with respect to the risk free rate). However, if any of them reject their regulator's proposed price controls and the matter is referred to the Competition Commission, the Regulator would be able to take this into consideration in reaching his final conclusions.

4.4 The way in which the Regulator has taken account of these precedents differentiates between generic assumptions which apply to any company (the risk free rate and the equity premium) and company specific assumptions (the debt premium, the equity beta and the level of gearing). Given the need for consistency, the Regulator considers that there is a strong case for adopting the same generic assumptions as those used by other regulators. With regard to the company-specific assumptions, he believes that the key question is whether the underlying risks faced by Railtrack are substantially different to those faced by other regulated companies. Whilst the Regulator has also reviewed the available evidence on each of the key assumptions, this implies that, if the underlying risks are the same, the appropriate allowed rate of return for Railtrack's core business would be the same as that allowed by other regulators.

4.5 The remainder of this chapter presents the Regulator's provisional conclusions on the following issues:

- the generic cost of capital assumptions;
- the extent to which Railtrack is different to other utilities;
- the implications for the company-specific cost of capital assumptions;
- the treatment of taxation;
- the appropriate cost of capital for use in the periodic review; and
- the role and values for other financial indicators.

Generic cost of capital assumptions

Risk free rate

4.6 The previous Regulator proposed a range of 2.25-3.0% for the risk free rate based on the current rates on index-linked bonds. By contrast, Railtrack argues that the use of current rates is inconsistent with the 'powerful and consistent

MMC precedent' and that it would be more appropriate to use a long term average rate of 3.5-3.8%.

4.7 Railtrack has recently provided a submission which claims that the previous Regulator, in focussing on current returns on index-linked bonds, put forward an unduly low range for the cost of capital. It argues that this view is supported by the following factors:

- its concerns which have emerged since December 1998 about the distortions in the market for index-linked bonds; and

- an alleged methodological error by the previous Regulator (and other regulators) in failing to include an allowance for inflation risk in his calculation of the risk free rate.

4.8 However, the range proposed by the previous Regulator encompasses the ranges used by OFWAT (2.5-3.0%) and OFGEM (2.25-2.75%). OFWAT notes that a recent London Business School (LBS) paper states that the standard cost of capital analysis always uses current market opportunity rates. OFWAT also argues that the combination of a forward looking cost of capital and an allowance for embedded fixed rate debt provides a more focussed assessment of required returns than can be given by historical averages. Similarly, OFGEM refers to recent evidence from the May 1999 Bank of England inflation report and analysis published by the Debt Management Office in July 1999 which suggests that the strong institutional demand and stable Government finances should continue into the medium term, indicating that the present rates are not unduly influenced by short term factors.

4.9 The Regulator also considers that if Railtrack considers that there are significant distortions in the market for index-linked bonds or significant inflation risks associated with other forms of financing, Railtrack should take account of these issues in deciding how best to finance its investment.

4.10 The Regulator is aware that the respective electricity and water and sewerage companies have generally adopted a similar position to Railtrack. However, unless any of these companies reject their regulator's proposals and are referred to the Competition Commission, he is minded to confirm the range proposed by the previous Regulator (2.25-3.0%). He notes that this range is substantially higher than the current real yield on long-term index-linked gilts.

Equity risk premium

4.11 The previous Regulator set out the evidence on the equity risk premium in the December 1998 periodic review document. This included reference to City analysts, other regulators and his own corporate finance advisers. Consistent with the intention to target a forward-looking cost of capital, he concluded that it would be appropriate to assume a value within the range 3.0-4.0%.

4.12 By contrast, Railtrack concludes that the appropriate value for the equity risk premium should be 3.5-5.0% based on previous MMC findings. Railtrack argues that, since the recent premium is at an historical low, a reasonable central estimate should lie within the upper part of this range.

4.13 Having reviewed the available evidence and given the need for consistency with other regulators, the Regulator is minded to confirm the range proposed by the previous Regulator. In order to identify a narrower central range for the cost of capital he proposes to focus on a central range of 3.25-3.75% for the equity risk premium (in line with the values assumed by OFGEM).

Is Railtrack different?

4.14 There are a number of elements to this question:

- assuming that the structure of Railtrack's charges becomes broadly cost-reflective (as is broadly the case with the form of control in other regulated utilities), would the underlying risks and the cost of capital associated with the core business be any different to those faced by these other utilities?

- if the structure of charges was modified to provide Railtrack with a positive incentive to promote growth, what impact would this have on the cost of capital?

- to what extent are the risks associated with enhancements different to those associated with maintenance and renewal and what are the implications for the cost of capital?

This chapter focuses exclusively on the first question. The potential impact of a volume incentive will be addressed if the Regulator decides to adopt this

approach next Spring. The rates of return applicable to enhancements are discussed further in Chapter 13.

4.15 Railtrack argues that there are many aspects of its operations which differentiate it from other regulated utilities. These are addressed in turn below.

4.16 First, Railtrack argues that, unlike other utilities, the scale of the task which it faces is large and has increased since privatisation. Although this may be true, these factors do not affect the forward-looking risks which now face the company (except, potentially, through indirect effects on other differentiating factors which are discussed below). The Regulator does not therefore believe that there should be any allowance for this factor in the cost of capital which is estimated for the periodic review.

4.17 Second, Railtrack asserts that the scale of enhancement investment over the next period is enormous (at least 100% of the RAB compared to 25% to 60% for other utilities). It is also claimed that the risk of capital expenditure overruns is higher in the rail industry than in other utilities and that the scale of certain projects is such that significant overruns could undermine Railtrack's ability to finance its relevant functions. However, it is the Regulator's present view that, even if these risks impact on the sustainable financial indicators (which are discussed in more detail below) or the cost of capital for enhancements (which is discussed in Part II), they should not influence the cost of capital for Railtrack's core business since this does not include major enhancement expenditure.

4.18 Third, Railtrack claims that it faces greater variations in its return on capital due to the following differences:

- it faces stronger financial incentives and penalties relating to the performance of its network; and

- it is dependent on a smaller number of relatively large customers who could become bankrupt.

However, the Regulator considers that to the extent that these risks are higher than in other industries, they are largely company specific and would not therefore contribute to a CAPM based estimate of the cost of capital (since only market related risks are reflected in the company's beta). In addition, he

considers that the risk associated with train operators' bankruptcy is relatively small since the Franchising Director would be able to step in to maintain the services.

4.19 Fourth, Railtrack argues that a given change in revenues or costs will have a relatively large effect on profitability since profits represent a smaller proportion of costs and revenues than in other utilities (i.e. its operational leverage is higher than other utilities'). This difference arises because the RAB is low relative to the company's expenditure requirements. For example, Railtrack estimates that operating expenditure over the next period is between 200% and 280% of the RAB, compared to ratios of 40% to 60% for other utilities. In the longer term, this difference will tend to decline since Railtrack's RAB is also expected to grow much faster than other utilities. At present, however, the Regulator considers that Railtrack's operational leverage is significantly higher than other utilities and that this should be reflected in the assumed cost of capital.

4.20 Finally, Railtrack indicates that financing is a major challenge. For example, it is argued that the company will not be able to tap the debt market opportunistically and that it will need to retain the option of raising further equity. Given the importance of investment, the Regulator agrees that it is important for him to be confident that the assumed cost of capital is sufficient to enable Railtrack to meet this challenge. This factor would therefore tend to support assumptions which are closer to the top end of the likely range of values than in other utility sectors.

Company specific cost of capital assumptions

Gearing

4.21 The appropriate level of gearing is discussed further in the section on relevant financial indicators. For the purposes of calculating the weighted average cost of capital, however, the Regulator proposes to assume gearing of 50% (defined as debt divided by debt plus equity). This is at the top end of the range assumed by the previous Regulator and in line with recent assumptions adopted by other regulators. In the long term, when investment in the network has stabilised, the Regulator believes that this level of gearing is likely to be seen as conservative.

Debt premium and allowance for embedded debt

4.22 The debt risk premium reflects the additional return required by the providers of debt finance to hold corporate rather than Government debt and can be estimated as a premium over the real risk free rate. It will depend on a range of company specific factors which are assessed by the rating agencies. Railtrack's current bonds are rated AA- and they have recently traded at between 140 and 170 basis points over the comparable gilt, depending on maturity. For comparison, BBB rated debt issued by electricity or water and sewerage companies recently traded between 100 and 270 basis points above the comparable gilt.

4.23 Railtrack has argued for a debt premium of 1.0-1.2% on the assumption that Railtrack's credit rating remains at or above a strong single A rating and that longer term historic rates are used for the risk free rate. The previous Regulator assumed a debt premium of 1.0-1.5%.

4.24 Given the assumption that Railtrack's gearing will increase to 50%, the Regulator is minded to adopt a range of 1.2-1.5%. This implies an overall real pre-tax cost of debt finance of 3.5-4.5%.

4.25 At future reviews, the Regulator would need to consider whether to make any allowance for any embedded long-term fixed rate debt which might be out of line with prevailing rates. In considering this issue, he would expect to have regard to the need for consistency with the mechanism for calculating the assumed risk free rate, the approach adopted by other regulators and comparisons with the financing options adopted by other similar companies (e.g. in relation to the choice between fixed, variable and index-linked debt).

Equity beta

4.26 A company's beta provides an indication of its riskiness relative to the market as a whole. It aims to predict the extent to which a company's share price would tend to change in response to changes in the level of the overall market and seeks to measure the company's non-diversifiable risk relative to equities generally. The equity beta depends on the overall level of gearing of the company since additional gearing increases the variability of equity returns.

4.27 The previous Regulator assumed an equity beta of 0.75 to 0.85 based on Railtrack's low historic level of gearing. Given this same level of gearing,

Railtrack argues that the appropriate range for its beta is 0.8 to 1.0. This is towards the top end of the range proposed by Railtrack's consultants since Railtrack discounts the recent share price movements as being unrepresentative due to the volatility associated with the periodic review.

4.28 If the equity beta that was used by the previous Regulator is adjusted so as to take account of an assumed gearing level of 50%, the result is an adjusted equity beta in the range of 1.20 to 1.35.

4.29 By comparison, OFGEM has assumed an equity beta of one (until recently OFWAT also assumed an equity beta of one). Since this equity beta is also based on an assumed gearing of around 50%, it is directly comparable with the ranges noted in the previous paragraph. The preceding section concluded that Railtrack does face greater risks than other regulated utilities (particularly because of higher operational gearing) and that it is important for the Regulator to be confident that his assumed cost of capital is sufficient to enable Railtrack to attract new debt or equity finance. This implies that Railtrack's equity beta would be higher than one (assuming 50% gearing).

4.30 This conclusion is supported by the MMC's assumed beta for BAA plc (which in some respects may be more similar to Railtrack – e.g. due to the scale of the construction programme). In 1996, the MMC assumed an equity beta for BAA of 0.7 to 0.9 based on 30% gearing. Assuming 50% gearing, the implied equity beta would increase to 1.0 to 1.25.

4.31 The Regulator believes that considerable caution is required in interpreting statistical evidence on equity betas. In particular, he notes that different results can be obtained by examining different time periods and that structural change may mean that estimates based on historical data are of limited relevance to the future. For example, Railtrack argues that the recent fall in its estimated beta is attributable to the uncertainty associated with the periodic review.

4.32 It is therefore necessary to look at the differentials between the estimated betas for different utilities over a period of time. Table 4.1 shows the London Business School beta estimates as published in the December 1998 periodic review document as well as the most recent estimates. In each case, the table shows the equity beta based on actual gearing, the asset beta (which assumes zero gearing) and the implied equity beta based on 50% gearing. It shows that Railtrack's beta has been around 0.1-0.2 higher than the average for other regulated utilities excluding BAA, when these are adjusted for gearing. These

data reflect the current structure of charges, in particular the very high fixed charge. However, if variable usage charges are increased to become more cost-reflective this would tend to increase the difference between Railtrack's observed beta and that for other utilities.

