Annex E

Cost of Capital

E.1 There are a variety of methods for estimating a firm's cost of capital. It is usually calculated as a weighted average of the costs of debt and equity finance.

E.2 The cost of capital can be expressed in real terms (after adjusting for inflation) or nominal terms. It can also be expressed in post or pre-tax terms. A pre-tax cost of capital should be compared with returns calculated on a pre-tax basis and a post-tax cost of capital with post-tax returns. The Director's approach is to use a pre-tax real cost of capital as a basis for setting charge controls. The following sections outline his approach and the values of the key variables in the calculation of mobile operators' cost of capital.

Estimating the Cost of Capital: the Capital Asset Pricing Model (CAPM)

Introduction

E.3 A number of different asset pricing models exist for calculating the cost of capital. In addition to the CAPM, which measures market risk via a single beta coefficient measured relative to a market portfolio, there are, for example, multifactor models which measure market risk using multiple risk coefficients estimated relative to different factors.

E.4 In the May consultation, the Director used the CAPM to estimate the cost of capital for the MNOs. The CAPM has a clear theoretical foundation and is simple to implement in comparison to other asset pricing models. This results in the continued wide use of the CAPM by the UK's economic regulators, and its wide use amongst all practitioners.

E.5 Under the CAPM methodology, the cost of equity is built up from three main factors. These are:

- the risk free rate;
- the market equity risk premium; and
- the value of beta for the company in question.

E.6 The relationship between these factors can be summarised by the following formula:

Cost of equity = RFR + (ERP x beta),

where RFR = the risk free rate, ERP = the equity risk premium.

E.7 The risk free rate is simply the expected rate of return on a risk free investment. The equity risk premium is the expected return on equities over and above the risk free rate (that is, it is the expected reward for holding equities compared with the reward for holding risk free assets). The value of beta reflects the variability of

returns of the equity of the company in question compared with the variability of returns on the equity market represented by an index.

E.8 Similarly, the cost of debt can be expressed as:

Cost of debt = RFR + Debt premium,

where the debt premium is the company specific risk premium for corporate debt above the risk free rate.

E.9 The weighted average cost of capital (WACC) takes account of the cost of equity and the cost of debt by weighting each of these by the proportion of equity and debt respectively in a company's financial structures in the following way:

WACC = (Cost of equity x (1 – Gearing)) + Cost of debt x Gearing,

where Gearing = Debt / (Debt + Equity).

E.10 The following sections discuss each of these major components in turn. Before this, the Director's views on the MNOs' comments on his continued use of the CAPM are provided below.

MNOs' comments

E.11 One of the MNOs, T Mobile, disagreed with the Director's use of the CAPM, instead advocating the use of a multifactor Arbitrage Pricing Theory (APT) based approach. It supplied the Director with estimates - based on this approach - which it had submitted during the 2002 Competition Commission inquiry. The use of such a model was advocated based on shortcomings of the CAPM, notably its failure to account for certain observations concerning stock returns, which are related to factors such as firm size and book-to-market ratios.

The Director's view

E.12 The use of the CAPM is widespread among practitioners. For example:

- during the 2002 Competition Commission inquiry, 3 out of the 4 MNOs used the CAPM;
- in its 2002 inquiry, the Competition Commission decided to use the CAPM, despite having been presented with the results of the same APT-based study that T Mobile has used to estimate the cost of capital in its response to the May consultation. The CC's view was based on, principally:
  - the fact that "four of the five main parties", and additionally the group of fixed operators that submitted evidence to the CC, advocated the use of the CAPM;
  - the Director's assertion during the inquiry that there was no consensus among practitioners regarding the use of alternative models, and that it was planning to carry out some further research in this area (the outputs of this research are described below); and

  - a literature review that the CC carried out itself, which found no consensus that a multi-factor approach was superior to the CAPM (this was confirmed by the CC's academic advisors);
- all the UK's economic regulators currently use the CAPM; and
- none of the MNOs other than T Mobile have advocated the use of an alternative model to the CAPM, despite having had access to details of the study conducted on behalf of T Mobile during the CC inquiry.

E.13 The Director is of the view that the CAPM remains the most appropriate model for WACC estimation. This view is supported by the output of an independent study carried out on behalf of Oftel and the UK's other economic regulators. The report, *A Study into Certain Aspects of the Cost of Capital for Regulated Utilities in the U.K*. was carried out on behalf of the regulators by Stephen Wright, Robin Mason, and David Miles, and published in February 2003 (http://www.oftel.gov.uk/publications/pricing/2003/cofk0203.htm).

E.14 This report was written after the Director had provided its authors with submissions made by T Mobile during the CC's inquiry advocating the use of a multifactor model, based on the same estimates that it submitted as a response to the May consultation. The report's conclusion, regarding the appropriateness of various asset pricing models is reproduced below.

> *In summary: the empirical shortcomings of the CAPM are known. Alternative models to address this issue have their own shortcomings - weak theoretical foundations and empirical challenges. In our view, there is at present no one clear successor to the CAPM for practical cost of capital estimation. We do however feel that alternative models provide helpful insights into the points of vulnerability of the CAPM, and may also provide information on the robustness of the CAPM beta.*

E.15 In light of this conclusion, and the continued widespread use of the CAPM by other UK regulators and competition authorities, the Director remains of the view that the CAPM is the most appropriate asset pricing model. He would need to be thoroughly and independently convinced about the validity of any new approach before departing from this view, but remains interested in any new evidence that becomes available.

