Disaggregating BT's Beta

June 2005

A report prepared for Ofcom by PricewaterhouseCoopers LLP

Public Version

Important Notice

This report was issued solely to Ofcom for the purposes of assisting it in developing an approach to risk in the assessment of the cost of capital. PricewaterhouseCoopers LLP, its partners and staff neither owe nor accept any duty of care to any third party whether in contract or in tort (including without limitation negligence or statutory duty or howsoever otherwise arising) and shall not be liable in respect of any loss, damage or expense of whatsoever nature which is caused by any third party's reliance upon information derived from the report. If any third party wishes to rely upon the report or information derived therefrom, they do so entirely at their own risk.

Executive Summary

In January 2005 Ofcom issued a consultation document on risk and the cost of capital which, amongst other proposals, suggested that Ofcom should consider whether it should apply different cost of capital figures to different parts of the BT group. In particular it proposed that the equity beta, which is an important determinant of the cost of equity within the capital asset pricing model framework, should be lower for BT's copper access business than for the BT group as a whole.

Responses to Ofcom's consultation document demonstrate that there is general acceptance of the principle that incentives and efficiency are better served by applying disaggregated betas where these betas differ, as long as such betas can be calculated reliably.

However, a number of respondents suggested that the consultation document did not contain enough evidence to justify setting different betas for different parts of BT's business. This led Ofcom to commission PricewaterhouseCoopers LLP, in consultation with Professor Julian Franks of the London Business School, to examine in more detail whether a disaggregation of BT's beta is appropriate, and if so, what evidence there is to enable the different beta figures to be calculated.

In this report we first assess whether different parts of BT's business, including the copper access business, differ in their systematic risk profiles. The report presents:

- A "first principles" analysis of the copper access business which suggests that it is exposed to low systematic risk relative to BT's other activities because its revenues fluctuate with connections and numbers of lines rather than call/data volumes (although we note that it may have relatively high operational gearing).
- A degree of additional support, which is provided by:
 - evidence on income elasticities of demand for different services;
 - observations of historical time series evidence on BT's group beta; and
 - precedents from regulation of telecommunications businesses internationally.
- A first principles analysis of Information and Communications Technology ("ICT") activities which suggests that they are likely to be subject to higher systematic risk. This is corroborated by inspection of available evidence of betas for "pure play" ICT companies which suggests that they have higher betas than for the BT group.

Although this evidence does not provide a basis for a quantification of disaggregated betas for BT, it nevertheless has value because it gives directional evidence of potential disaggregated betas. However, the key responses by BT and others to Ofcom's original proposals emphasise that in order for Ofcom to be justified in using disaggregated betas it would be necessary for these to be estimated with a sufficient degree of reliability. BT's submission suggests that they cannot in principle be estimated sufficiently reliably because of the lack of pure play comparators for the different parts of BT's business.

Precedents suggest that other telecommunications regulators have been prepared to apply different betas where the evidence has not been as conclusive as BT suggests it needs to be. Conversely, some regulators appear to have concluded that concerns associated with the degree of uncertainty in calculating the precise beta estimates have limited the ability to use disaggregated betas, even if directional evidence suggests that this may be appropriate.

In an attempt to quantify what the beta should be for BT's copper access business we have undertaken two pieces of empirical research. The first looks at a sample of international telecommunications businesses, and seeks to infer, by relating variations in their overall group betas to variations in the composition of their businesses, estimates of betas associated with the different parts of the business (our cross section approach). The second looks at variations in BT's group beta over the last ten years, and seeks to infer disaggregated betas from how fluctuations in beta have been affected by the changing composition of BT's business (our time series approach).

Both the cross section and time series approaches yield results which are directionally consistent with the qualitative and indicative quantitative evidence. They reinforce the evidence that BT's ICT business is likely to have a beta that is higher than that for the group as a whole and also suggest that core telecommunications activities such as copper access are likely to have a lower beta. Moreover, the beta estimates, whilst subject to much error, suggest that the range could be relatively large.