Table 4.1: A comparison of equity and asset betas

	Current gearing D/(D+E)		Equity beta current gearing		Asset beta no gearing		Equity beta 50% gearing	
	Dec 98	Dec 99	Dec 98	Dec 99	Dec 98	Dec 99	Dec 98	Dec 99
Water group	0.30	0.36	0.84	0.55	0.65	0.39	1.10	0.67
PES group	0.39	0.24	0.92	0.65	0.63	0.53	1.08	0.91
National Grid	0.21	0.36	0.66	0.57	0.47	0.41	0.81	0.70
BAA	0.25	0.27	1.06	0.97	0.84	0.77	1.43	1.31
BG	0.27	0.28	0.69	0.57	0.54	0.45	0.92	0.77
Average	0.28	0.30	0.83	0.66	0.65	0.51	1.10	0.87
Average exc BAA	0.29	0.31	0.78	0.58	0.60	0.45	1.02	0.75
Railtrack	0.10	0.18	0.73	0.61	0.68	0.53	1.15	0.90

4.33 In conclusion, for the reasons explained above, the Regulator currently proposes to assume an equity beta of 1.1 to 1.3 based on 50% gearing and assuming that the structure of charges is broadly cost reflective. Due to the identified differences in risk, this is 0.1-0.3 higher than the comparable betas which OFGEM has assumed for electricity companies. It is also consistent with the range assumed by the MMC for BAA.

Adjusting for taxation

4.34 The August 1999 periodic review document raised the question of the appropriate treatment of taxation. There are three alternative options:

- calculate a post-tax WACC but exclude the tax shield on debt and apply this to post-tax cash-flows assuming 50% gearing – this is the approach adopted by OFWAT and the previous Regulator;

- calculate a post-tax WACC and include the tax shield on debt and apply this to post-tax ungeared cash-flows – this is the approach adopted by Railtrack; and

- calculate a pre-tax WACC and apply this to pre-tax cash-flows – this is the approach adopted by OFGEM, OFREG (Office for Electricity and Gas Regulation in Northern Ireland) and, in most cases, the MMC.

4.35 As long as these different approaches are applied consistently, they should in principle give the same result (at least in the longer term). However, the rate of return which is applied to enhancements which are negotiated between reviews is inevitably calculated on a pre-tax basis (since it is not appropriate to calculate the tax effects of each individual project). The Regulator considers that it would be most appropriate to adopt the same approach at the periodic review. Adopting a different approach could create distortions, particularly where the residual value of these enhancements enters the RAB at a subsequent review. Using a pre-tax WACC also minimises the need for detailed regulatory involvement in Railtrack's tax and financing assumptions.

4.36 In its report on Cellnet and Vodafone, the MMC adjusted the cost of equity finance upwards by a tax wedge to take account of corporation tax payments. In calculating this tax wedge, the MMC assumed that companies would pay the mainstream corporation tax rate, giving a multiplier of 1/(1-0.3) or 1.429. OFGEM has adopted the same multiplier in its review of distribution price controls and the Regulator proposes to adopt this approach for the purposes of his provisional conclusions.

4.37 It is for consideration, whether the Regulator should take account of the fact that Railtrack's effective tax rate has historically been lower than 30%. However, the effective tax rate would need to be calculated on a forward-looking basis using a definition of profit which is consistent with the price control methodology.

Conclusions on the cost of capital

4.38 Table 4.2 below sets out the calculation of the pre-tax WACC based on the assumptions explained above. This results in a range of 5.9-7.9%. In the light of the uncertainty relating to the level of the risk free rate and the need for the Regulator to be confident that the rate of return is sufficient to enable Railtrack to raise new finance without undue difficulty, the Regulator proposes to assume a value towards the top end of his assumed range. The Regulator's provisional conclusion is that the appropriate value for the pre-tax real cost of capital is in the range 7.0-7.5% pre-tax. This is 0.5-1% higher than the value proposed by OFGEM on the same basis. For the purposes of his

provisional conclusions on Railtrack's revenue requirements he assumes a value of 7%.

Table 4.2: Railtrack's WACC

	Low	High
Cost of debt		
Risk free rate	2.25%	3.0%
Debt premium	1.2%	1.5%
Pre-tax cost of debt	3.5%	4.5%
Cost of equity		
Risk free rate	2.25%	3.0%
Equity risk premium	3.25%	3.75%
Equity beta	1.1	1.3
Post-tax cost of equity	5.8%	7.9%
Tax adjustment	1.43%	1.43%
Pre-tax cost of equity	8.3%	11.3%
Gearing	50%	50%
WACC pre-tax	5.9%	7.9%

Financial indicators

The role of financial indicators

4.39 Financial indicators and their trends are an important tool used by investors to assess the riskiness of a company's cash-flows. They therefore have a potentially important impact on both the cost of new finance and the company's capacity to raise new finance. It is, however, necessary to recognise that other factors, such as the perception of regulatory and commercial risks, also have a major impact on these issues.

4.40 The Regulator considers that the way in which Railtrack finances its investment requirements is a matter for the company. However, Chapter 2 described the role of financial indicators as a check that the conventional approach of setting the price controls does not make it unduly difficult for Railtrack to finance its licensed activities (including potential enhancement projects which are excluded from the baseline). Although there are a number of alternative ways in which Railtrack's investment requirements could be financed, he recognises that it is particularly important for him to have regard to the financial indicators which the debt and equity markets regard as significant. These will have a particular impact on the amount of investment

which Railtrack is able to finance from debt without having to raise new equity or cut dividends.

4.41 The Regulator has therefore undertaken detailed investigations into the financial indicators considered most important by relevant City institutions. This programme has included consultation with a range of equity and credit analysts, credit rating agencies and major lending banks. He has also consulted his corporate finance advisors, Singer & Friedlander, and discussed these issues with Railtrack and other industry parties. Finally, the Regulator has noted the financial indicators used by OFGEM and OFWAT in the water and electricity distribution price control reviews.

4.42 The remainder of this section considers the following issues:

- What are the relevant financial indicators?
- What is the appropriate credit rating for the Regulator to assume in setting price controls?
- What are the implied levels of the relevant financial indicators?
- Should the Regulator take account of dividends paid by Railtrack PLC to Railtrack Group PLC?

Relevant indicators

4.43 The Regulator's consultations support his view that the emphasis should be placed on cash-based financial indicators. The Regulator will therefore focus on earnings before interest, tax, depreciation and amortisation (EBITDA) interest coverage, funds from operations (FFO) interest coverage, FFO to total debt, and the ratio of net cashflow to capital expenditure. Other measures which are widely used in other circumstances will also be examined although the Regulator considers that these are likely to be less relevant in this case (such as EBIT interest coverage and conventional gearing). In addition, the Regulator considers that it is relevant to examine the level of debt as a proportion of the overall RAB (plus the value of assets which are excluded from the RAB) since the RAB represents the value of debt plus equity on the assumption that the company will earn only its cost of capital. The relevant financial indicators are defined in Table 4.3 below.

Table 4.3: Definition of relevant financial indicators

Indicator	Definition
EBITDA interest coverage	Earnings from continuing operations before interest, taxes, depreciation and amortisation *Divided by* Gross interest incurred before subtracting capitalised interest and interest income
FFO interest coverage	Funds from operations (i.e. net income from continuing operations plus depreciation, amortisation, deferred income taxes, and other non-cash items) *Divided by* Gross interest before subtracting capitalised interest and interest income
FFO to total debt	Funds from operations (as above) *Divided by* Long term debt plus current maturities, commercial paper, and other short-term borrowings
Net cashflow to capex	Net cash inflow from operating activities *Divided by* Total capital expenditure
EBIT interest coverage	Earnings from continuing operations before interest and tax *Divided by* Gross interest before subtracting capitalised interest and interest income
Gearing	Net debt (i.e. long term debt plus current maturities, commercial paper, and other short-term borrowings, less investments and cash at bank and in hand) *Divided by* Long term debt plus current maturities, commercial paper, and other short-term borrowings + shareholders' equity (inc preferred stock) plus minority interest
Debt to RAB	Net debt (as above) *Divided by* RAB plus value of enhancements not included in RAB

4.44 When considering the impact of his decisions on these financial indicators, the Regulator will take note of the trends over the second control period and beyond, rather than concentrating on the value of any single indicator at any one point in time. This forward-looking approach reflects the approach generally adopted by credit rating agencies, lenders and investors.

Applicable credit rating

4.45 Given Railtrack's current level of gearing, it is likely that it will look to raise a significant proportion of its immediate funding requirements from new debt. The credit rating given to Railtrack will play a key role in determining both the cost and availability of such funds. The Regulator has therefore consulted on the credit rating which he should assume when considering the appropriate level of the relevant financial indicators referred to above.

4.46 The Regulator notes that both OFGEM and OFWAT have required licensees to maintain an investment grade credit rating on their debt, the minimum investment grade categories being Baa3 (Moody's) and BBB- (Standard &

Poor's). These requirements are calculated to ensure that each company manages its affairs to maintain access to a wide range of sources of finance, readily and at reasonable cost. OFGEM also notes that it would seem reasonable for it to take account of this requirement in the periodic review.

4.47 The Regulator agrees that it is important for Railtrack to maintain at least an investment grade credit rating in the long term. He is also mindful of the potential scale of Railtrack's investment requirements at this stage in the development of the network and the construction risks associated with these investments. He therefore agrees that there may need to be a degree of headroom so that the rating is only likely to slip if there is a significant shock to Railtrack's costs or revenues or to the credit markets themselves. In the longer term, when the network is nearer to a steady state, he believes there should be less need for this type of headroom.

4.48 The Regulator's consultation process confirmed that a credit rating of BBB would not, in itself, prevent Railtrack from raising significant amounts of additional debt finance from the Sterling, Euro and US Dollar markets. However, a combination of factors means that a BBB rating might make it unduly difficult in practice for Railtrack to have confidence that it would be able to raise sufficient long-term debt finance at an appropriate cost. In particular, the sterling market is much smaller for companies with BBB or lower ratings. Whilst the market for long-term debt is very limited in the Euro-denominated market, both the Sterling and US Dollar markets do have considerable capacity to provide funds of sufficient maturity. However, the proceeds from US Dollar borrowings would need to be swapped into Sterling and such long dated swaps might be relatively difficult or expensive for a company with a BBB rating to obtain.

4.49 Railtrack's current rating is AA- from Standard & Poor's and A2 from Moody's. Railtrack has argued that the Regulator should set the price controls such that it is able to maintain a strong A rating (i.e. at least A+) in order that there can be no threat of the rating falling below A-. The Regulator presently considers that this degree of headroom may be unnecessary, particularly given the low underlying risks arising from the nature of regulation. He therefore proposes to assess his proposals against the relevant financial indicators that would be required to maintain a flat A rating (although several respondents suggested that a rating of A- would be reasonable).

The level of the relevant financial indicators

4.50 Standard and Poor's 1998 financial ratio guidelines for energy transmission and distribution companies suggest that for a BBB rating, FFO interest coverage should be around 2.0, FFO to total debt ratio should be around 10%, and total debt to capital ratio should be 65%. For a single A rating, these move to 3.25, 15% and 55% respectively. It is important to note that these guidelines are only indicative. Credit rating agencies also pay close attention to perceived levels of business risk and cashflow volatility (for example, Standard and Poor's quote higher interest coverage ratios and lower gearing for power generation companies at a given credit rating).

4.51 The recent determinations issued by OFWAT and OFGEM set out the ranges for financial indicators considered consistent with an investment grade credit rating. The Regulator notes that the figures quoted were broadly consistent with Standard and Poor's 1998 guidelines. Given the perceived differences between Railtrack and other utilities, the Regulator has considered the constraints on the financial indicators that would be consistent with maintaining a flat A credit rating. His provisional conclusions are set out in Table 4.4 which compares the proposed ratios with those used by OFGEM and OFWAT.

Table 4.4: Constraints on expected financial indicators

Indicator	ORR	OFWAT	OFGEM
EBITDA interest coverage	Min 3x	Min 3x	Min 2.25x
EBIT interest coverage	Min 2x		Min 1.5x
FFO interest coverage	Min 3x		Min 2x
FFO to total debt	Min 15%		Min 12%
Gearing (D/D+E)	Max 50%	Max 45-55%	Max 65%
Cashflow to capex ratio	Min >40%	Min 40%	

Dividends paid to the Group

4.52 Railtrack PLC has proposed substantial special dividends to Railtrack Group PLC. It argues that this strengthening of the Group balance sheet is necessary to enable it to proceed with Phase 2 of CTRL and the London Underground, and that this is different to the special dividends for unrelated diversification of other utilities.

4.53 Railtrack has argued to the Regulator that payment of these dividends will not jeopardise Railtrack PLC's ability to meet the reasonable requirements of operators and funders in the current control period. It has also indicated that in subsequent control periods the company would expect there to be no material impact providing the regulatory determination properly reflects the level of renewals spend required to sustain the network in the next control period and allows an appropriate return to be earned on enhancement investment.

4.54 The Regulator would be concerned if these dividends affected Railtrack's ability to finance major enhancements as part of the regulated business, including the possibility of new equity finance. He will therefore need to consider this issue further before reaching final conclusions.