Risk Free Rate

Introduction

E.16 In the May consultation, the Director used a range of 4%-5% for the risk free rate.

MNOs' comments

E.17 One of the MNOs, Vodafone, advocated a higher range than that used by the Director, specifically 5-5.5%. Its justifications for the use of a higher range were that:

- current yields may be affected (lowered) by distortions in the government bond market; and
- there is a need for consistency between the basis of estimation of the risk free rate and the equity risk premium, ie a higher (or lower) risk free rate is consistent with a lower (or higher) equity premium and a consistent estimate of the cost of equity.

E.18 Vodafone additionally commented that a range of 5-5.5% is similar to the range of 5.1-5.3% used by the CC in its inquiry (the CC's higher range was to some extent based on relatively high current yields at the time of the CC conducting its analysis).

The Director's view

E.19 The Director's view is that is appropriate to make a small upward adjustment to the range used for this parameter in the May consultation. The justification for this, together with background information relating to the risk free rate, is outlined below.

E.20 The Director has previously expressed a view that the inflation risk premium is not significantly different from zero. Given the persistence of low inflation and interest rates and the assumption that conditions have not changed dramatically, he has not made an adjustment for an inflation risk premium in the calculation of risk free rates.

E.21 The risk free rate of interest is an input into the calculation of both the cost of debt and the cost of equity. The nominal risk free rate is usually calculated as the yield on fixed term government debt of certain maturity. There is a range of maturities on government debt that could be used as the basis for an estimate of the risk free rate. These maturities range from less than 1 year to over 30 years.

E.22 There are arguments in favour of both short and long-term gilts as the best estimate of the risk free rate for the purposes of this market review. For example:

- a maturity of 3 years may be appropriate, as the review is concerned with charge controls to be applied over a three-year period; and
- mobile operators are required to make longer term investments, for example regarding network infrastructure and hence a longer term gilt may be appropriate.

E.23 On balance, the Director considers that weight should be given to a number of different values, and therefore that the use of 5-year gilts to be a reasonable compromise between these two objectives. The gilt curve is currently relatively flat, meaning that using the yield on longer term gilts would produce only marginally higher estimates.

E.24 The Director uses current estimates of yields on nominal gilts as a proxy for the risk free rate. The objective is to obtain a forward-looking estimate of the risk free rate. The nominal risk free rate for 5-year gilts in November 2003 ranged from 4.8% to 5.0%[37] with an average of 4.9%. This rate compares with a *real* rate of return of 2.0% for similar term index-linked gilts. This difference between the real and nominal

[37] Source: Bank of England, http://www.bankofengland.co.uk/statistics/yieldcurve/

rate implies an inflation rate of approximately 2.8%. The implied inflation rate is calculated on a geometric basis: (1+nominal rate)/(1+real rate) –1.

E.25 An additional consideration is that interest rates calculated from government securities currently provide too low a benchmark for a risk free investment due to factors such as, notably, recent strong demand from pension funds. In addition to the method described above of determining the risk free rate from current returns on gilts, the Director therefore finds some merit in the approach taken by the CC in its inquiry, namely taking account of redemption yields over a longer period of time as well as the current spot rates. As described in the CC's report and in the May consultation, such techniques tend to give rise to slightly higher estimates than those based on current returns. With this in mind, the Director is minded to round up the above range to a value of 5%. This rounding up also reflects any ambiguity as to the appropriate bond maturity to use (e.g. it might be argued that longer values than 5 years would be appropriate). This value is slightly lower than that used by the CC because of the falls in the yield on government debt that have happened since the CC conducted its analysis.

E.26 The issue of consistency between estimates of the risk free rate and the equity risk premium can be difficult to address in practice given, especially, the degree of uncertainty concerning values of the latter parameter. If he were relying on a single means of estimation for the equity risk premium (e.g. the analysis of historical data), the Director would be likely to explicitly address the issue of consistency. However, as outlined below, the Director's preferred value for the equity risk premium is influenced by a wide range of data sources, e.g. historical values, estimates of future growth, and the judgement of investment managers. The Director has not, for example, weighted these data sources according to the appropriate level of emphasis to place on each. Instead, he has made a judgement, based on the range of available estimates and a desire to err on the side of caution, i.e. in favour of high estimates. In this context, the Director's view is that attempting to ensure (with exact precision) consistency between the equity risk premium and the risk free rate is not a key exercise.

E.27 The Director has erred on the side of caution, i.e. in favour of high estimates, relative to, for example, the CC, in terms of an implicit value for total equity market returns as measured by the sum of the risk free rate and the equity risk premium.

Equity Risk Premium

Introduction

E.28 In the May consultation, the Director used a value of 5% for the equity risk premium.

MNOs' comments

E.29 One of the MNOs, T-Mobile, advocated a range with a midpoint higher than the value used by the Director, specifically one of 5-6%. T-Mobile was particularly critical of the use by the CC of values below the Director's value of 5% (see below) and

stated that it "would expect the opportunity to respond fully" were such a value to adopted by the Director.