However, both approaches are subject to data, specification and interpretation uncertainties. For example, the cross section approach is used to draw inferences about BT from a sample of international companies which operate predominantly in different geographic areas under varying regulatory regimes. Because of data limitations we proxy the copper access business with the fixed line business and use revenue to weight the different activities rather than share of economic value. Our results differ significantly depending upon the choice of method for calculating the group betas (e.g. whether based on monthly, weekly or daily data).

There are also some issues and problems with the time series approach. These include an implicit assumption that estimates of betas of disaggregated businesses are constant over time; that we proxy copper access by using the access & core network; that regulatory capital values are good proxies for economic values; and that, as with the time series analysis, our results vary according to the time period and frequency of observation used to measure the group beta. These problems which affect the interpretation of the results suggest that less significance should be attached to the absolute figures than to the relative directions they suggest for disaggregated betas.

Whilst none of the individual pieces of directional or quantitative evidence we examined is by any means conclusive on its own, taken together they suggest that the ICT business beta is higher than that for the group as a whole and the copper access beta is lower.

The remaining issue is whether it is possible to estimate sub-group betas for BT with sufficient confidence to enable them to be applied in a regulatory context. In his annex to BT's response to Ofcom's consultation document Professor Ian Cooper of the London Business School sets out what he believes to be the required methodologies to calculate disaggregated betas satisfactorily, and concludes that these methodologies simply cannot be implemented satisfactorily in the case of BT's copper access business, largely because of the absence of relevant pure play comparators.

None of our evidence meets the empirical standard suggested by Professor Cooper. Whilst with more time it might be possible to refine our approach or implement other methodologies to improve the quantity and reliability of the evidence available to Ofcom, it seems to us having conducted this analysis that the disaggregation of group telecommunications betas is an inherently difficult area where the evidence is likely to remain imperfect.

We accept that in an ideal world we would have data for more direct comparators. However, we note that in many business applications it is difficult to find a significant number of good comparators for beta estimation, but conducting such analysis on less than perfect comparators is generally preferred to not conducting the analysis at all. We also note that any calculation of beta involves a degree of judgement (for example, concerning what measure of beta to use, which comparators to consider etc.). There is, for example, no precise, accepted estimate of BT's group beta available to Ofcom, but nevertheless Ofcom

needs to adopt a figure in order to apply the CAPM framework in setting regulated prices, and therefore uses its judgement of the best figure, given the available, imperfect evidence.

We conclude that there is sufficient directional evidence for serious consideration to be given to applying disaggregated betas, with the strongest evidence suggesting that a distinction could be made between BT's information and communications technology (ICT) activities and the rest of BT's business. There is weaker, but almost entirely consistent directional evidence to suggest a further disaggregation between the copper access business and the rest of the non-ICT business. Because of the inherent problems associated with estimation, in our view it seems inevitable that it will be a matter for regulatory judgement whether the directional evidence is sufficient to suggest that disaggregated figures should be applied in practice.