4.55 In the longer term, the Regulator also intends to consider how Railtrack's network licence should be modified to require greater ring-fencing of the regulated business. He presently considers that it would be appropriate for him to introduce conditions similar to those which have been adopted in the electricity, gas and water industries. This might, for example, include a requirement for the company to maintain a specified credit rating.

Conclusions and next steps

4.56 The proposed ranges for the cost of capital and the appropriate financial indicators take account of the approaches taken by other regulators and the differences between Railtrack and other utilities. For consistency with the treatment of enhancements which are negotiated between reviews, the Regulator proposes to adopt a pre-tax measure of the cost of capital.

4.57 Consultees are invited to comment on the Regulator's provisional conclusion that the appropriate range for the assumed real pre-tax cost of capital is 7.0-7.5%. Consultees are also invited to comment on the relevance of other financial indicators as well as their proposed values and the appropriate credit ratios. Finally, consultees are invited to comment on the appropriate financial ring-fencing arrangements for Railtrack PLC.

Appendix D

Economic regulation & the CoC

Economic regulation and the Cost of Capital

- Annex -

November 2001

Civil Aviation Authority
CAA House, 45-59 Kingsway, London WC2B 6TE

TABLE OF CONTENTS

Appendix D.

Executive Summary

This is the Annex referred to in the CAA's November 2001 paper *Heathrow, Gatwick, Stansted and Manchester Airports' price caps 2003-2008, CAA Preliminary Proposals.*[1] It sets out in more detail the CAA's methodology for estimating the cost of capital.

The cost of capital is a key regulatory parameter for capital-intensive businesses such as airports. While the price cap is to be set in terms of the Civil Aviation Authority's (CAA) statutory duties for the 2003-08 period, the long term nature of airport investment problems and opportunities suggests that a long term view be taken to the maximum extent appropriate.

The CAA has taken a conventional approach drawing on best regulatory practice and the latest Competition Commission decisions in respect of generic parameters, up-dated to take account of the latest data. Firm-specific parameters have to be estimated from available data with a degree of judgement involved. Estimates for congested airports with major new projects in the pipeline may differ from airports with capacity available. It should therefore be noted that all figures presented in this section are estimated for the CAA's preferred regulatory option and apply both to BAA and Manchester Airport.

The cost of capital framework assumes debt to regulatory asset value ratios within a conventional range, certainly less than 100%. The CAA believes that the firm itself working with its financiers is best placed in deciding on its appropriate financial structure. If the firm decides to change its financial structure, for example through moving to a more highly geared structure, then, in the view of the CAA, the gains should be seen as efficiency gains and considered as such in the next price cap review. The CAA firmly believes that the associated risks will have to be borne by the firm and its financiers and not by the users. A changed financial structure should therefore not result in a higher future cost of capital for the assets in the regulated business.

The first part of this paper discusses the framework surrounding the cost of capital, the underlying assumptions and the uncertainties surrounding its estimation.

The latter part of this paper presents the CAA's estimates of the real post-tax and real pre-tax WACC and their components. The range for the pre-tax WACC will be 6.7%-8.6%, say 6.5% - 8.5%[2], with a mid-point of 7.5%; the range for the post-tax WACC is 4.7%-6.0% with a mid-point of say 5.3%. Those figures are calculated for the CAA's preferred regulatory option. The real pre-tax figure is the same as last review's real pre-tax figure for BAA and very close to last review's figure used for Manchester, which was 7.75%. However, in the current review the figure is arrived at in a slightly different manner. Both the cost of debt and the cost of equity are different compared with the last review, however as a full tax shelter has been allowed in the current review, the end-result is similar but the components of the WACC are different.

[1] This Annex is referred to in paragraph 16.1 in the main paper.

[2] We use the broader range in order to avoid a suggestion of (spurious) accuracy and hence have rounded the figures to 6.5% and 8.5%.

In response to its June 2001 consultation paper on the Cost of Capital, the CAA received six reactions. Apart from BAA's and Manchester Airport's responses (both requested confidentiality), the CAA has received responses from British Airways, Virgin Atlantic, the Symonds Group and Dr. John Cavalla. The CAA has taken note of all responses and the key issues raised are discussed in the appropriate sections.

1. Introduction

1.1 The cost of capital is the level of return required by the financial markets in order to provide capital to a firm. For a given level of return, rational investors will select the investment with the minimum risk; also for a given level of risk rational investors will select the project that maximises returns. Risk is caused by the possibility of different outcomes, which results in uncertainty.

1.2 The cost of capital is often a critical issue in the regulation of capital-intensive utilities via RPI-X regulation where small changes in the cost of capital can have a major impact on the price cap and investment. This is the case for airports.

1.3 The great level of uncertainty surrounding cost of capital estimations must be stressed. The first part of this paper summarises the theoretical framework relied on in estimating the cost of capital. Recent empirical evidence is presented which confirms the considerable uncertainties surrounding the estimation of the equity risk premium[3] and betas. The second part of this paper presents estimates of the various components of the cost of capital for the designated airports. The estimations are in real terms.

1.4 The CAA proposes to draw on what it considers to be regulatory best practice in coming to a conclusion on the key issues affecting the generic elements of the cost of capital (the risk-free rate and the equity risk premium). In doing so the CAA is aware of the fact that the data used to estimate these parameters exhibits high variances.

1.5 The CAA is conscious that investment is a priority and hence from that point of view, it would be preferable to set the cost of capital too high rather than too low given the considerable uncertainty in determining the 'true cost of capital'. Virgin Atlantic disagreed with this view, noting that designated airports are the only party that can challenge the level at which the price cap has been set by triggering a mid-term review and therefore the CAA should err on the side of setting a price cap tighter. British Airways acknowledges that there is clearly a risk that the estimated cost of capital is incorrect, however erring on the high rather than low side may not ensure adequate or timely investment and additionally will penalise users through the adoption of an inflated cost of capital figure.

1.6 The CAA does acknowledge that trade offs have to be made. The CAA's preferred regulatory option has to be sustainable in order to provide the right incentives to BAA and Manchester Airport in meeting capacity requirements in an efficient manner. The CAA therefore faces a trade off between setting the price cap (and thus cost of capital) high enough to ensure an efficient investment level but also keep the price cap tight enough to prevent too large rent transfers which would potentially render the preferred approach unsustainable.

[3] The equity risk premium (ERP) is the expected return on equities over and above the risk-free rate to compensate for the additional risk associated with investing in equities rather than risk-free securities and hence is not affected by firm specific factors.

2. The CAPM framework

2.1 The cost of capital is the level of return required by the financial markets in order to provide capital to a firm.

2.2 Efficient markets and constant conditional expected returns justify equating the cost of capital with the expected (arithmetic mean) return in multi-period discounting formulas.[4]

2.3 If conditional expected returns are time-varying, linking the discount rate to be used in multi-period discounting formulae to conditional expected returns is more complicated. When there is stochastic autocorrelated variation in the risks and/or prices of risk, and thus the expected one-period returns; market value is no longer equal to a sum of expected cash flows discounted at one-period expected (arithmetic mean) returns. Despite this, the cost of capital and present value as concepts are widely applied to cases where the expected returns are time varying.

2.4 Most cost-of-capital models are built on the assumption of efficient markets. According to the efficient market hypothesis, in an efficient market all relevant available information is reflected in the current price. As a result, the information embedded in prices can be used as a signal for the allocation of capital. The capital asset pricing model (CAPM) is one of the oldest and most widely used cost-of-capital models.

The main advantages and disadvantages of CAPM

2.5 The main advantages of an approach based on the CAPM are that (i) it is an industry standard specifically in the context of estimating appropriate return benchmarks for regulated industries; (ii) it is easy to implement and interpret; (iii) the implied 'beta' estimates for regulated industries can normally be expected to lie below, but not very far, from one, hence the approach is in practice fairly close to using the market return as the appropriate equity benchmark; (iv) the model is founded on reasonable and standard behavioural axioms.

2.6 The main drawback of the CAPM approach is that it is based on unobservable variables. This causes major conceptual problems. Empirically the CAPM based model has not performed particularly well. However there is no consensus if this is due to inadequate proxies for unobservable variables or a failure of the model itself (e.g. Roll's critique).

2.7 A further problem is caused by the high volatility of the data used for the estimation of a CAPM based model. As a result, a considerable amount of judgment is involved in an approach based on CAPM.

[4] Appendix 2 contains a short derivation of this multi-period discounting formula. For a detailed treatment, see Fama, E. F. (1996) "Discounting Under Uncertainty", *Journal of Business*, Vol. 69 No. 4, October 1996.

Alternatives to the CAPM

2.8 More recent alternatives to CAPM include multi-factor models[5] such as the three-factor model by Fama and French[6] and a macro-factor model by Chen, Roll, and Ross[7]. One of the big problems with multi-factor models is how to decide which factors to include without resorting to "data mining", as the latter would undermine the predictive powers of the model.

2.9 An alternative forward-looking methodology to the use of historical averages is the Dividend Growth Model (DGM) as used by Fama and French[8]. The DGM methodology is based on the principle that investors are concerned with expected cash flows and their present value, with the future stream of cash flow from equity being the expected dividend payments. The major difficulty in applying the DGM when estimating the current equity risk premium is how to determine the forward-looking expected annual dividend growth rate.

2.10 Therefore, having considered both the CAPM and alternatives to the CAPM approach, the CAA has decided to base its estimation of the cost of capital on the CAPM approach, whilst recognising the shortcomings of the CAPM approach[9].

The principles underlying the CAPM approach

2.11 The intuition behind CAPM is that investors are only rewarded for carrying non-diversifiable risk (also known as systematic or market risk). The rationale behind this is that firm-specific risk (also known as idiosyncratic or non-systematic risk) is diversifiable, i.e. it can be costlessly eliminated by spreading the funds over a large number of investments.

2.12 CAPM describes the equilibrium expected return on an asset as a function of its risk. In its basic form, CAPM states that $E(R_i) = r_{tf} + \beta_{i,M}[E(R_M) - r_{tf}]$, where $E(R_i)$ is the expected return on security i, r_{tf} the risk-free rate, $E(R_M)$ is the expected return on the market portfolio of risky assets, and $\beta_{i,M}$ the simple regression coefficient of security i's return on the market portfolio's return.

2.13 The "beta" of security i with respect to the market portfolio of the risky assets, $\beta_{i,M}$, is the risk of security i in the market portfolio divided by the variance of the market portfolio's

[5] CAPM decomposes returns into systematic and firm-specific components. However, R^2 of the market model (CAPM based regression) tends to be low, thus suggesting that only a small part of the variation in a stock's return can be attributed to variation in the market return. This suggests that systematic risk might not have one single source. Macro-factor models explicitly address this by including different factors capturing uncertainty about the business cycle, interest rates and inflation. Other multi-factor models include factors capturing book-to-market ratio, firm size etc., in order to include different sources of risk. However, this raises the question how to decide which factors to include, without resorting to data-mining, i.e. there should be a solid economic basis for including a certain factor.

[6] Fama, E. F. and French, K. R. (1993) "Common Risk Factors in the Returns on Bonds and Stocks", *Journal of Financial Economics*, Vol. 33.

[7] Chen, N., Roll, R., and Ross, S.A. (1986) "Economic Forces and the Stock Market", *Journal of Business* 59.

[8] Fama, E.F. and French, K.R. (2001), "The Equity Premium" to be published in *Journal of Finance*, The Center for Research in Security Prices - working paper No. 522, April 2001, University of Chicago Graduate School of Business.

[9] Fama, E. F. and French, K. R. (1996) "Multifactor Explanations of Asset Pricing Anomalies", *Journal of Finance*, Vol 51 No. 1, March 1996.

return. In the equilibrium, the expected returns of the securities are linearly related to their betas with the market portfolio. Only $\beta_{i,M}$ is necessary to explain differences in returns among securities. The expected return of an asset with $\beta_{i,M} = 0$ is given by the risk-free rate and the expected return of an asset with $\beta_{i,M} = 1$ is the same as the expected return on the market.

2.14 In cost of capital estimations an estimate of the firm's equity beta is required. An estimate of the firm's equity beta can be obtained by estimating the market model (i.e. CAPM type model) using historical returns. Like in the case of individual securities, the firm's equity beta reflects the co-movement of the firm's equity returns with the returns on the market portfolio, i.e. the asset's non-diversifiable risk explained by the returns on the market portfolio.