The Director's view

E.30 The equity risk premium is the difference between the overall return on equities and the nominal risk free rate. Its value in the UK reflects the risk of investing in UK equities generally. There is considerable debate about the appropriate method of calculating the value of the equity risk premium and the calculation is problematic because different methods produce different values. In particular, methods based on an analysis of current market expectations tend to give lower values than those based on analysis of historical estimates from stock market data. But determining current market expectation is a difficult and controversial task.

E.31 In its report, the CC refers to two high-profile studies published in 2002, namely *The Equity Premium*, Fama and French, Journal of Finance, April 2002, and *Triumph of the Optimists,* Dimson, Marsh and Staunton, Princeton University Press, 2002. These publications provide a range of estimates using both historical averages of equity returns and evidence of investors' expectations.

E.32 The UK's economic regulators have adopted a range of measures of the ERP, for example:

- OFGEM, in its September 2001 Review of Transco's Price Control from 2002, http://www.ofgem.gov.uk/temp/ofgem/cache/cmsattach/315_26sep01_pub1.pdf, suggested an ERP of 3.5%, based primarily on survey forecast evidence;
- OFWAT, in *Final Determinations: Future water and sewerage charges 2000-05 25 November 1999*, http://www.ofwat.gov.uk/aptrix/ofwat/publish.nsf/AttachmentsbyTitle/finaldets99part11.pdf/$File/finaldets99part11.pdf, assumed an equity risk premium of 3.0%–4.0%. Again, this estimate was based primarily on survey forecast evidence; and
- The CAA, in *Economic Regulation of BAA London Airports (Heathrow, Gatwick and Stansted) 2003 – 2008*, February 2003, decided to use the CC's most recent range of 2.5% to 4.5%.

E.33 Estimating the equity risk premium based on historical data typically leads to higher values. For example, historical estimates from the London Business School for figures as at the end of 2000 showed the estimate of the real equity risk premium assessed relative to gilts (based on an arithmetic mean) measured over 101 years in the UK to be 5.6% (4.4% using a geometric mean)[38]. However, a significant problem with relying on historical estimates is that they can vary markedly depending on the period used, as shown by the following table.

Table 1: UK mean equity risk premiums over various periods (geometric mean)

Period	Relative to gilts (index of various maturities)

[38] *Triumph of Optimists,* Dimson, Marsh and Staunton, Princeton University Press, 2002, Table 32-1, p301.

Period	Relative to gilts (index of various maturities)
1900 to 2000	4.4
1900 to 1949	2.1
1950 to 2000	6.8
1960 to 2000	4.6
1970 to 2000	3.5
1980 to 2000	3.6
1990 to 2000	0.4

Source: *Triumph of Optimists,* Dimson, Marsh and Staunton, Princeton University Press, 2002

E.34 The differences shown in this table reflect the wide range of factors that impact gilt and stock returns (eg bond returns from 1990 to 2000 were relatively high given the movements of inflation and interest rates over this period).

E.35 The Monopolies and Merger Commission (now the CC), in its 1998 report on the cost to call a mobile phone estimated the equity risk premium to be in the range of 3.5%-5.0%, with a mid-point of 4.25%. In subsequent publications, this estimate has been revised downwards, due in part to downward trends in historical data. In its report on calls to mobile in December 2002, the CC estimated a nominal range of 2.6%-4.6%. However, in paragraph 7.265 of the CC report, it noted that the extent of uncertainty concerning the downward trend in recent years made a degree of caution appropriate when implementing this decline, in part to help prevent volatility in the short term. It felt that this factor was most appropriately taken account of not by modifying their judgement of the range for the equity risk premium but by increasing the overall level of the WACC by 0.25% in real terms.

E.36 In deciding the appropriate value for the equity risk premium, the Director has taken into account a range of evidence, both historical and forward-looking. The Director's judgement reflects his recognition of the need to balance both short and long-term interests of consumers. A low rate of return on capital can bring benefits to consumers in the short term in the form of lower prices. However, it could damage consumers' longer-term interests. The telecommunications industry depends on high levels of discretionary investment to support innovation and rapid market growth. The funds for such investment are often internationally mobile. Too low a figure for the cost of capital could deter such investment, thus disadvantaging consumers in the longer term.

E.37 The Director's previous view has been that 5% is an appropriate value for the ERP. A wide range of new evidence from academia has been forthcoming in the last two years. The current view of the Director's academic adviser, Professor Julian Franks of the LBS, is that the Director should, during the second consultation period, review the use of this estimate in the light of the evidence that has recently been made available. The Director is therefore very interested in any views that respondents may have on an appropriate value for this parameter.

E.38 The Director has decided to continue to use a value at the upper end of the range of available estimates, and has therefore decided to continue to use a value of 5% for the equity risk premium in his second consultation. However, there is a possibility that his view of a reasonable range and hence his preferred value will be

amended following further research in this area in the coming weeks, hence the Director's request for the views of respondents.