PricewaterhouseCoopers LLP

June 2005

Contents

1 IN ⁻	RODUCTION	1
2 OF	COM'S PROPOSALS AND THE MAIN RESPONSES TO THEM	2
2.1	OFCOM'S PROPOSALS	2
2.2	MAIN RESPONSES TO OFCOMS PROPOSALS	5
3 AN	ALYSIS OF DIFFERENT PARTS OF BT'S BUSINESS	9
3.1	FIRST PRINCIPLES ASSESSMENT	9
3.2	EVIDENCE FROM DIFFERENCES IN INCOME ELASTICITIES	. 16
3.3	EVIDENCE FROM HISTORICAL CHANGES IN BT'S GROUP BETA	. 17
3.4	EVIDENCE FROM PRECEDENTS IN INTERNATIONAL TELECOMMUNICATIONS REGULATION .	. 22
3.5	CONCLUSION	23
4 PC	SSIBLE APPROACHES TO ESTIMATING DIFFERENT BETAS FOR DIFFEREN	г
PARTS	OF BT'S BUSINESS	25
4.1	PRECEDENTS FROM OTHER REGULATORS	25
4.2	PROFESSOR IAN COOPER'S VIEWS ON AVAILABLE METHODOLOGIES	. 27
4.3	OUR APPROACH	. 28
5 QL	ANTITATIVE ANALYSIS OF THE BETAS OF A CROSS SECTION OF	
5 QL TELEC	ANTITATIVE ANALYSIS OF THE BETAS OF A CROSS SECTION OF OMMUNICATIONS BUSINESSES	. 30
5 QL TELEC 5.1	ANTITATIVE ANALYSIS OF THE BETAS OF A CROSS SECTION OF DMMUNICATIONS BUSINESSES OUR METHODOLOGY	30 30
5 QU TELEC 5.1 5.2	ANTITATIVE ANALYSIS OF THE BETAS OF A CROSS SECTION OF DMMUNICATIONS BUSINESSES OUR METHODOLOGY OUR RESULTS	. 30 . 30 . 31
5 QL TELEC 5.1 5.2 5.3	ANTITATIVE ANALYSIS OF THE BETAS OF A CROSS SECTION OF DMMUNICATIONS BUSINESSES OUR METHODOLOGY. OUR RESULTS INTERPRETATION OF OUR RESULTS	. 30 . 30 . 31 . 33
5 QL TELEC 5.1 5.2 5.3 5.4	ANTITATIVE ANALYSIS OF THE BETAS OF A CROSS SECTION OF DMMUNICATIONS BUSINESSES OUR METHODOLOGY OUR RESULTS INTERPRETATION OF OUR RESULTS CONCLUSIONS FROM CROSS SECTION ANALYSIS.	30 30 31 33 33
5 QL TELEC 5.1 5.2 5.3 5.4 6 QL	ANTITATIVE ANALYSIS OF THE BETAS OF A CROSS SECTION OF OMMUNICATIONS BUSINESSES OUR METHODOLOGY OUR RESULTS INTERPRETATION OF OUR RESULTS CONCLUSIONS FROM CROSS SECTION ANALYSIS ANTITATIVE ANALYSIS OF BT'S BETA OVER TIME	30 30 31 33 33 34 36
5 QL TELEC 5.1 5.2 5.3 5.4 6 QL 6.1	ANTITATIVE ANALYSIS OF THE BETAS OF A CROSS SECTION OF OMMUNICATIONS BUSINESSES OUR METHODOLOGY OUR RESULTS INTERPRETATION OF OUR RESULTS CONCLUSIONS FROM CROSS SECTION ANALYSIS ANTITATIVE ANALYSIS OF BT'S BETA OVER TIME OUR METHODOLOGY	30 30 31 33 34 36 36
5 QL 5.1 5.2 5.3 5.4 6 QL 6.1 6.2	ANTITATIVE ANALYSIS OF THE BETAS OF A CROSS SECTION OF DMMUNICATIONS BUSINESSES OUR METHODOLOGY. OUR RESULTS INTERPRETATION OF OUR RESULTS CONCLUSIONS FROM CROSS SECTION ANALYSIS. ANTITATIVE ANALYSIS OF BT'S BETA OVER TIME. OUR METHODOLOGY. OUR METHODOLOGY.	30 30 31 33 34 34 36 40
5 QU 5.1 5.2 5.3 5.4 6 QU 6.1 6.2 6.3	ANTITATIVE ANALYSIS OF THE BETAS OF A CROSS SECTION OF DMMUNICATIONS BUSINESSES OUR METHODOLOGY. OUR RESULTS INTERPRETATION OF OUR RESULTS CONCLUSIONS FROM CROSS SECTION ANALYSIS. DANTITATIVE ANALYSIS OF BT'S BETA OVER TIME. OUR METHODOLOGY. OUR RESULTS CONCLUSIONS FROM TIME SERIES ANALYSIS.	30 31 33 33 34 36 36 40 40
5 QL 5.1 5.2 5.3 5.4 6 QL 6.1 6.2 6.3 7 CC	ANTITATIVE ANALYSIS OF THE BETAS OF A CROSS SECTION OF OMMUNICATIONS BUSINESSES OUR METHODOLOGY. OUR RESULTS INTERPRETATION OF OUR RESULTS CONCLUSIONS FROM CROSS SECTION ANALYSIS ANTITATIVE ANALYSIS OF BT'S BETA OVER TIME. OUR METHODOLOGY. OUR METHODOLOGY. OUR RESULTS CONCLUSIONS FROM TIME SERIES ANALYSIS	. 30 . 30 . 31 . 33 . 34 . 36 . 40 . 46 . 48
5 QL 5.1 5.2 5.3 5.4 6 QL 6.1 6.2 6.3 7 CC APPEN	ANTITATIVE ANALYSIS OF THE BETAS OF A CROSS SECTION OF DMMUNICATIONS BUSINESSES OUR METHODOLOGY. OUR RESULTS INTERPRETATION OF OUR RESULTS CONCLUSIONS FROM CROSS SECTION ANALYSIS. ANTITATIVE ANALYSIS OF BT'S BETA OVER TIME. OUR METHODOLOGY. OUR METHODOLOGY. OUR RESULTS CONCLUSIONS FROM TIME SERIES ANALYSIS. DIX 1 - LIST OF COMPANIES USED IN THE CROSS SECTION ANALYSIS.	. 30 . 31 . 33 . 34 . 36 . 40 . 46 . 48 . 50
5 QU 5.1 5.2 5.3 5.4 6 QU 6.1 6.2 6.3 7 CC APPEN	ANTITATIVE ANALYSIS OF THE BETAS OF A CROSS SECTION OF OMMUNICATIONS BUSINESSES	. 30 . 30 . 31 . 33 . 34 . 36 . 40 . 46 . 48 . 50
5 QL 5.1 5.2 5.3 5.4 6 QL 6.1 6.2 6.3 7 CC APPEN APPEN	ANTITATIVE ANALYSIS OF THE BETAS OF A CROSS SECTION OF OMMUNICATIONS BUSINESSES	30 30 31 33 34 36 40 46 46 48 50 53