2.15 Non-diversifiable risk is the risk that cannot be diversified away by adding extra securities to the portfolio. Examples of non-diversifiable risk are: changes in interest rates and inflation. Generally speaking, non-diversifiable risk is likely to be a very small part of the firm's risk, as most of its risk will not depend on the performance of the market portfolio and hence is diversifiable. Examples of diversifiable risk are: new product innovations, changes in management, lawsuits, labour strikes etc.

2.16 Cyclical firms, i.e. firms whose earnings strongly depend on the state of the business cycle, do tend to have a higher than average degree of non-diversifiable risk and hence their equity betas tend to be greater than one (market portfolio has a beta of one). However, airports facing excess demand, i.e. constrained capacity, will be less vulnerable to the economic cycle. Thereby, regulated firms tend to have lower betas due to the fact that the regulator will ensure a reasonable rate of return as the caps are re-set. Ability to re-open caps is also relevant.

2.17 The main advantage of the CAPM approach in cost of capital estimations is that it enables a statistically more accurate measurement of a firm's or a project's expected return. Direct estimates of expected return are much more imprecise than direct estimates of risk. Thus, if one is confident in CAPM being an accurate description of reality, the CAPM approach enables a more precise estimation of expected returns by first estimating the risk and then using the risk estimate as an argument in the CAPM expected-return equation. More accurate estimates of expected returns result in more accurate valuation of risky streams of cash flows and therefore in a better allocation of resources.

2.18 Underlying the CAPM approach is a theory of investor choice based on conventional assumptions about the rational behaviour of individuals when confronted with the task of ranking risky alternatives. A typical derivation of the Sharpe-Lintner[10] CAPM makes the following assumptions:

[10] Sharpe, W. F.(1964) "Capital Asset Prices: A Theory of Market Equilibrium under Conditions of Risk", *Journal of Finance*,19 and Lintner, J. (1965) "The Valuation of Risk Assets and the Selection of Risky Investments in Stock Portfolios and Capital Budgets", *Review of Economics and Statistics*, 47.

i. Portfolio return distributions are normal;

ii. In choosing among the available portfolios, investors are only concerned with wealth to be received one period ahead, and the marginal utility of wealth is positive but declining with wealth;

iii. There is complete agreement among investors about the joint distribution of next period's payoffs on securities

iv. There is unrestricted risk-free borrowing and lending;

v. All assets are perfectly divisible; and

vi. All investors act as price takers.

2.19 The fundamental objects of choice from the investor's point of view are the payoffs offered by a portfolio in different states of the world through assigning probabilities to the various possible outcomes. The main way to assess different outcomes is by looking at a measure of location and a measure of dispersion. Assumption (i) about the nature of optimal portfolios implies that all relevant characteristics of portfolios are summarised by their expected return and return standard deviation (or, alternatively, return variance).

2.20 The investors' wealth one period ahead is a random variable, $\tilde{w}_{t+1} = (1 + \tilde{R}_{t+1})w_t$. Because the next period wealth is a linear function of the return, the wealth is normally distributed with mean $E(\tilde{w}_{t+1}) = (1 + E(\tilde{R}_{t+1}))w_t$ and standard deviation $\sigma(\tilde{w}_{t+1}) = w_t\sigma(\tilde{R}_{t+1})$.

2.21 By assumption (ii), the investor maximises her expected utility $E(U(w_{t+1}))$, where $U' > 0$ and $U'' < 0$. If the wealth distribution is normal, given the expected wealth she prefers lower variance of wealth and given the variance of the wealth she prefers higher expected wealth. Because the next period wealth is a linear function of the return, given the expected portfolio return she prefers lower portfolio return variance and given the portfolio return variance she prefers higher expected portfolio return.

2.22 The minimum variance opportunity set is the locus of risk and return combinations offered by portfolios of risky assets that yield the minimum variance for a given rate of return. The efficient set is given by the set of mean-variance choices from the investment opportunity set where for a given variance no other investment opportunity offers a higher mean return.

2.23 Given the investment opportunity set, the investor only invests in the efficient portfolios. That is, in the optimum, she will not invest in any portfolio A, if there exists a portfolio B with either (1) the expected return strictly higher than A's and variance lower or equal to A's or (2) the expected return equal or higher than A's and variance strictly lower than A's.

2.24 In the equilibrium, all investors must hold optimal (i.e., efficient) portfolios given the portfolio opportunity set they face. Otherwise they would have an incentive to trade and the markets would not be in equilibrium. In the presence of unrestricted risk-free borrowing and lending (assumption (iv)), the set of mean-variance efficient portfolios is the linear combinations of risk-free asset and the tangency portfolio of the risky assets with a positive weight on the tangency portfolio. That is, the set of optimal portfolio returns is

$R_x = (1-x)R_{rf} + xR_t, x \leq 0$, where R_t denotes the return on the tangency portfolio. The tangency portfolio is the mean-variance efficient portfolio of risky assets at the point that has a tangent (of the efficient frontier of risky assets) intersecting with the y-axis at the risk-free rate. Every efficient portfolio has the risky assets in same proportions.

2.25 By assumption (iii), all investors agree on the joint distribution of the payoffs of the securities one period ahead. Therefore, for any given set of candidate equilibrium prices, they also agree on the joint distribution of the returns. Because the investors agree on the joint distribution of the returns given the prices of the risky securities and the risk-free rate, they agree on the efficient set and the tangency portfolio (and the portfolio opportunity set in general). Hence, in equilibrium, all investors hold the same efficient portfolio of the risky assets, i.e. the tangency portfolio.

2.26 In equilibrium, the asset markets clear and all securities are held by some investors. (If the risk-free asset has zero net supply, the risk-free asset must clear at the rate where the net demand is zero.) The value-weight market portfolio of the risky assets is, therefore, the wealth weighted average of the individual investors' risky asset portfolios. All investors hold the same portfolio of risky assets, the tangency portfolio. Hence, the value weighted market portfolio of the risky assets equals the tangency portfolio.

2.27 Investors will have a utility maximising portfolio (R_p) consisting of a combination of the risk-free asset (r_{rf}) and the market portfolio of risky assets (R_M). As a result, each investor's portfolio will be situated on the Capital Market Line (CML), given by $E(R_p) = r_{rf} + \left[\left(E(R_M) - r_{rf}\right)/\sigma(R_M)\right]\sigma(R_p)$. The intercept of the CML is given by the risk-free asset, (r_{rf}), and its slope is given by the Sharpe ratio of the market portfolio, $([E(R_M) - r_{rf}]/\sigma(R_M))$.

2.28 For any minimum-variance portfolio e, the following relation holds $E(\tilde{R}_i) = E(\tilde{R}_{0e}) + \left[E(\tilde{R}_e) - E(\tilde{R}_{0e})\right]\beta_{i,e}$, where $\beta_{i,e} = \text{cov}(\tilde{R}_i, \tilde{R}_e)/\sigma^2(\tilde{R}_e)$ and $E(\tilde{R}_{0e})$ is the expected return on a portfolio of risky securities that has a zero covariance with the portfolio e. This relation holds for all securities i in the considered universe, if short selling is unrestricted. If short sales of risky securities are constrained, this relation only holds for securities whose short sale constraints are not binding (i.e. securities that have strictly positive weights on the portfolio.).

2.29 The value-weight market portfolio is efficient. Therefore, it is also a minimum variance portfolio. Hence, the following relation holds for all securities i: $E(\tilde{R}_i) = E(\tilde{R}_{0M}) + \left[E(\tilde{R}_M) - E(\tilde{R}_{0M})\right]\beta_{i,M}$, $\beta_{i,M} = \text{cov}(\tilde{R}_i, \tilde{R}_M)/\sigma^2(\tilde{R}_M)$.

2.30 By assumption (iv), there exists a risk-free security. The risk-free security has a zero covariance with the market portfolio of risky assets. Therefore, in the market equilibrium $R_{rf} = E(\tilde{R}_{0M})$. Substituting the risk-free rate to the linear pricing relation yields $E(\tilde{R}_i) = R_{rf} + \left[E(\tilde{R}_M) - R_{rf}\right]\beta_{i,M}$.

2.31 If there does not exist a risk-free security, but the short selling of risky securities is unrestricted, a different version of CAPM can be derived. Using the fact that a positively weighted linear combination of efficient portfolios is also an efficient portfolio, Black[11] derived the following version of the linear pricing relation: $E(\tilde{R}_i) = E(\tilde{R}_{0M}) + \left[E(\tilde{R}_M) - E(\tilde{R}_{0M})\right]\beta_{i,M}$, where $E(\tilde{R}_{0M})$ is the expected return on a portfolio of risky securities that has a zero covariance with the market portfolio.

2.32 Typically, the CAPM is applied to estimation of expected return on equity securities (i.e., the equity cost of capital). Despite this, in principle, the theory applies equally well to risky debt for which the CAPM assumptions are satisfied. However, since the promised yield of debt securities enables an efficient estimation of debt cost of capital via the comparable securities method, CAPM is used less often in the case of debt valuation. Conceptually, however, CAPM may be a useful way to think about the risk and expected return on debt.

[11] Black, F. (1973) "Capital Market Equilibrium with Restricted Borrowing", *Journal of Business* 45.

3. Practical problems surrounding CAPM and the WACC

3.1 The WACC formula[12] requires the cost of equity, cost of debt, tax rate, and capital structure as inputs. The cost of equity is estimated using CAPM, and requires the risk-free rate, beta, and equity risk premium (ERP) as further inputs. The cost of debt is determined by the comparable-securities method. Whereas the risk-free rate and to a lesser extent the debt premium can be estimated using current market data, the ERP and beta are estimated using historical data.

3.2 Considerable uncertainty surrounds the validity of the data used for the calculation of the cost of capital. This is partially due to the fact that the main variables in the CAPM are unobservable. This gives rise to major conceptual problems. Empirical failure of the CAPM model could therefore be the result of the use of inadequate proxies for the unobservable variables. Another problem is caused by the high volatility of the data. This section summarises the key issues involved in using the CAPM approach when estimating the cost of equity.

3.3 The CAPM is based on expected returns, however only past (i.e. realised) returns are observed. Therefore, the estimation of parameters such as beta and the ERP are based on average past returns, the idea being that past returns, on average, measure expected returns. In practical CAPM implementations, this raises two issues: (1) how to calculate average returns from historic data and (2) in how far are past returns on average a good measure of expected returns

Calculation of average returns: geometric or arithmetic average?

3.4 In order to calculate the ERP, we have to compare the average returns on equities with the average returns on either treasury bills or treasury bonds. The two main ways for calculating average returns are either by using a geometric average or an arithmetic average. The arithmetic average should be used if expected returns are constant and the estimation period is long. However, Fama[13] and Campbell[14] point out, that when returns are negatively serially correlated (i.e. periods of high returns are followed by periods of low returns and vice versa) the arithmetic returns might be misleading. The arithmetic mean is always larger than the geometric mean, therefore the arithmetic average might be overstating expected future returns over long periods of time. For example, the arithmetic mean of two returns of respectively +25% and –20% will be (25-20)/2=2.5% whereas the geometric mean is given by $\sqrt{(1+0.25)*(1-0.20)}-1=0\,\%$. The more volatile the sequence of returns, the greater the difference between the geometric and average mean return will be.

[12] See Appendix 1
[13] Fama, E. F. (1996) "Discounting Under Uncertainty", *Journal of Business*, Vol. 69 No. 4, October 1996
[14] Campbell, J.Y. (2001), *"Forecasting US Equity Returns in the 21st Century"*, Harvard University, http://kuznets.fas.harvard.edu/~campbell/papers.html

3.5 Dimson, Marsh and Staunton[15] show that the ERP based on arithmetic mean returns is considerably higher than the ERP based on geometric mean returns over the 1900-2000 period. This is not surprising, given the high level of volatility which characterised parts of the 20th Century, e.g. periods of hyper-inflation.

3.6 Campbell therefore argues that the geometric average is a better measure when taking the long-term perspective. Research by Campbell[16] shows that under the assumption of constant long-term growth of the economy, the geometric average return on US equity would no longer be 7% but rather would be in the 3.7% - 4.7% range.

In how far are past returns on average a good measure of expected returns

3.7 Fama and French[17] have pointed out that average past US stock returns are so high that they exceed estimates of the return to equity (ROE) for US corporations[18]. If the sample average ROE and stock return are representative of the population expectations, instead of investing corporations should have paid all their earnings to the shareholders. This conclusion is clearly very problematic and raises serious doubts about the sample-average methodology used for calculating the cost of capital.