Equity Beta

Introduction

E.39 In the May consultation, the Director used a range of 1.0 to 1.6 at 10% gearing as a value for the equity beta of an MNO. These values are the same as those used by the CC in its inquiry. The CC's justification for the use of this range is outlined below.

> *"We believe a range of 1 to 1.6 takes into account all of the uncertainties brought about by taking daily as opposed to monthly returns, choosing the appropriate time period, any differences between UK and overseas activities and any differences between the regulated and non-regulated operations of the MNOs. The lower end of this range takes account of monthly data and that which could apply to a regulated operator. The upper end takes account of daily data and that which could apply to overall activities of the MNOs. In order to avoid the difficulties caused by overseas ownership, our upper estimate of beta is based on mmO_2 and not Vodafone"*

E.40 The CC's reasoning, i.e. the need to give weight to a number of techniques in the absence of a unique "best" beta estimate, is similar to that previously used by the Director in cost of capital estimation.

E.41 In its response to the May consultation, T Mobile made an argument that, when weightings are made on estimates using different techniques, then these should be weighted in inverse proportions to: (1) the errors of each estimate; and (2) the covariances between estimates. Such a weighting would result in, notably, a high weighting being given to estimates based on daily data. The Director has not used such as weighting. The justification for this is set out in The Brattle Group's *Issues In Beta Estimation For UK Mobile Operators: Update*, December 2003 for details. As outlined in this report, T Mobile's proposition only holds in cases where:

- the estimates are derived by the same *methodology*, but from different *sample data*; and
- the sample data come from the same population.

E.42 As outlined in the Brattle Group's report,

> *"If these conditions do not hold then the results are not statistically comparable in the manner implied by CRA, and Oftel should not combine them. Therefore, when using different methodologies, or samples drawn from different populations, such a weighting technique is not applicable."*

E.43 These conditions do not hold for the Director's range of estimates since, crucially, some use different approaches to estimation such as the Dimson and Bayesian adjustments.

MNOs' comments

E.44 Two of the MNOs advocated the use of higher equity beta values. Specifically (in relation to a gearing level of 10%):

- T-Mobile advocated the use of a range of 1.7 to 2.1; and
- Vodafone advocated the use of a range of 1.3 to 1.8.

E.45 These high equity beta estimates were based on some or all of the following key assumptions:

- estimating betas based on daily data;
- the use of adjustments to reflect the fact that the returns of the Vodafone (international) group are likely to be less highly correlated with those of the UK market index than those of Vodafone's UK operations would be; and
- the use of data windows that included data from the years of the telecoms market "bubble" period (e.g. 2000 and 2001).

E.46 The Director's view on the optimal approach to beta estimation, together with some background information relating to beta estimation, is outlined in the sections below.

The Director's view

Introduction

E.47 The value of a mobile operator's equity beta measures the movements in return from the mobile operator's shares relative to the movement in the return from the equity market as a whole. It will rise with a mobile operator's debt equity ratio (gearing), since a higher level of gearing implies higher volatility in the returns to shareholders.

E.48 The Director's approach to beta estimation, as used, for example in the May consultation and in his September 2001 statement, is to adopt a broad range of potential beta estimates at a 10% (and 30%) gearing on a debt to debt plus equity basis. Lower estimates have typically been set at about 1.0, which corresponds roughly with LBS RMS estimates for MNOs, and for telecoms companies in general. Higher values used by the Director have generally been in the region of 1.5 (1.6 in the May consultation), closer to beta values obtained by regression analysis based on daily data on the returns of the MNOs.

E.49 In 2002, the validity of such a range was verified by an independent study carried out on the Director's behalf by The Brattle Group[39], which produced a wide range of estimates that were consistent with his chosen range. Notably, values in roughly the middle of the Director's range were obtained by making estimates based on daily data and the Dimson adjustment (see the original report for details).

[39] *Issues in Beta Estimation for UK Mobile Operators*, The Brattle Group, July 2002.

E.50 Beta estimation is a difficult exercise. As identified above, two contentious issues in previous reviews have been the choice of data frequency (daily / weekly / monthly) and estimation period (how many years' worth of data to use, and which period to choose). As described in the May consultation, the choice between these two methods can have a very significant impact on beta estimation.

E.51 Beta estimation is further complicated by, inter alia, the following issues:

- isolating relevant activities:
  - excluding overseas activities;
  - excluding non voice termination domestic activities; and
- the need to measure risk relative to an appropriate index (i.e. domestic or international).

E.52 The Director's current views on each of the key issues identified above is outlined below.

Relevant business for beta estimation

E.53 Returns on the stocks of the MNOs have varied very significantly over the past few years. The Director believes that it is very unlikely that the bulk of this variation is related to factors relating to those parts of the MNOs' business that are relevant to the proposed charge control, i.e. *voice call termination in the UK.*

E.54 The ownership of the UK MNOs is such that beta estimation is a difficult exercise. It is difficult to isolate the relevant activities since:

- O_2 is part of a group that has overseas interests that, based on data for 2002/03, account for 37% of group revenue[40];
- Orange is part of a group that includes a number of other (non-UK) companies, including the French incumbent fixed operator;
- T-Mobile is part of a group that includes a number of other (non-UK) companies, including the German incumbent fixed operator; and
- Vodafone is part of a group that includes a number of other (non-UK) mobile operators. Vodafone's response to the May consultation stated that by 2001, earnings from outside the UK accounted for 85% of the Vodafone Group's total.