1 Introduction

In January 2005 Ofcom issued a consultation document¹ seeking the views of respondents on a number of issues relating to risk and return. One of its key proposals was that Ofcom should consider whether, and if so how, it should apply different cost of capital figures to different parts of the BT group.

Several respondents suggested that the consultation document did not contain enough evidence to justify setting different rates of return for different parts of BT's business. In April 2005 Ofcom therefore commissioned PricewaterhouseCoopers LLP, in consultation with Ofcom's adviser Professor Julian Franks of the London Business School, to examine in more detail whether a disaggregation of BT's cost of capital is appropriate, and if so, what evidence there is to enable the different figures to be calculated.

This report sets out our findings. It is organised as follows:

- Section 2 summarises Ofcom's original proposals, and the main responses to them, with a particular focus on BT's response.
- Section 3 describes the different parts of BT's business, and considers what evidence there is to suggest that in principle they have different risk profiles and hence different costs of capital.
- Section 4 discusses the different methods that could be used to estimate separate cost of capital figures for the different parts of BT's business.
- Section 5 describes the first part of our quantitative analysis, a statistical analysis of a cross section of international telecommunications operators.
- Section 6 describes the second part of our quantitative analysis, a statistical analysis of BT's historical group cost of capital.
- Section 7 sets out our conclusions.

¹ "Ofcom's approach to risk in the assessment of the cost of capital – an Ofcom consultation", 26 January 2005.