3.8 However, under the assumption that the US corporate sector does not destroy value in the aggregate, one explanation might be that either (i) the average ROE was lower than the expected ROE or (ii) the average realised stock return was higher than the expected stock return.

3.9 It should be noted that typical methods for estimating the cost of capital assume that risk premia are constant. However, this is a very strong assumption. During the 1980s and especially during the 1990s it has been argued that the stock market has been irrationally high. One possible explanation for high stock prices would be a very low ERP. However, this is debatable: there is no consensus if high stock prices imply a low ERP or a high ERP.

3.10 Hall[19] argues that the equity risk premium should be interpreted in the context of cash flow growth. Swings in cash flow growth directly affect the capitalisation factor (ratio of value to current cash flow). A high capitalisation factor predicts either a decline in the future stock price or an increase in cash flow. During the 1990s, the stock market has been characterised

[15] Dimson, E., Marsh, P. and Staunton, M. (2001), *Millennium Book II: 101 years of Investment Returns*, ABN AMRO/London Business School, p.134
[16] Campbell, J.Y. (2001), *"Forecasting US Equity Returns in the 21st Century"*, Harvard University, http://kuznets.fas.harvard.edu/~campbell/papers.html, p.4
[17] Fama, E.F. and French, K.R. (2001), "The Equity Premium" to be published in *Journal of Finance*, The Center for Research in Security Prices - working paper No. 522, April 2001, University of Chicago Graduate School of Business.
[18] ROE (Return on Equity) is a tool used by investors in valuing the prospects of a company. By relating the earnings generated to the shareholders' equity the investor can see how much cash is created from the existing assets, therefore, all things being equal, a firm with a high ROE presents a better investment opportunity than a firm with a lower ROE. This method is most appropriate for medium to long term investment horizons and for firms with reasonably predictable earnings.
[19] Hall, R.E. (2001), "Struggling to Understand the Stock Market", *The American Economic Review*, Vol. 91, No.2, May 2001, p1-11

by high expected cash flow growth coupled with low discount rates thus resulting in a very high capitalisation factor. Hall stresses that cash-flow growth is the key factor in understanding movements in the stock market. The key to understanding the stock market generally and the equity risk premium more specifically is therefore the level of cash-flow growth.

3.11 Recently, it has been argued by economists such as McGrattan and Prescott and Jagannathan, McGrattan and Scherbina[20] that the structural equity premium[21] is now close to zero, this view would be consistent with the view that the market has reached a new steady state. Several explanations have been put forward to explain the current decline in the equity risk premium, e.g. (1) the strong economy has made investors more tolerant to risk[22]; (2) investors have initially overreacted to positive news about fundamentals in the 1990s[23]. If so, this would imply poor returns in the near future but a return to the historical levels once valuations have been restored.

3.12 In Campbell's view valuation ratios will return partially to historical levels but not fully because of the likely presence of negative serial correlation/mean reversion of stock returns during the 21st Century. If equity returns are indeed lower on average in the future then short-term as well as long-term real interest rates are likely to be somewhat higher. Therefore, the (real) equity risk premium will be reduced both because an increase in the risk-free rate and reduced risk aversion by investors as table 1 shows.

Table 1 Campbell's estimates of ERP and Risk-free rate

Equity risk premium		Risk-free rate	
Long run (geometric)	Long run (arithmetic)	Short term	Long term
1.5-2.5%	3-4%	3.0%	3.5%

(Source: Campbell, J.Y. (2001), 'Forecasting US Equity Returns in the 21st Century', Harvard University)

3.13 Nevertheless, as Campbell points out, these figures should be handled with care for policy purposes. Due to the high level of uncertainty a reasonably wide confidence band should be selected. Especially, due to its role in setting the price cap, the social loss function of setting the cost of capital either too low or too high should be taken into account. Unregulated industries could increase their capital stock when facing a fall in the equity returns i.e. a falling

[20] Campbell, J.Y. (2001), *"Forecasting US Equity Returns in the 21st Century"*, Harvard University, http://kuznets.fas.harvard.edu/~campbell/papers.html

[21] I.e Equity risk premium adjusted for inflation.

[22] Campbell and Cochrane found that investors judge their well-being by their consumption relative to a recent average of past aggregate consumption, however as Campbell points out the model they used might not be able to explain the more recent extreme market movements (see Campbell, 2001)

[23] Shiller (2000) in Campbell, J.Y. (2001), *"Forecasting US Equity Returns in the 21st Century"*, Harvard University, http://kuznets.fas.harvard.edu/~campbell/papers.html

cost of capital. The cost of capital for regulated industries should work similarly with real reductions eventually leading to lower output prices, more output, and capital being substituted for labour. The lags may be longer however.

Volatility of stock returns

3.14 Another issue when estimating the cost of capital based on the CAPM approach is the high variability of stock returns: there is a lot of "noise" in the data. The return on equity in the UK over the 1919-1998 period was 7.7% p.a. with a standard deviation of 22%. Assuming a normal distribution this implies that actual annual returns varied between –15% and +30%l For the US over the 1891-1998 period the equivalent numbers were 7.2% and 18.6% respectively.

3.15 Hence, if returns are white noise, and the true mean return is constant, then in the case of the UK the standard deviation of the estimate of the mean is 2.4%[24] and there is approximately a 95% chance that the true mean lies between 2.75% and 12.65%[25].

3.16 The implication is that under the constant-expected-returns assumption, the shorter the sample period, the bigger the variation is likely to be. As a result, the standard deviation of the coefficients estimated by CAPM over a five-year period will be very large thus displaying a high level of uncertainty about what the right figure should be. This is one of the main reasons why generally speaking returns over a longer period are preferred when estimating CAPM. The downside however is the increased risk of structural breaks in the data set, one of the most crucial assumptions underlying the use of CAPM in calculating the cost of capital is that of a constant population beta, i.e. beta is not time-varying.

3.17 As pointed out, considerable uncertainty surrounds the validity of the data used for the calculation of the cost of capital. This should be borne in mind when debate focuses on a point estimate of the cost of capital with a narrow range around it.

[24] The standard deviation of the estimate of the mean is $\sigma/\sqrt{T}$ hence in the case of the UK over a 77 year period it would be 0.22/8.89= 2.4%.

[25] Two standard deviations plus/minus the mean: 7.7-(2*2.4%) = 2.75% and 7.7+(2*2.4%) = 12.65%

4. Estimation of the WACC

4.1 In this section figures are presented for the various components of the WACC and corresponding pre-and post-tax WACC figures. The WACC combines all the costs of various types of financing into a tax-adjusted and capital-structure-adjusted estimate of the firm's cost of capital. In the WACC approach, the different sources of capital are weighted by the market value of the claims.

4.2 The WACC formula[26] requires the cost of equity, cost of debt, tax rate, and capital structure as inputs. The cost of equity is estimated using CAPM, and requires the risk-free rate, beta, and equity risk premium (ERP) as further inputs. The cost of debt is determined by the comparable-securities method. The expected return on risk-free fixed-income securities is adjusted upwards by adding a debt premium that reflects the systematic default risk.

4.3 The tax rate is another input in the WACC calculations, because of the tax benefit (i.e. tax shelter) provided by the tax deductibility of interest payments at corporate level.

4.4 The final input needed in order to calculate the WACC is the level of economic gearing[27]. The WACC approach assumes a stable capital structure, measured at market values. A stable capital structure implies that debt to regulatory asset value ratios have to be within a conventional range (i.e. certainly less than 100%). The level of economic gearing is determined by the market values of debt and equity, i.e. debt is valued at market rather than book values.

4.5 One of the issues involved when determining the gearing level is whether an optimal gearing level or actual/projected gearing levels should be used as inputs. As pointed out by British Airways in its response to the CAA's June 2001 Cost of Capital Position Paper, firms with too low a level of financial gearing might carry too high a cost of capital and hence in their view optimum gearing levels should be established. Although the CAA shares the view that the firm's capital structure is important in calculating its cost of capital, the CAA is not aware of any satisfactory model indicating what the optimal capital structure would be. To quote a leading authority Stewart Myers "There are to my knowledge no formally developed theories of capital structure derived from the conditions for efficient coinvestment of human and financial capital"[28]. As there are no adequate normative models available to allow regulators to take a view on the optimal gearing level, the CAA has decided on an approach based on actual gearing for its WACC under RRCB pricing. In the case of large investments such as Terminal 5 (see section on Terminal 5), the CAA has assumed a projected gearing level consistent with fundamentals with the airport's business plan, whilst remaining within a conventional range.

[26] See Appendix 1
[27] Also known as financial gearing.
[28] Myers, S. (2001), "Capital Structure" in *The Journal of Economic Perspectives*, Spring 2001, Vol.15, No.2, p.81-102

4.6 Finally, before presenting the figures for the various inputs of the WACC, it should be noted that all figures presented in this section are estimated for the CAA's preferred regulatory options unless stated otherwise. These are that RRCB pricing be applied at Stansted and Manchester airport, with a move to a more fixed price path at Heathrow and Gatwick airport.

Table 2: An overview of approaches adopted by other regulators and the MMC/ Competition Commission

Institution	Case	Basis of estimation	Risk-free rate, %	Equity risk premium, %	Equity Beta	Debt premium, %	Approach to gearing	WACC, %
MMC	BAA, 1996	Real pre-tax.	3.5-3.8.	4.0-5.0.	0.7-0.9.	0.3 - 0.8.	30% Estimated, but not optimal	6.4-8.3.
MMC	Cellnet-Vodafone, 1999	Nominal pre-tax.	6.5-6.8 (nominal); 3.5-3.8 (real).	3.5-5.0	1.27 (4 year average, LBS)	0.7 - 1.0.	9.1% Planned level	14.9-17.8. (nominal)
Ofwat	Water and sewerage charges, Nov. 1999	Real post-tax.	2.5-3.0.	3.0-4.0.	0.7 - 0.8.	1.5 - 2.0	50% Optimal	4.6-6.2.
Ofgem	PES review, December 1999	Real pre-tax.	2.25-2.75.	3.25-3.75.	1.0.	1.85 - 1.7 (adj. from 1.4 to reflect LT debt).	50% Optimal	6.0-6.9.
Competition Commission	Sutton and East Surrey Water August 2000	Real pre-tax	3.0	4.0	0.7 - 1.0	1.5 - 1.9	25% - 50%	7.3
ORR	October 2000 (based on Competition Commission central values)	Real pre-tax	3.0	4.0	1.1 - 1.3	1.5 - 1.75 (to reflect impact of gearing)	50% (assumed)	6.9 - 8.2
Ofgem	Transco September 2001	Real pre-tax	2.75	3.5	1.0	1.5 – 1.9	62.5%	6.0 - 6.25
Oftel	Effective Competition Review: Mobile, September 2001	Nominal pre-tax	5.2 (nominal); 3.0 (real)	5.0	0.94 – 1.86	1.0 – 1.75	10% - 30% Optimal	13.01 – 16.95 (nominal)

The Risk-free rate

4.7 The risk-free rate is an input both in the cost of equity and the cost of debt. The redemption yield on UK index-linked gilts provides a direct estimate of the real risk-free rate for different maturities.

4.8 At present, the yield curve for UK gilts is downward sloping. It has been argued that due to the Minimum Funding Requirement (MFR) increased demand has driven up the price of government securities whilst affecting their liquidity. The abolition of MFR might see a decrease in demand (resulting in higher yields). However, it is too early to judge the impact of the abolition of the MFR.

4.9 The most recent Competition Commission decisions[29] have used a (real) risk-free rate range of 2.75%-3.25% with a mid-point of 3.0%[30]. The Competition Commission has determined this risk-free range by correcting for specific UK liquidity factors that might have reduced the real yield on longer-term gilts. The main reason for this correction is that the risk-free rate is used to estimate the cost of equity and the cost of equity should not be affected by these liquidity factors. This decision followed previous (then) Monopolies and Mergers Commission's conclusions in relation to BAA (1996)[31], Manchester Airport (1997)[32], Northern Ireland Electricity (1997)[33] and Cellnet-Vodafone (1999)[34] where the real risk-free rate was assumed to be 3.5%-3.8%.

4.10 The Competition Commission's conclusions are based on UK index linked gilts' yields estimated by the Bank of England covering the period for which index linked stocks have been available, 1982. Therefore, the data do not provide a (very) long-term average of the type often used in estimating the risk-free rate.