E.55 Since stock return data for the MNOs is only available at the *group* level, there is a significant degree of imprecision inherent in beta estimation for the purposes of the proposed charge control. The above details suggest that Vodafone, or, especially O_2 is likely to provide the best proxy for a UK MNO, subject to other issues such as data availability. With the notable exception of the CC's report, the analysis of Vodafone returns has hitherto been the focus of most of the estimations carried out by MNOs and the Director. This was the case in the responses to the May consultation made by both T-Mobile and Vodafone.

[40] But only 3% of EBITDA due to the UK business currently being very profitable relative to the others. The Director does not have a strong view as to which of these figures would provide a better guide as the importance of non-UK operations.

E.56 An additional issue to consider is that the charge control is on mobile call termination only. Call termination accounts for a relatively small proportion of the MNOs' revenues (just under 23% of revenues in 2002/03).

E.57 As stated above, the correct beta value to use is that of the part of the business of an MNO that is:

- UK specific; and
- voice call termination specific.

E.58 The "UK operations" issue has been discussed at length in submissions made by MNOs during the CC inquiry and in response to the May consultation. The Director's view is that a good way to control for this issue may be to make estimations based on data for O2.

E.59 The issue of isolating the termination of voice calls has been an area of rather less focus, although the issue was discussed by the Competitive Operators Group (COG) during the CC's inquiry, and also by the CC itself. The key consideration is not that - unlike other mobile services - charges for call termination have been subject to regulation, and that this has an impact on beta estimates, but rather that voice call termination, being a mature product has significantly different characteristics to the other products that account for the majority of the income of the MNOs. The Director's view is that the very significant variations in MNOs' returns in recent years are likely to have been substantially based on expectations regarding new (e.g. data based) applications that have been and will be introduced by the MNOs. It is certainly difficult to square such fluctuations with a mature product like voice call termination.

E.60 The implication of the factors outlined above is that it is not clear as to what the most appropriate values to use in assessing the true betas of mobile call termination are. The issue of foreign operations may suggest that O_2 data is more suitable for this exercise than Vodafone data, and the fact that call termination accounts for a small proportion of the value of MNOs means that all results must be interpreted with caution.

Data frequency and data window

E.61 A key issue in beta estimation is the choice of daily or monthly (or indeed weekly) returns. The relative merits of these are summarised in the CC's report, and were discussed at some length in the 2002 paper by the Brattle Group referred to above. The potentially very significant impact of this issue is indicated in Table 1 above, and has also been highlighted in the responses to the May consultation made by Vodafone and T-Mobile.

E.62 Advantages of using daily data in beta estimation include:

- obtaining greater statistical accuracy (shown by lower standard errors); and
- the fact that beta estimates based on monthly returns are often sensitive to the day of the month on which data points are taken.

E.63 Disadvantages of using monthly data in beta estimation include:

- statistical problems that are inherent in the use of daily data, notably non-synchronous trading bias. However, these problems can be mitigated (see the Brattle Group's 2002 paper for details) by the use of a Dimson adjustment; and
- there is no widely recognised published source of beta estimates using daily data (such as the LBS RMS beta which is based on monthly data).

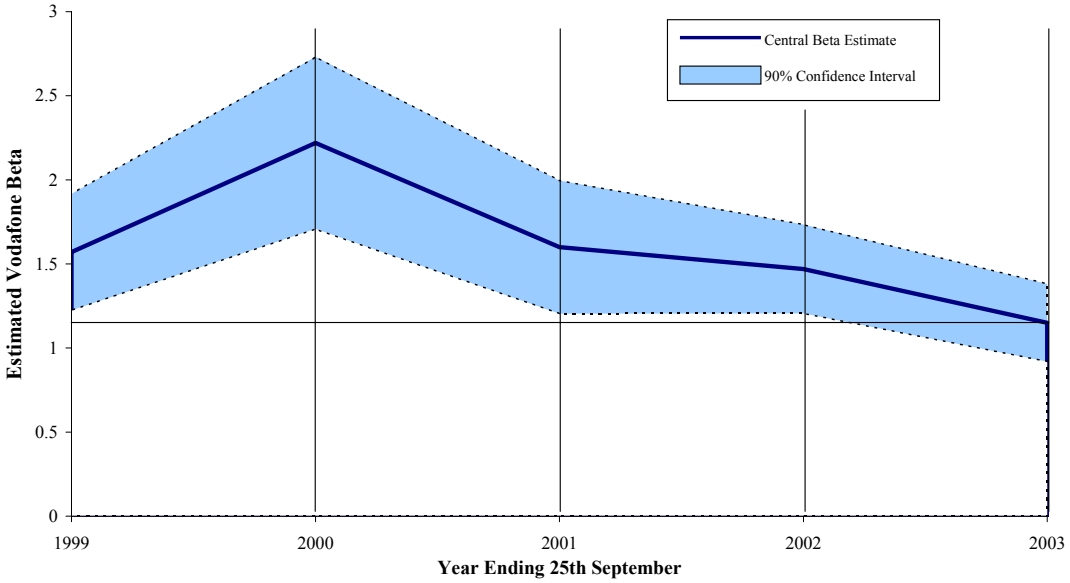
E.64 Given the degree of uncertainty involved (caused, for example, by being unable to isolate call termination as a distinct activity and ensuing difficulties in interpreting statistical tests), a degree of judgement is involved. The Director's preferred approach therefore remains to place a degree of weight on all estimation methods.