2 Ofcom's proposals and the main responses to them

Ofcom's consultation document discusses a number of issues relating to risk and return, but this report is only concerned with the issue of applying different costs of capital to different parts of BT's business. This section briefly describes Ofcom's proposals in this area, and the main responses to these proposals.

2.1 Ofcom's proposals

2.1.1 Establishing the principle of different costs of capital

In its consultation document Ofcom sets out the reasons why it proposes to apply different costs of capital to different parts of BT's business. Ofcom argues that:

- In its view there is reason to believe that different parts of BT's business do indeed have different risk characteristics – "BT provides a wide range of retail and wholesale activities, including well-established products such as voice call origination and termination, new products such as broadband services, and as yet undeveloped services that will be offered via 21st Century networks^{*}.
- The implication of the above is that if, in fact, the risks faced across BT's product line do differ materially, then the use of a single return would have an adverse impact on Ofcom's ability simultaneously both to encourage efficient investment and to protect customers from excessive pricing. Ofcom notes that if "the company WACC and expected cash-flows are used as a basis for investment appraisal or regulated charge setting (rather than the allowed return reflecting the systematic risk of the particular project), then there is a possibility of suboptimal market decisions being made"⁸.

2.1.2 The CAPM framework

Having set out its view that, in principle, differentiated costs of capital for BT might be appropriate, Ofcom also discusses approaches to establishing what these should be. Ofcom adopts the capital asset pricing model (CAPM) approach to calculating the cost of equity. Within this framework, the cost of capital is calculated according to the following formula:

 $WACC = (K_e * E/V) + (K_d * (1-T) * D/V)$

Where $K_e = R_f + \beta_e^* ERP$ (the CAPM formula)

And $K_d = R_f + DP$

Where:

Ke	=	Cost of equity
Kd	=	Cost of debt
E	=	Value of equity invested in business
D	=	Value of debt (net of cash and equivalents)
V	=	Value of enterprise (E + D)

² Ofcom's consultation document, paragraph 5.1.

³ Ofcom's consultation document, paragraph 5.11.

R _f	=	Risk-free rate
β_{e}	=	Equity beta of investment
ERP	=	Equity risk premium
DP	=	Debt premium
Т	=	Corporate tax rate

For the purposes of our work, an important property of the CAPM framework is that the key variable determining differences in the cost of capital between businesses or activities is the equity beta. This measures the sensitivity of the returns of a company to overall market returns and captures its non-diversifiable, or systematic risk, within a portfolio of other investments.

The systematic risk associated with a business or activity, in turn, depends on expectations of (a) the extent to which variations in revenue are correlated with variations in the market or aggregate demand and (b) the extent to which such variations in revenue have a direct impact on profits or cash flows, this in turn being determined largely by the level of fixed costs associated with the business or activity (termed operational leverage) and the level of fixed interest payments associated with debt financing (termed financial leverage).

During our work it has been appropriate to remove the impact of financial leverage, by unlevering the equity betas to calculate unlevered or asset betas. This enables us more closely to assess the operating risk properties of the different entities. The formula we use for unlevering betas is:

$$\beta_a = \beta_e^* (E/V) + \beta_d^* (D/V)$$

where:

 β_a = Asset beta

 β_d = Debt beta

Asset betas capture the bulk of the variation in the cost of capital within the CAPM framework, but some of the other components can also vary by business or activity⁴. Our work was solely focussed on the extent to which there is evidence to suggest that costs of capital might vary as a result of different parts of BT's business having different asset betas. We also make the assumption that the debt beta is zero⁵.