4.11 The return on index-linked gilts since the mid-1980s has been higher than ex-post (historic) returns on government bonds over the twentieth century as a whole. Jenkinson (1999)[35] calculates that the real return on Treasury Bills from 1919-1998 was 1.7% (average annual) to 2.1% (average 10 year holding, annualised). The LBS Millennium Book[36] estimates a lower return of 1.0% p.a. over the century, which seems consistent with US data. However, it should be noted that the yield on index-linked gilts can not directly be compared with the ex-post returns on bonds. One possible explanation for the lower long-term figures might be

[29] See Table 2 for an overview of approaches adopted by other regulators and the MMC/Competition Commission
[30] Competition Commission (August 2000), *Sutton and East Surrey Water Plc, A report on the references under sections 12 and 14 of the Water Industry Act 1991*, London: The Stationary Office, chapter 8, page 118, paragraph 8.16.
[31] Monopolies and Mergers Commission (June 1996), *BAA plc, A report on the economic regulation of the London airports companies (Heathrow Airport Ltd, Gatwick Airport Ltd and Stansted Airport Ltd)*, London: The Stationary Office
[32] Monopolies and Mergers Commission (July 1997), *Manchester Airport plc, A report on the economic regulation of Manchester Airport plc*, London: The Stationary Office
[33] Monopolies and Mergers Commission (April 1997), *Northern Ireland Electricity Plc., A report on a reference under Article 15 of the Electricity (Northern Ireland) Order 1992*, London: The Stationary Office
[34] Monopolies and Mergers Commission (1999), *Cellnet and Vodafone: Reports on references under section 13 of the Telecommunications Act 1984 on the charges made by Cellnet and Vodafone for terminating calls from fixed-line networks*, London: The Stationary Office
[35] Jenkinson, T.J. (1999) "Real Interest Rates and the Cost of Capital" in *Oxford Review of Economic Policy*, 15(2), p.122.
[36] Dimson, E., Marsh, P. and Staunton, M. (2001), *Millennium Book II: 101 years of Investment Returns*, ABN AMRO/London Business School, p.57, table 13.

that they are the result of one-sided errors in inflationary expectations in the Twentieth Century. Smithers and Wright[37] argue that in periods when inflationary expectations have roughly been correct, the risk-free rate has been approximately in line with an estimate of around 3%. This figure is also consistent with for example the post-war experience in Germany, where the Bundesbank's control of inflation meant that there were no significant errors in inflationary expectations.

4.12 Ofwat[38], the Office of the Rail Regulator[39] and Ofgem[40] have opted for a more forward looking basis in their reviews by focusing on current market rates on index linked UK government stocks. Oftel[41] has opted for an approach based on the current estimates of yields on nominal gilts as a proxy for the risk free rate, proposing a nominal risk free rate of 5.1%. In its 1999 Periodic Review, Ofwat[42] proposes a real risk-free rate in the range of 2.5%-3.0%. The Office of the Rail Regulator[43] proposes a risk-free rate of 3% for Railtrack, which is based on the Competition Commission's central estimates of the risk-free rate for Mid Kent Water plc and Sutton and East Surrey Water plc. In its September 2001 paper on Transco, Ofgem[44] proposes a real risk-free rate of 2.75%.

4.13 Given short-term volatility and the investment focus of the current review, the CAA continues to be attracted to using historical data for the purposes of the risk-free rate. The CAA proposes a reduction in the risk-free rate compared with the last airport review[45] where a range of 3.5% to 3.8% was used. The current CAA judgement on the risk-free rate for the purpose of this review is that it falls in the range of 2.75%-3.25% with a mid-point of 3% in line with the Competition Commission's decision in the water cases.

Equity risk premium (ERP)

4.14 The equity risk premium (ERP) is the expected return of equities over and above the risk-free rate to compensate for the additional risk associated with investing in equities rather than risk-free securities. The ERP is a market-wide parameter and is not affected by firm specific factors. As expected returns cannot be observed, two different approaches might be followed in order to obtain an estimate of the ERP: (1) past returns as a proxy for future returns and/or (2) survey of investors' views. The CAA has not had access to any recent surveys in

[37] Smithers, A. and Wright, S. (2001), *"The Equity Risk Premium"*, London: Smithers & Co. Ltd., available from the authors on request
[38] OFWAT (1999), *Final Determinations, Future water and sewrage charges 2000-05*, Birmingham: OFWAT
[39] Office of the Rail Regulator (ORR) (October 2000), *Periodic Review of Railtrack's access charges: Final conclusions*, Volume 1, London: ORR
[40] OFGEM (2001), *Review of Transco's price control from 2002*, September 2001, www.ofgem.gov.uk/docs2001/56_transco.pdf
[41] OFTEL (2001), *Effective competition review: mobile*, September 2001, http://www.oftel.gov.uk/publications/mobile/mmr0901_an10_13.htm, Annex 11, sections A11.11 and A11.12
[42] Ibid, p 130
[43] Office of the Rail Regulator (ORR) (October 2000), *Periodic Review of Railtrack's access charges: Final conclusions*, Volume 1, London: ORR, p.46
[44] Ibid
[45] Monopolies and Mergers Commission (June 1996), *BAA plc, A report on the economic regulation of the London airports companies (Heathrow Airport Ltd, Gatwick Airport Ltd and Stansted Airport Ltd)*, London: The Stationary Office

order to judge the relevance and reliability of survey results. The CAA therefore favours the first approach in estimating the ERP.

4.15 Long-run time series tend to suggest an ERP for the UK in the range 4.7%-6.5%[46] relative to bills and depending on whether geometric or arithmetic means are used. Over the same time period, but relative to bond returns, the ERP for the UK has a slightly narrower and lower range of 4.4%-5.6%[47] again depending whether geometric or arithmetic means are used. Over the 1900-2000 period, estimates of the ERP in the US are in the range of 5.6%-7.5% relative to bills (roughly 100 basis points higher than the UK ERP over this period) and again depending on whether geometric or arithmetic means are used.

4.16 However, when looking at the underlying equity returns, Campbell[48] shows that under the assumption of constant long-term growth of the economy, the geometric mean return on US equity would no longer be 7% but 3.7% or at most 4.7%. This figure is confirmed by looking at the price-averaged earnings ratio, which would imply a 3.2% return forecast. These figures support arguments by regulators and the Competition Commission that ERP estimates may be over-stated as the best indicator of the forward-looking ERP because of the very high returns over the last two decades. Surveys of current market expectations are also drawn on to suggest that some shaving of these estimates is required.

4.17 In the previous review concerning BAA (1996) the Monopolies and Mergers Commission opted for an ERP within the range 4.0%-5.0%[49], whereas more recently in the and Cellnet-Vodafone case (1999)[50], the Monopolies and Mergers Commission adopted the midpoint of a slightly wider range of 3.5%-5.0%, i.e. 4.2%. In the water cases the Competition Commission used a central estimate of 4%, which was 50 basis points higher than Ofwat's central estimate.

4.18 Although acknowledging the importance of stability in regulatory decisions, more recently, the Competition Commission[51] argued that the small reduction in ERP was justified by the fact that long-term averages are lower than previously thought and also by continued high equity valuations.

4.19 In its most recent paper on Transco, Ofgem[52] suggests an ERP of 3.5%, whereas Oftel[53] considers an ERP of 5%. The CAA is inclined to accept the Competition Commission's

[46] Dimson, E., Marsh, P. and Staunton, M. (2001), *Millennium Book II : 101 years of Investment Returns*, ABN AMRO/London Business School, p.120, Table 25
[47] Ibid, p.125, Table 26
[48] Campbell, J.Y. (2001), *"Forecasting US Equity Returns in the 21st Century"*, Harvard University, p.4
[49] Monopolies and Mergers Commission (June 1996), *BAA plc, A report on the economic regulation of the London airports companies (Heathrow Airport Ltd, Gatwick Airport Ltd and Stansted Airport Ltd)*, London: The Stationary Office, p.83
[50] Monopolies and Mergers Commission (1999), *Cellnet and Vodafone: Reports on references under section 13 of the Telecommunications Act 1984 on the charges made by Cellnet and Vodafone for terminating calls from fixed-line networks*, London: The Stationary Office, p.65
[51] Competition Commission (August 2000), *Sutton and East Surrey Water Plc, A report on the references under sections 12 and 14 of the Water Industry Act 1991*, London: The Stationary Office, Chapter 8, p.121, paragraph 8.30.
[52] OFGEM (2001), *Review of Transco's price control from 2002*, September 2001, www.ofgem.gov.uk/docs2001/56_transco.pdf
[53] OFTEL (September 2001), *Effective competition review: mobile*, September 2001, http://www.oftel.gov.uk/publications/mobile/mmr0901_an10_13.htm, Annex 11 and OFTEL (February 2001), *Proposals for Network Charge and Retail Price Controls from 2001*, Annex E, paragraph E.13, http://www.oftel.gov.uk/publications/pricing/pcr0101.htm

conclusion in the water cases of a point estimate of 4.0%, therefore in the view of the CAA a reasonable range for the ERP would be 3.5% – 4.5% with a midpoint of 4.0% taking account of the CAA's proposals on the risk free rate. The midpoint is on the low side of the range used in the last airport review.

Beta

4.20 Under CAPM the cost of equity is defined as the risk-free rate plus the product of the equity risk premium and equity beta. The equity beta coefficient is an adjustment to the equity risk premium based upon the risk perception for the firm in question, i.e. it can be characterised as a measure of the non-diversifiable risk of the firm or investment project (it measures the cash-flow risk to the firm's equity holders[54]). The asset beta[55] on the other hand, measures the underlying business risk faced by the whole firm independent of its level of gearing.

4.21 Where a firm's shares have a track record of being traded in a liquid stock market over time, historical estimates of the firm's equity beta can be estimated using movements in the firm's share price and dividend payments relative to the entire stock market. Such data is available for BAA as a whole, including its non-regulated activities. No such data is available for Manchester Airport, which is owned by local authorities.

4.22 The most recent London Business School Risk Management Survey gives BAA's equity beta as 0.79. This follows recent falls from a level above 1.0 in 1998 and 1999, which perhaps reflected the windfall tax and uncertainty over the phase out of duty free. In the 1996 MMC review BAA put forward a beta of 0.9. The MMC's conclusion was to use a range of 0.7-0.9 for the beta. A similar number was implicitly used for Manchester Airport.

The effect of regulation on beta

4.23 An important parameter determining the equity cost of capital, the equity beta, might differ depending on what regulatory option is chosen. In its December 2000 Consultation Paper[56] the CAA pointed out that the scope for regulatory failure is extended under the single till approach. Under the single till, the commercial side of the airport business, e.g. retail, which would normally not be subject to ex-ante economic regulation is affected by price caps. This might result in reduced incentives to develop these commercial businesses fully and

[54] Some confusion may arise between non-diversifiable risk and the expected return on assets. In a competitive market technology risk could affect the expected return on a project, without having any impact on its beta. If technology risk were to increase, for example, then the expected return on the project might fall. Thus the project may no longer pass the cost of capital hurdle. But the cost of capital itself should not change (as long as the technology risk is indeed diversifiable). In a regulated industry the impact on the expected return is likely to be softened since the regulator is likely to allow a return on appropriate capital expenditure, even where its *ex post* value is less than anticipated. Of course, the impact of regulatory risk might be greater where there is significant technology risk.

[55] See Appendix 3 for formulae portraying the relationship between the equity beta and asset beta.

[56] CAA (2000), *"The 'Single Till' and the 'Dual Till' Approach to the Price Regulation of Airports"*, Consultation Paper, December 2000, www.caaerg.co.uk

efficiently. It might also result in the aeronautical side of the business (at least partially) being driven by the performance of the commercial businesses.

4.24 In its response to the June 2001 Cost of Capital paper, which presented potential ranges for the components of the cost of capital, Virgin Atlantic[57] argued that the airports currently face both low financial risk and low operational risk. Especially in the case of Heathrow and Gatwick carriers would tend to operate services with smaller aircraft rather than withdrawing services altogether in response to an economic downturn, given the severe capacity constraints. Virgin Atlantic therefore argued that aeronautical revenues at these airports vary less over the economic cycle than at some other airports. It also argued that revenues from commercial activities vary less over time and hence that BAA's beta estimated by the CAA was too high.

4.25 British Airways[58] accepted that the airport's commercial revenue streams are by no means risk-free, but questioned the level of risk attached as the revenue is generated by a captive and growing market provided by the airlines.

4.26 However, in the view of the CAA, the equity beta might actually be reduced when moving to RRCB pricing due to the fact that the potential of regulatory failure is reduced, and the risk faced by a regulated monopoly may be lower than that faced by commercial businesses facing competition. By only regulating the aeronautical side of the business, beta will be mainly a function of the number of passengers[59].