E.65 A related issue is that of the appropriate data window. Monthly betas are typically measured over 5 years, in order to provide a reasonably number of observations (60). However, given the large number of data points available in estimation using daily data (from which low standard errors are derived), the choice is less straightforward when using daily data.

E.66 In its response to the May consultation T-Mobile described a trade-off between a need to reflect the most recent possible data in order to proxy future values (which favours the use of shorter estimation periods) and the desirability of obtaining low standard errors of estimation by including many observations (which favours the use of longer estimation periods). It concluded that three years of daily data best reconciled these two conflicting objectives. Based on similar considerations, Vodafone advocated the use of a two year window.

E.67 The Director's view is that, when using daily data for the MNOs, the most appropriate time period to use is, at present, a relatively short window. This is because the beta for MNOs (time series data reaching from before 2001 to the present is only available for Vodafone) has changed so much over time in recent years. This is illustrated below.

Figure 1: 90% Confidence Intervals for Annual Vodafone Beta vs. All Share (Daily Data, ±1 Dimson Adjustment)



Source – The Brattle Group

E.68 The fall in estimated beta between 2002 and 2003 is relatively modest by the standards shown in the 1999-2003 period. Despite this, the 2003 beta lies outside the 90% confidence interval of the 2002 beta. Given these rapid changes (which may well be unrelated to changes in market sentiment relating to voice termination specifically), the Director's view is that, when using Vodafone data, estimates based on data windows going back more than 12 months are, at present, unlikely to be robust. A similar approach seems sensible regarding O_2, particularly given the limited availability of time series data going back more than two years. Using a single full year's worth of data seems like a reasonable compromise between a sufficiently large sample size and the need to use up-to-date information. It is important to note that future changes in market conditions could mean that the Director might feel it appropriate to use a longer, or perhaps even shorter, data window for beta estimation.

Appropriate market benchmark

E.69 The Director has also considered whether betas should be estimated against international market indices, e.g. the FTSE All World index, rather then domestic ones, e.g. the FTSE All Share index. This is intended to reflect the fact that investors are (to some extent) fully diversified across all markets. In the light of the "home bias puzzle" (the widely observed bias towards domestic markets in international asset allocation), the Director is minded to put less weight on such estimates than on those based on estimation against UK market indices. He does however believe that they are of some interest, even if he understands the MNOs' reluctance to use World indices in attempting to produce their view of a single best estimate.

Conclusion on beta estimates

E.70 Following the responses received to the May consultation, the Director commissioned a new piece of analysis from The Brattle Group, *Issues In Beta Estimation For UK Mobile Operators: Update*, December 2003. Based on the new estimates calculated in this project, the table below shows a range of beta estimates.

Table 2: Equity beta estimates (all at actual gearing levels) supplied by The Brattle Group (2003)

#	Estimated for MNO	Data Frequency	Index	Period	Gearing	Estimate (range)
1.	O_2	Daily	UK	2002-03	0_2 actual	1.58
2.	Vodafone	Daily	UK	2002-03	Vodafone actual	1.42
3.	O_2 (+ Dimson adjustment)	Daily	UK	2002-03	0_2 actual	1.15-1.25
4.	Vodafone (+ Dimson adjustment)	Daily	UK	2002-03	Vodafone actual	1.01-1.31
5.	O_2	Daily	World	2002-03	MNOs' actual	1.33
6.	Vodafone	Daily	World	2002-03	Vodafone actual	1.09

Note that:

- estimates (3) and (4) for O_2 and Vodafone respectively are lower than corresponding estimates (1) and (2) because the Dimson adjustment has been applied to the former; and
- estimates (5) and (6) differ from estimates (1) to (4) in that they are measured against the FTSE All World index.

E.71 The table below shows a range of other beta estimates that have been made available to the Director by MNOs, together with a published estimate from the LBS RMS service and the Director's preferred range.

Table 3: Further equity beta estimate/s

#	Author (estimated for MNO)	Data Frequency	Index	Period	Gearing	Estimate (range)
7.	T Mobile (Vodafone)	Daily	UK	2000-03	10%/ 30%	1.7-2.1/ 2.2-2.7
8.	Vodafone (Vodafone)	Daily	UK	2001-03	10%	1.6-1.9
9.	RMS (Vodafone)	Monthly	UK	1997-02	Vodafone actual	1.0
10.	**Oftel**	**-**	**-**	**-**	**10%/ 30%**	**1-1.6/ 1.3-1.9**

Note that:

- estimates (7) and (8) are higher than those in the table showing the Brattle Group's estimates since they:

    - use a longer data window;
    - include an upward adjustment for Vodafone's foreign holdings; and
    - do not use the Dimson adjustment
- estimate (9) includes a Bayesian adjustment.