2.1.3 Approaches to disaggregating beta

Ofcom's consultation document notes⁶ that a company's overall equity beta is a weighted average of the betas of the various separate investments or activities in which the company is engaged:

 $\beta = W_1\beta_1 + W_2\beta_2 + \dots + W_n\beta_n$

⁴ The equity risk premium is generally regarded as being common to all businesses and activities, but in principle all the other components could be regarded as varying to a greater or lesser extent between businesses and activities, including the debt capacity and gearing (e.g. more risky businesses are typically less able to support high debt levels for a given interest cost), risk-free rate (e.g. for differences in the relevant time profile, and hence the duration of the relevant government bond) and the tax rate (e.g. if effective rather than statutory tax rates are used).

⁵ While a debt beta of zero is clearly an assumption, it is relatively commonplace in beta analysis of large firms with investment grade credit ratings.

⁶ Ofcom's consultation document, paragraphs 5.21-5.22.

where the company's overall beta is β , and it is comprised of n different investments or activities with different betas. In principle the weighting factors (W₁...W_n) should be calculated as the relative market or economic values of each investment or activity, but in practice other proxies may be needed as market values may not be observable.

In addition to the measurement issues associated with the weights in the beta disaggregation formula, there are also important issues associated with determining (a) the number and identity of the individual investments or activities into which to split the company and (b) estimating the corresponding separate investment or activity specific equity betas.

With regard to (a), Ofcom suggests that the key determinant in choosing which parts of BT's business (if any) should be separately identified in a beta disaggregation exercise is the materiality of differences in their betas from the overall group beta – continuing to use a single group beta or WACC would be appropriate *"if the differences in systematic risk relevant to the main regulated products offered by regulated firms were so small as to make no significant difference to WACC estimation"*.

With regard to (b) Ofcom suggests two approaches to estimating the equity beta at a subcompany level. The first of these is to identify *"companies with risk profiles similar to those of the activity being contemplated, and [to use] the betas of these firms as benchmarks in relation to the activity in question"*⁸. We refer to this as the "pure play" approach. The second is to infer whether there are differences in the underlying systematic risk associated with different activities by examining evidence on differences in the income elasticity of demand. We refer to this as the "fundamental analysis" approach.

2.1.4 Applying beta disaggregation to BT

Ofcom's consultation document suggests that, whilst the BT group incorporates a large number of different activities and products, it would be impractical to disaggregate the group beta into all the separate components. Rather, on the basis of practicality and materiality, Ofcom's initial view is that *"it would be appropriate to isolate the special case of wholesale regulatory products that give retail operators access to BT's copper access network"* as *"these may involve significantly less systematic risk than BT group as a whole"*⁹.

In order to determine what the level of a separate equity beta for BT's copper access network might be Ofcom carries out some preliminary analysis, using two pure play benchmarks (UK utilities and US telecommunications companies) and applying fundamental analysis by examining differences in the income elasticity of demand. Ofcom acknowledges that none of these analyses gives a direct indication of the absolute value of the equity beta for the copper access business, but all three approaches suggest that it is reasonable to conclude that its value should be lower than Ofcom's estimate of the BT group equity beta.

In order to suggest an actual figure, Ofcom considers what the implications would be for the implied equity betas of other parts of BT's business for a given range of values for the copper access network beta, given the overall group beta and the different shares of BT's business accounted for by access and the other activities. For this purpose, Ofcom splits BT up into three parts – the copper access network, other regulated activities and the rest of the business – and assumes that other regulated activities have a beta equivalent to the group average.

Based on this analysis Ofcom concludes that a beta for the copper access network significantly lower than 1.0 would not be plausible given the implications for the implied beta

⁷ Ofcom's consultation document, paragraph 5.13.

⁸ Ofcom's consultation document, paragraph 5.17.

⁹ Ofcom's consultation document, paragraph 5.25.

for the rest of the business, and suggests a beta for the access network in the range 0.9 to 1.2.

2.2 Main responses to Ofcom's proposals

2.2.1 BT's response

BT's response¹⁰ covers all aspects of Ofcom's consultation document, but for our work we are concerned only with those aspects of its response which relate to the issue of applying different costs of capital to different parts of BT's business. This is covered both in the main body of BT's response, and also in more detail in an annex written by Professor Ian Cooper of the London Business School.