4.27 To quantify the impact of the above effects on beta two different approaches might be followed. Either the company beta for BAA plc and other airport companies' betas might be taken as a basis for the beta of the regulated part of BAA and Manchester Airport or the betas of companies which are likely to have similar systematic-risk characteristics as the regulated parts of airports might be used as an indicator of the beta of the regulated part of BAA and Manchester Airport. It should be clear from the earlier discussion that in both approaches a considerable amount of judgment is involved in deciding on the appropriate beta.

4.28 Other regulated firms may be partial comparators, e.g. Transco, National Grid and Railtrack (pre-administration). The main attraction of using other utilities as comparators is that their beta may reflect an element of regulatory risk and that their profits are strongly influenced by price controls. Ofgem records equity betas of 0.68 for Railtrack and 0.66 for the National Grid Group[60]. Ofgem estimates that Transco has an equity beta of 1.0, consistent with the average risk for the market as a whole. The Office of the Rail Regulator's [61] conclusions on

[57] Virgin Atlantic's response was written mid-July 2001.

[58] British Airways response to the CAA's June 2001 Cost of Capital paper was written in August 2001

[59] The inclusion of service quality in the price-cap would have a (slight) hedging effect. However, as this effect is likely to be very small the CAA has decided not to reduce beta.

[60] OFGEM (June 2001), *Review of Transco's price control from 2002*, Draft Proposals, paragraph 7.50, p.158

[61] Office of the Rail Regulator (ORR) (October 2000), *Periodic Review of Railtrack's access charges: Final conclusions*, Volume 1, London: ORR, p.42

Railtrack's equity beta used a range of 1.1-1.3 reflecting the projected increased level of operational gearing[62].

4.29 There are differences between the above comparators and the designated airports however. The airports have large commercial income that will no longer be subject to regulation under RRCB pricing. The commercial activities will be subject to greater competition than the core regulated business and hence it might be expected that their beta will be higher.

4.30 As indicated elsewhere in cases of excess demand, e.g. Heathrow and Gatwick, the CAA is proposing to move towards a more fixed price framework. Compared to cost of service regulation this implies greater risk. For its incremental cost calculations the CAA has therefore used a beta in the range of 0.9 – 1.1, reflecting the higher level of risk involved in a move to output-based renumeration. This would apply to additional assets and Terminal 5. For its financial modelling purposes the CAA has used a beta of 0.8.

Impact of major investments on beta

4.31 Most of the risk involved in building projects as Terminal 5, e.g. the risk of cost overruns, could be seen as diversifiable risk. Due to the high sunk costs, operational gearing is likely to increase. Often a positive relationship between operating leverage and systematic risk is assumed, however it is not clear why this type of risk could not be diversified.

4.32 Nevertheless, it could be argued that high levels of operational gearing potentially magnify the effects of higher levels of financial gearing, especially considering the fact that beta will mainly be a function of the number of passengers. As a result, the potential impact on profits of relatively small levels of underperformance might increase BAA's vulnerability.

4.33 In the case of regulated firms, like utilities, it seems that despite considerable increases in gearing levels, their equity betas have remained reasonably constant. This has led SBC Warburg to argue that the gearing adjustment suggested by conventional finance theory might not be applicable if the starting level of debt was low[63]. It could be argued that not only in the case of utilities but also in the case of airports the starting level of debt is on the low side. Hence, increased gearing levels might have less effect on the firm's equity beta than suggested by conventional theory. However, it should be noted that the cost of capital framework assumes debt to regulatory asset value ratios within a conventional range, certainly less than 100%.

Estimates of BAA's equity beta for the next five years

4.34 Having taken the various factors into account, the CAA would argue, that given the great level of uncertainty surrounding the estimation of beta, and after considering the various effects of a change in regulatory regime, the equity beta for the aeronautical side of the

[62] A high level of operational gearing implies a high proportion of fixed costs relative to variable operating costs. It has been argued that this results in greater business risk.
[63] Quoted in NERA (2001), *Aer Rianta's Cost of Capital, A Final Report for Aer Rianta*, June 2001, http://www.aviationreg.ie/downloads/appendix5.pdf, paragraph 4.4.3.1

business is still likely to fall within the current range (0.7-0.9) and therefore the mid-point of this range (i.e. 0.8) would be the best representation of BAA's equity beta for cost of capital calculations. However, for its incremental cost calculations the CAA has used an equity beta in the range of 0.9 - 1.1, reflecting the higher level of risk involved in a move to output-based renumeration.

Debt premium

4.35 The cost of debt consists of the risk free rate plus the debt premium. Financial markets demand a premium on corporate debt over equivalent gilts to allow for the greater risk of default on corporate debt. The cost of debt is the incremental cost of debt, i.e. not the existing debt. It is necessary to take into account the incremental cost of raising debt as existing debt may have been contracted when interest rates were different. However, the CAA does not have a financing duty for airports, in the view of the CAA embedded debt is like any other cost pass-through.

4.36 The debt premium of regulated firms is likely to be lower than that of non-regulated firms, due to (1) the protection provided by regulation and (2) the limited competition faced by regulated firms. However, given recent developments, investors will be carefully considering the totality of the regulatory regimes, the potential risks involved and available mitigation strategies.

4.37 According to OXERA[64] the appropriate future premium on BAA debt is 1.40%. This is higher than the range used by the Monopolies and Mergers Commission for BAA's regulated business in 1996 which was 0.3%-0.8%. At the last review Manchester Airport advised the Monopolies and Mergers Commission that their premium was 0.8%[65]. However the CAA notes that recent regulatory decisions have used estimates in the 1.5%-2% range. For example, the Competition Commission in the Sutton case used a premium of 1.5% with gearing of 25%, rising to 1.9% with a gearing of 50%. Nevertheless it could be argued that this comparison is inappropriate as Sutton is a much smaller firm than BAA.

4.38 It has also been argued that the debt premium should incorporate an adjustment for inflation risk. However, the independence of the Bank of England with respect to monetary policy could be argued to reduce long-term inflation risk as observed over most of the twentieth century. The debt premium is by definition a premium over the risk-free rate. The risk-free rate has been estimated using yields on index linked bonds, which are largely insulated from inflation risk (timings of adjustments may leave some residual inflation risk). However, the debt premium has been estimated using comparisons on yields on corporate debt with nominal gilts. If the risk of inflation differing from expectations is not diversifiable, nominal gilt yields may be subject to a degree of systematic risk. The standard method of measuring the cost of debt would not allow for this. There are the usual problems of measurement of market expectations of inflation here.

[64] OXERA (2001), Response to questions raised by the CAA
[65] Monopolies and Mergers Commission (July 1997), *Manchester Airport plc, A report on the economic regulation of Manchester Airport plc*, London: The Stationary Office, p. 69, paragraph 4.38.

4.39 The CAA also notes that there may be other explanations for any premium on nominal gilts over index linked gilts, such as differential tax treatment. The CAA believes that this is relevant to the assessment of the pre-tax cost of capital 'tax wedge', but is not inclined to allow an inflation premium on the debt premium.

4.40 In the recent water cases, the Competition Commission pointed out that the cost of debt does not only depend on interest payments but might also include fees. The CAA acknowledges the fact that fees are a factor to be taken into account, however, if fees were to be incurred they should clearly be treated as one-off costs.

4.41 It is important to understand that for a risky bond the promised yield is not equal to the expected return. The promised yield is the maximum possible return if the bond is held to maturity. In the case of a default, the actual return will be lower. Therefore, if the probability of default is non-zero, the expected return on debt (and thus the cost of debt) is lower than the yield. On the aeronautical side (i.e. the regulated side of the airport), it could be argued that debt becomes less risky because of the potential of earning normal returns (hence the default probability decreases). However, with the commercial side no longer being regulated, the insurance effect provided by regulation is removed. Therefore, the debt premium for the commercial side might slightly increase. Due to a non-zero default probability, the cost of debt will be lower than the yield. In practice, the two sides of the firm will not be able to borrow separately; ultimately it is BAA plc that issues corporate bonds. The effect of RRCB pricing on the debt premium is therefore likely to be somewhat ambiguous.

4.42 Apart from the above, the main reason why the CAA remains cautious about increasing the debt premium is BAA's continued low gearing and high level of credit worthiness as supported by current trading figures for BAA's existing short-to-medium term debt.

Impact of major investments on the debt premium

4.43 The debt premium will vary depending on perceived risk with gearing being a major factor. If projects such as Terminal 5 are mainly financed through gearing, investors might require a higher debt premium in order to hold BAA corporate bonds. As only BAA plc issues bonds, this might be expected to result in an increase in its debt premium. However, in the view of the CAA gearing levels should be consistent with fundamentals with the airport's business plan. Hence, gearing is expected to remain within a conventional range.

4.44 Taking all the above into account, the CAA proposes to increase the range to 50-100 basis points as being a reasonable range within which the debt premium for BAA's and Manchester Airport's regulated business should be under the RRCB approach. BAA's gearing is likely to increase if its proposed investment programme is delivered as planned, however it is expected to remain within a conventional range. For the purpose of its incremental cost calculations, the CAA has therefore used a debt premium in the range of 80 - 120 basis points.

Gearing

4.45 Gearing can be calculated in various ways. In the view of the CAA, for the purpose of price regulation gearing should be calculated as economic gearing, i.e. economic value of debt divided by the regulatory asset base (RAB), this implies that debt is valued at market rather than book values. The CAA has used gearing levels in the range of 20% - 30%. BAA's actual economic gearing at 31 March 2001 falls into this range.

4.46 Gearing can have positive as well as negative effects. Up to a certain level, increasing gearing reduces costs through exploiting the tax shield (i.e. interest payments are tax deductible), however, a too high level of gearing might result in increased risk. Hence it is often argued that firms (and/or regulators) should aim to achieve an optimal capital structure. For example, in its response to the June 2001 Cost of Capital paper, British Airways argued that the CAA should aim at establishing optimal gearing levels.

4.47 The CAA has examined the approaches followed by other regulators as well as recent academic literature. Approaches followed by other regulators and the Competition Commission can be found in Table 2. With respect to academic literature, Hart's recent study of financial approaches[66] illustrates both the positive and negative effects of gearing by examining the dynamic relationship between the various stakeholders (through assessing who has the control and decision-making rights). Hart argues that the diversity between stakeholders (especially debt and equity holders) could be seen as part of an optimal mechanism when intervention by an outside investor is costly due to the fact that creditors impose discipline on the firm's management in a way that shareholders won't be able to do (due to the costs involved). Diversity is therefore positive as it changes incentives. Hart therefore concludes that heterogeneous claimants are able to put more pressure on the management than homogeneous claimants when intervention is costly. However, if the debt level becomes very large, then the disciplinary role of debt will be lost.

4.48 Both theoretical and empirical evidence seem to suggest that the firm's capital structure does matter. However as far as the CAA is aware, there is no adequate theory and neither a normative model that would enable a regulator to establish this "optimal" gearing level. The CAA will therefore use the actual (or projected) gearing as an input into calculating the cost of capital.

4.49 As pointed out by Hart, very high levels of debt might not only have positive effects (e.g. efficiency gains) but might also have a negative side (i.e. increased risk). This risk should be borne by the firm and its financiers and not by the users. In the view of the CAA the firm itself working with its financiers is best placed in deciding on its appropriate financial structure. Therefore, if the firm decides to change its financial structure, this should not result in a higher future cost of capital for the assets in the regulated business.

[66] Hart, O. (2001), *"Financial Contracting"*, Working Paper 8285, US:National Bureau of Economic Research, http://www.nber.org/papers/w8285

Tax

4.50 The treatment of tax is an important issue in the determination of a firm's cost of capital:

- corporation tax is a charge on corporate profits which, for a price regulated firm, are largely determined by the regulatory assessment of the cost of capital;
- timing differences between the liability to tax and the recognition of accounting profits are generally associated with capital transactions;
- the liability to corporation tax is significantly influenced by the capital structure of the firm, notably by the mix of debt and equity;
- the tax position of shareholders and bondholders is, in principle, influential in determining the cost of equity and debt with firms being price takers in respect of capital in competitive international capital markets.

4.51 Convention to date seems to have allowed for full or near-full adjustment of the cost of capital by the tax benefit given by the deductibility of interest payments at the corporate level.