E.72 In its paper the Brattle Group recommends the following beta ranges for MNOs:

- against the FTSE all share index:
    - 1.15 to 1.25 for Vodafone; and
    - 1.01 to 1.31 for O2;
- against the FTSE all world index:
    - 1.09 for Vodafone; and
    - 1.33 for O2.

E.73 In view of the uncertainty involved the Director does not have a view as to which of these estimates is most appropriate for use in the proposed charge control. In setting a range of 1.0 to 1.6 (midpoint 1.3), he has erred on the side of caution, ie in favour of estimates towards the top of or above the range recommended by The Brattle Group.

E.74 The midpoint of the Brattle Group's range against the FTSE is 1.2 for Vodafone, and 1.15 for O_2. The Director's range has a higher midpoint, reflecting the degree of uncertainty in estimation, and other factors such as the possible need for an upwards adjustment for foreign operations.

E.75 It may be worth noting that the top of his range at 10% gearing, at 1.6, is very close to the beta of the O_2 group (for which foreign holdings are less significant than for Vodafone) measured against the UK index using one year's worth of data from 2002 to 2003, ie estimate (1), 1.58. This observation is of interest given that estimate (1):

- does not use a Dimson adjustment. As outlined in its report *Issues In Beta Estimation For UK Mobile Operators: Update*, December 2003, The Brattle Group recommends the use of such adjustments using similar data sets;
- primarily reflects returns on O_2 activities other than voice call termination; and
- is based on a gearing level that is substantially higher than 10% (see Figure 2 below in the Director's discussion of gearing levels).

E.76 The Director's view is that such caution is justified given the investment imperative in this industry.

Debt Premium

Introduction

E.77 In the May consultation, the Director used a range of 1% to 3.5% as a value for the debt premium of an MNO.

MNOs' comments

E.78 Orange stated that its debt premium was, “above Oftel’s upper limit”. No alternative estimate was provided by Orange or any other MNO.

The Director’s view

E.79 Given that, with the possible exception of Orange, the MNOs agree with the assumed debt premium used in the May consultation, and that he is not aware of any reasons why the logic used previously would not apply now, the Director’s view is that the figure used previously remains appropriate. His reasoning is outlined below.

E.80 The cost of corporate debt is made up of a risk free component and a company specific risk premium. Historical evidence suggests that blue chip corporate debt, such as that of mobile operators, commands a small risk premium, although estimates of this premium vary considerably.

E.81 During the CC’s 2002 investigation, interested parties submitted a wide range of estimates for the debt premium. These estimates ranged from the Competitive Operators Group’s (COG) estimated average medium term debt premium of 0.81%, based on recent debt premiums for water and electricity companies, to Orange’s average estimate of its own debt premium of 5.17%. The CC used a range of 1%-4% at a 10% gearing in its December 2002 report, based on The Director’s low estimate and the average of the higher premiums paid by MNOs in 2002.

E.82 It has been suggested that the debt premium used should be set equal to the contractual rate on debt currently offered by the MNOs. However, for some of the MNOs, the promised yield is an inaccurate proxy for the debt premium since it differs substantially from the expected debt premium. Where the probability of default is significant, i.e. where the promised yield rates are substantially higher than the gilt rate, the expected rate on debt (and therefore the cost of debt to the MNO) is lower than the promised yield. The promised yield is effectively the maximum possible return on the bond – it would only be realised if the bond were to be repaid at maturity. In other cases, the actual return would be lower (for example, substantially below the gilt rate). The size of the premium of the MNOs’ promised yield on debt over gilts rates submitted to the CC indicates that the probability of default was significant. In calculating the WACC, it is correct to use the expected cost of debt, which means that the promised yield rate must be adjusted downwards in order to approximate the expected cost of debt more closely.

E.83 After taking account of default probability, the Director considers a range of 1.0% to 3.5% to be reasonable. For the purposes of calculation, he has used this wide range of debt premium both at a 10% and 30% gearing, whilst recognising that the debt premium is more likely to lie at the lower end at a 10% gearing and to be higher at a 30% gearing.

E.84 The Director’s estimate of the mobile operators’ cost of capital is based on beta of debt of zero for the first one percent of the debt premium and increasing by 0.2 for every one percent of debt premium above one percent. The debt beta measures the riskiness of the returns on debt. The Director’s estimate of the debt beta implies that the first one percent of premium on mobile operators’ debt is due to liquidity risk

rather than default risk. Any increase in debt premium beyond that level is attributed to the risk of default.

E.85 In summary, on the basis of the current information available, the Director considers that a debt premium ranging from 1.00% to 3.50% for a gearing of 10% to 30% is reasonable.

Optimal gearing

Introduction

E.86 In the May consultation, the Director's calculation applied equal weight to gearing ratios of 10% and 30%.

MNOs' comments

E.87 Orange stated that its gearing ratio was, "at or slightly above the upper end of the range defined by Oftel".