BT believes that the group WACC should continue to be applied to all parts of its business because "there is no objective or reliable way of determining the relative risk levels of different parts of BT"¹¹, and that "in the absence of reliable and objective evidence, any determination of different rates would be arbitrary and subjective, and as such would be inappropriate for an evidence-based regulatory regime"¹². BT states that, because of this lack of direct evidence, in its internal investment appraisal it does not use different discount rates for projects in different parts of its business (and BT states that this is also true of many other publicly quoted firms in the UK and the USA).

This tends to suggest that BT's main objection to the use of decomposed betas is the lack of reliable, objective evidence to support such decomposition in a robust manner. This interpretation is supported by its statement that *"although in principle different systematic risk levels should be rewarded by different rates of return, in practice it is difficult to establish a robust methodology"*³. Professor Ian Cooper is even clearer on this point, stating that *"if the required return on the copper access assets could be reliably estimated, it should be used.* Not doing so would introduce errors that Ofcom discusses^{#4}.

BT also acknowledges that "non-expert observers would anticipate that BT's local access network activities would have a lower risk than the rest of BT's operations (e.g. on the basis that demand for copper-based telephony and data services is, to some extent, not dependent on the state of the market as a whole). There are superficial similarities with other 'utility' local distribution networks, although we do not believe these comparisons are wholly valid...If Ofcom insists on disaggregating BT's cost of capital, we believe it would be least damaging to separate it into only two parts – the local copper access network and the rest of BT...the absence of objective quantification for different rates indicates that any difference in regulatory cost of capital should be very smallⁿ¹⁵.

Taken together, these statements might tend to suggest some acknowledgement that there may be a case in principle for adopting a lower beta for the copper access network, but that the key difficulty in implementing this is the practical issue of quantification, necessitating caution. However, BT also states that *"various parts of BT share the same risk profile, being that of the telecommunications market, and the complex inter-relationships between various components and wholesale/retail products means that risk is spread and not meaningfully*

¹⁰ "Ofcom's approach to risk in the assessment of the cost of capital – BT's response to Ofcom consultation document published 26th January 2005, 5 April 2005.

¹¹ BT's response, Overview, page 4.

¹² BT's response, Overview, page 5.

¹³ BT's response, Responses to specific questions, page 12.

¹⁴ BT's response, Annex 2, "The risk of the copper access network", by Professor Ian Cooper, page 3.

¹⁵ BT's response, Responses to specific questions, page 15.

differentiated^{*m*6}, which tends to suggest that the "in principle" point is not fully conceded by BT. We return to BT's comments in this regard in Section 3.

Much of BT's submission, and virtually Professor Cooper's entire annex, set out views suggesting that the preliminary evidence presented by Ofcom does not support its proposed range for a separate, lower beta for the copper access business. In particular, BT and Professor Cooper argue that:

- UK utilities are extremely poor pure play comparators for the copper access business as evidence from other studies suggests that risks in the telecommunications sector are significantly higher than in the gas, electricity and water sectors.
- US telecommunications companies are also poor pure play comparators, because of differences in the regulatory regime between the UK and the USA, the rapidly evolving structure of the US telecommunications sector, and difficulties in interpreting apparent differences between local exchange and long distance carriers.
- Whilst differences in income elasticities are suggestive of differences in beta, many other factors need to be taken into account, and there is no reliable way to estimate asset betas from fundamental information of this type.