4.52 The extent to which a firm can use tax shields should be reflected in its cash flows. Whatever tax advantages the firm possesses will be priced out in a competitive market. It can be argued that the relevant tax rates that are "incorporated" in the pricing of capital assets in competitive capital markets must therefore also take account of personal tax rates. This is particularly the case where the corporation tax can be regarded as a withholding tax[67]. While the top marginal personal tax rate is higher than corporate tax rates in the UK and the US, the concessions[68] in respect of the tax treatment of capital gains may mean the relevant effective personal tax rate is lower than the corporate rate. Plausible estimates of the relevant effective tax rates imply that the true tax shelter given by the deductibility of debt at the corporate level may be much smaller, non-existent or even negative[69].

4.53 The post-tax approach is used by Ofwat to assess the cost of capital for water and sewerage firms so that the effects of different tax and investment circumstances can be taken explicitly into account. The pre-tax approach is used by other regulators such as ORR and Ofgem, generally applying a relatively simple adjustment to the cost of capital: "grossing up" the post-tax cost of equity by the corporation tax rate. Provided the two approaches are handled consistently there should be no difference between them[70].

[67] See for example Copeland, T.E. and Weston, J.F.(1992), *Finance Theory & Corporate Policy*, 3rd Edition, p.541 and Auerbach, A.J. (2001),"Taxation & Corporate Financial Policy", NBER working paper 8203 April 2001

[68] From the perspective of a comprehensive income tax.

[69] Fama and French could not find any statistical evidence that interest tax shields contribute to the market value of the firm (Fama, E.F. and French, K.R.(1998), 'Taxes, Financing Decisions, and Firm Value' in *Journal of Finance*, June, 53:3, pp.819-43).

[70] LECG (2000), "*Analysis of the Proposed Introduction of a New Method of Estimating the Costs of Tax & Capital*", 18 April 2000.

Effective versus statutory tax rates

4.54 Because of timing differences between the tax and statutory accounting rules effective and statutory tax rates can differ. The effect of inflation on the real value of capital allowances does reduce the impact of this deferral in present value terms. On the other hand, the existence of inflation means that airports will receive tax relief not just for the real cost of debt imputed in the CAPM model, but also on the inflation element of nominal interest payments. This is a real tax benefit. The combined effect of accelerated capital allowances and the tax treatment of interest would reduce the effective tax rate for airports over the investment cycle, reducing the size of the tax-wedge necessary to ensure that the pre-tax cost of capital covers the cost of debt, normal equity returns and the cost of tax.

4.55 In the last regulatory decision on airports the Monopolies and Mergers Commission and the CAA used the statutory corporation tax rate in the cost of capital calculations. In the water cases the Competition Commission used the effective tax rate calculated from their financial modelling. The CAA is reluctant to change existing regulatory practice for airports without careful analysis and modelling supporting such a change. It would seem that such a move requires a careful assessment by the regulator of optimal versus actual gearing including the tax liability management policy of the regulated firm. This would seem to be more intrusive than is desirable given the CAA statutory duties. Thus the CAA would propose to use statutory corporation tax rates in the cost of capital calculation.

5. Summary: cost of capital estimates

5.1 The CAA has calculated the WACC based on actual gearing and the statutory corporation tax rates. By incorporating the tax shield in its calculations, the CAA has assumed a flat corporate tax rate of 30%. The real pre-tax WACC estimate is 7.5%, with the impact of the corporate tax shield of debt included. This figure is the mid-point of 6.5%-8.5%[71] and it is the same as last review's real pre-tax figure for BAA and very close to the figure used for Manchester (7.75%).

5.2 The range of the real post-tax WACC is 4.7%-6.0% with a mid-point of say 5.3%. Taking the estimates and assumptions specified above, the CAA has estimated the WACC as set out in Table 3 below.

Table 3 Summary of cost of capital estimates

	Present Review			Last Review		
	Low	High	Midpoint	Low	High	Midpoint
asset beta	0.66	0.70		0.58	0.75	0.67
gearing	0.3	0.2		0.3	0.30	0.30
risk free rate (real)	2.75%	3.25%		3.50%	3.80%	3.65%
ERP	3.50%	4.50%		4.00%	5.00%	4.50%
equity beta	0.8	0.8		0.7	0.9	0.80
pre-tax cost of equity				5.04%	6.64%	5.84%
dividend tax credit				0.8	0.8	0.8
post-tax cost of equity	5.55%	6.85%		6.30%	8.30%	7.30%
debt premium	1.00%	0.50%		0.30%	0.80%	0.55%
cost of debt	3.75%	3.75%		3.80%	4.60%	4.20%
corporation tax	30.00%	30.00%		33.00%	33.00%	33.00%
pre-tax WACC	6.7%	8.6%	7.5%	6.4%	8.3%	7.4%
post-tax WACC	4.7%	6.0%	5.3%	5.6%	7.2%	6.4%

[71] The actual range using the estimates for the several components is 6.7%-8.6%, however, in order to avoid spurious accuracy this range has been widened to 6.5%-8.5%.

6. Specific airport factors

6.1 We consider that the above analysis applies in full to Heathrow and Gatwick airports given the excess demand they face. In the last review, the Monopolies and Mergers Commission adjusted Manchester Airport's cost of capital upwards from BAA's by 25 basis points. The CAA accepted that adjustment in its decision. The main arguments related to Manchester Airport facing greater competitive risks than BAA's airports. It is not clear which parameter the Monopolies and Mergers Commission adjusted in making this overall adjustment. Even though the Monopolies and Mergers Commission considered the issue, no off-setting adjustment was made reflecting Manchester Airport's government ownership status because of the then limitations on Manchester Airport's borrowing freedom. These have since been removed.

6.2 The CAA is not attracted to the concept of an ad hoc adjustment of Manchester Airport's cost of capital because of its public sector status unless the debt premium justifies it. This is because resources used in public sector entities also have opportunity costs in terms of forgone private sector consumption and investment. However, the CAA accepts that the competitive and developmental positions of Stansted airport as well as Manchester Airport could be different from the others. Thus the CAA would consider argument and evidence that the cost of capital is, or will be, higher at Manchester Airport and Stansted (via debt premia and/or equity betas) given their competitive, regulatory and developmental position. Nevertheless, at present, given the proposed regulatory approach, the same range has been used for all designated airports.

7. Conclusion

7.1 The cost of capital is a key parameter for this review. Given the importance of getting the best possible investment incentives for desired airport development, particularly in the South-East, we judge that in setting this parameter it is critically important not to set it too low. The adverse consequences of it being set too high are, in comparison, lower. The CAA has adopted a pragmatic approach drawing as much as possible on best practice as used by other regulators and the Competition Commission in terms of approach, analysis, and data. The aim of this paper has been to present the CAA's approach and current data sources as transparently as possible.

7.2 The CAA has calculated the WACC based on a level of gearing in the range of 20%-30%. By incorporating the full tax shield[72], the pre-tax WACC will be 7.5%, which is the midpoint of the range of 6.5%-8.5%; the range for the post-tax WACC is 4.7%-6.0% with a mid-point of say 5.3%.

7.3 The pre-tax figure is the same as the figure used for BAA in the last quinquennial review. However, there are some key differences in how the figure has been arrived at. For the current review, the cost of debt and cost of equity are different compared with the last review, but as a result of the allowance of a full tax shelter, the final pre-tax figure is the same.

7.4 Given the uncertainties in estimating this parameter and the importance of not setting it below the true cost given the investment focus in this review the CAA considers that the proposed ranges address these risks adequately. This applies to both Heathrow and Gatwick airport. For Manchester and Stansted airport, given the proposed regulatory approach, a similar range has been used.

[72] Statutory corporate tax rate of 30%

Appendix 1

Weighted Average Cost of Capital

The Weighted Average Cost of Capital (WACC) is the common way in which the cost of capital is expressed and has two main components. They are debt and equity and their relative weighting in overall financing together with tax. The conventional post-tax formula is as follows:

$$WACC = g.(r_f + \rho)(1-t_c) + (1-g)(r_f + (ERP)\beta) \qquad ①$$

where

	g	=	gearing
	r_f	=	risk-free rate
	ρ	=	debt premium
	t_c	=	corporate tax rate
	ERP	=	equity risk premium
	β	=	beta

The pre-tax equivalent is

$$WACC = g.(r_f + \rho) + ((1-g)(r_f + (ERP)\beta)/(1-t_c)) \qquad ②$$

Appendix 2

Deriving the multi-period discounting formula when expected returns are constant

$1+r_t = \frac{P_t + D_t}{P_{t-1}}$, where P_t = Stock price in the end of year t,

D_t = Per - share dividend paid in the end of year, r_t = Stock return for the year t

Take expectations : $1+r_t = \frac{P_t + D_t}{P_{t-1}} \Rightarrow E_{t-1}(1+r_t) = \frac{E_{t-1}(P_t) + E_{t-1}(D_t)}{P_{t-1}}$

Assume constant expected return : $E_{t-n-1}(1+r_t) = 1 + E(r) \quad \forall t, n < 0$

Solve for the price : $P_{t-1} = \frac{E_{t-1}(P_t) + E_{t-1}(D_t)}{1+E(r)}$

Do the same for $t+1,..,t+n$ returns : $1+r_{t+1} = \frac{P_{t+1} + D_{t+1}}{P_t}, ..., 1+r_{t+n} = \frac{P_{t+n} + D_{t+n}}{P_{t+n-1}}$

Repeat the process of taking $t+n-1$ expectations :

$E_t(1+r_{t+1}) = \frac{E_t(P_{t+1}) + E_t(D_{t+1})}{P_t}, ..., E_{t+n-1}(1+r_{t+n}) = \frac{E_{t+n-1}(P_{t+n}) + E_{t+n-1}(D_{t+n})}{P_{t+n-1}}$

Again, assume constant expected returns and solve for the price :

$P_t = \frac{E_t(P_{t+1}) + E_t(D_{t+1})}{1+E(r)}, ..., P_{t+n-1} = \frac{E_{t+n-1}(P_{t+n}) + E_{t+n-1}(D_{t+n})}{1+E(r)}$

Take time $t-1$ expectations and use the law of iterated expectations :

$E_{t-1}(P_t) = \frac{E_{t-1}(P_{t+1}) + E_{t-1}(D_{t+1})}{1+E(r)}, ..., E_{t-1}(P_{t+n-1}) = \frac{E_{t-1}(P_{t+n}) + E_{t-1}(D_{t+n})}{1+E(r)}$

Start with the original expression and keep substituting in the next price.

(0) $P_{t-1} = \frac{E_{t-1}(P_t) + E_{t-1}(D_t)}{1+E(r)}$

(i) $P_{t-1} = \frac{E_{t-1}\left[\frac{E_{t-1}(P_{t+1}) + E_{t-1}(D_{t+1})}{1+E(r)}\right] + E_{t-1}(D_t)}{1+E(r)} = \frac{E_{t-1}(D_t)}{(1+E(r))^1} + \frac{E_{t-1}(D_{t+1})}{(1+E(r))^2} + \frac{E_{t-1}(P_{t+1})}{(1+E(r))^2}$

...

(n) $P_{t-1} = \sum_{i=0}^{n} \frac{E_{t-1}(D_{t+i})}{(1+E(r))^{i+1}} + \frac{E_{t-1}(P_{t+n})}{(1+E(r))^{n+1}}$

Assuming $\lim_{n\to\infty}\left[E_{t-1}(P_{t+n})/(1+E(r))^{n+1}\right] = 0$ yields $P_{t-1} = \lim_{n\to\infty} \sum_{i=0}^{n} \frac{E_{t-1}(D_{t+i})}{(1+E(r))^{i+1}}$, if this limit exists.

Appendix 3

Asset Beta

The firm's asset beta (also known as the unlevered equity beta) can be seen as a function of its equity beta, debt beta, and its capital structure. The asset beta depends on the firm's assets alone and hence enables:

- A comparison of the impact of different gearing levels
- A comparison of operational risk (i.e. non-diversifiable risk) faced by firms

By holding the asset value constant, the firm's asset beta will increase with an increase in its fixed costs. It can be calculated as follows:

$$\beta_A = \beta_D \frac{D}{D+E} + \beta_E \frac{E}{D+E}$$

with:

β_A	= asset beta
β_D	= debt beta
β_E	= equity beta
D	= proportion of debt
E	= proportion of equity
D+E	= total value of the firm

The debt beta represents the sensitivity of the firm's debt premium to the overall debt market, i.e. it is used to de-lever or re-lever the asset beta to the gearing level assumed for the firm. As a result the debt beta is not directly observable. An approximation of the asset beta could be obtained by assuming that the debt beta is zero (i.e. debt is riskless):

$$\beta_A = \frac{\beta_E}{1+(1-t_c)\frac{D}{E}}$$