The Director's view

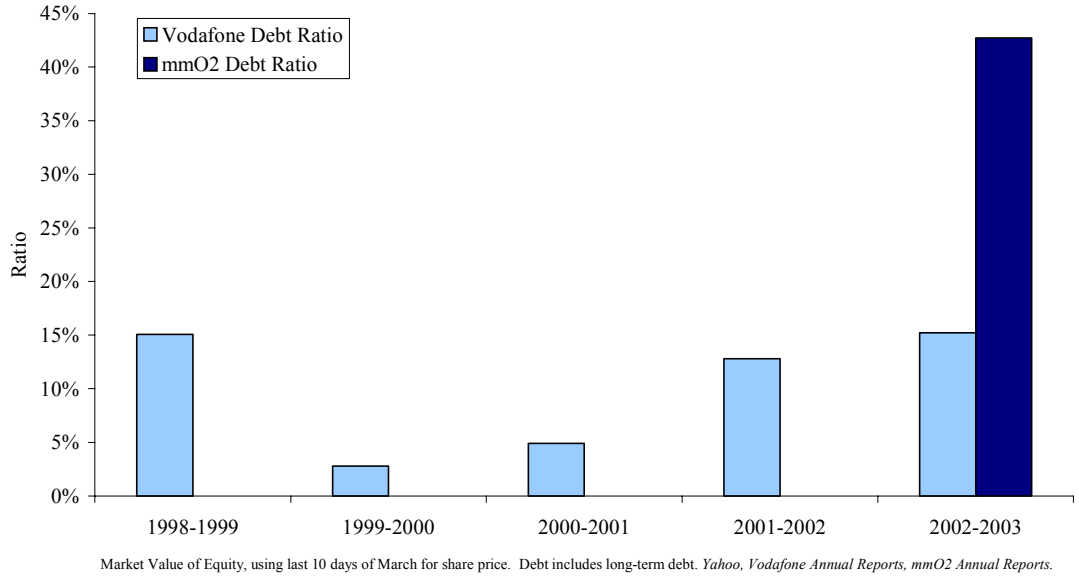
E.88 Under the standard Capital Asset Pricing Model a firm can potentially lower its overall cost of capital by increasing its gearing. This is because debt is generally cheaper than equity as a result of tax advantages to debt.

E.89 A report submitted to the CC in its 2002 inquiry by the COG[41] highlighted a number of factors which may drive up gearing over the coming years including the ability to take on greater debt as profitability and stability improve potentially enabling a lower overall cost of capital.

E.90 The Director believes that it is still appropriate to consider the wider range of 10% to 30% for the optimal gearing of UK mobile operators to allow a potential for different capital cost structures. This range is broadly consistent with the actual gearing ratios of the UK MNOs in recent years (see below). Figure 1 shows that the Director's range is in line with current actual levels of gearing. Data on O_2 is only available for the most recent financial year.

Table 4: gearing ratios for the Vodafone and O_2

[41] *European Mobile Operators Mobile Valuation*, Enders Analysis, September 2002



Market Value of Equity, using last 10 days of March for share price. Debt includes long-term debt. *Yahoo, Vodafone Annual Reports, mmO2 Annual Reports.*

Source – the Brattle Group

Effective Corporate Tax Rate

The Director's view

E.91 The calculations set out above are on a post tax basis. The Director's financial models calculate pre tax returns, so it is necessary to convert the post tax cost of capital into an equivalent pre tax figure. This is achieved by dividing the post tax figure by a factor of (l-t_c), where t_c is the effective corporate tax rate. The Director has assumed, as did the CC in their recent report, that the mobile operator's effective tax rate is the current standard rate of corporate tax of 30%.

Conclusion

E.92 Overall, using a broad range of parameters, the Director estimates the pre-tax nominal cost of capital for UK mobile operators providing 2G services to be between 13.3% and 17.6%. This compares to his previous estimate of between 12.1% and 17.6% as stated in the May consultation. The new range, as described above, reflects recent increases in the returns on UK government debt. The breadth of these ranges reflects the uncertainty surrounding estimation of the key parameters, in particular, betas for the mobile operators.

E.93 As derived in the table below, in pre-tax *real* terms, the Director's estimate for the cost of capital ranges from 10.2% to 14.3% with a mid-point of 12.2%. This compares with his previous mid-point estimate of 12.0% in the May consultation. In calculating fair termination charges the Director has rounded the figure of 12.2% to the nearest quarter of a percentage point, ie to 12.25%.

Table 5: Estimates of pre-tax real WACC

	Low Gearing		**High Gearing**	
	Low estimate	**High estimate**	**Low estimate**	**High estimate**

	Low Gearing		High Gearing	
	Low estimate	**High estimate**	**Low estimate**	**High estimate**
Risk free rate	5.0	5.0	5.0	5.0
Equity risk premium	5.0	5.0	5.0	5.0
Equity beta	1.0	1.6	1.3	2.0
Cost of equity (post tax)	10.00	13.00	11.43	14.57
Debt Premium	1.00	3.50	1.00	3.50
Cost of debt (post tax)	6.00	8.50	6.00	8.50
Optimal Gearing	10%	10%	30%	30%
Corporate tax rate	30%	30%	30%	30%
WACC (post tax nominal)	9.42	12.30	9.26	11.99
WACC (pre tax nominal)	13.46	17.56	13.23	17.12
WACC (pre tax real)	**10.33**	**14.33**	**10.11**	**13.89**