Professor Ian Cooper also sets out five methods which he believes would need to be employed to calculate a robust separate copper access business beta:

- The best approach is to identify pure play, traded copper access business comparators. Such comparators would need to be UK-based in order to reflect correctly the risks faced by BT's access business. Clearly such comparators do not exist so Professor Cooper suggests that this approach cannot be used.
- Identify pure play traded companies that operate only in the non-copper access network activities of BT, and infer the copper access network beta from their beta and the BT group beta. Not only is this a less direct method than the first, but again it cannot be used because such traded comparators do not exist in the UK.
- Identify traded companies that have operations in copper access assets, and operations in other assets for which the betas can be identified, and infer the copper access beta by comparing these other activity betas with their overall beta. This is another indirect method, and cannot be implemented because of the absence of traded companies that have copper access assets identical in risk to BT.
- Use accounting data to estimate either the absolute or relative level of risk of the copper access business (an "accounting beta"). Professor Cooper suggests that this cannot be done because of the absence of historical accounts for the copper access business¹⁷.
- Estimate beta based on theoretical arguments or fundamental analysis of the business. Professor Cooper suggests that this is the least reliable of the five methods identified because it is not based on stock market information.

Professor Cooper therefore concludes that, as there is no available evidence to allow a copper access network beta to be calculated using any of the first four methods, and the fifth method is fundamentally unreliable, it follows that *"there is no evidence that is closely related"*

¹⁶ BT's response, Responses to specific questions, page 11.

¹⁷ We examined BT's regulatory accounting data as part of our work but found that no reliable conclusions could be drawn from this.

to the problem that Ofcom seeks to address⁷¹⁸, and that in setting any separate cost of capital for this business "the element of judgement rather than evidence is bound to be overwhelming, because the relevant direct evidence does not exist⁷¹⁹.

2.2.2 Other responses

We examined the other publicly available responses to Ofcom's consultation document²⁰. In brief, these suggest that:

- There is broad agreement on the principle that different betas should be applied if there
 is evidence to support this, although several respondents do express a concern that
 any lower cost of capital for the copper access business might affect investment in
 competing next generation access networks.
- With regard to Ofcom's view that the beta for BT's copper access business is lower than that for the BT group as a whole, most respondents either agree, or do not offer a comment on this. However, Vodafone said that the evidence for this is ambiguous, given the degree of operational gearing of the copper access business and the constraints placed on it by regulation.
- There is significant disagreement regarding the evidence to support disaggregation in practice. Several respondents argue that any particular disaggregation chosen is likely to be arbitrary; there is significant disagreement over the value of Ofcom's analysis of pure play comparisons with UK utilities and US telecommunications businesses; there is concern that the analysis could be affected by the use of group, rather than business-specific, gearing figures21; and there is also disagreement concerning Ofcom's approach to justifying a lower bound for the copper access business beta by checking the implications for the unregulated business beta. Whilst some respondents state that this evidence suggests that Ofcom has set too low a copper access business beta, others argue that the BT group beta used by Ofcom is too high, constraining the level of the copper access business beta also to be unduly high.

2.2.3 Implications for our work

We conclude the following from our examination of Ofcom's consultation document and the responses to it:

- There is general acceptance of the principle that incentives and efficiency are better served by applying disaggregated betas where these betas differ.
- There is some acceptance that it is plausible that BT's copper access network is subject to lower systematic risk than the BT group as a whole, and therefore should have a lower beta than the BT group beta. However, this is not accepted within BT's and Vodafone's responses and so we need to consider the evidence for this (see Section 3).
- There is no agreement on further disaggregation of BT's beta beyond a two way split into the copper access network and the rest of BT. Ofcom does not formally suggest any further disaggregation, although it does apply a three way split when it checks the plausibility of its range for the copper access business beta. BT suggests that, if Ofcom were to apply a decomposition of beta, a two way split would be least

¹⁸ BT's response, Annex written by Professor Ian Cooper, pages 7-8.

¹⁹ BT's response, Annex written by Professor Ian Cooper, page 3.

²⁰ Available on Ofcom's website at http://www.ofcom.org.uk/consult/condocs/cost_capital/responses/?a=87101

²¹ To deal with this issue we focus on the asset beta rather than the equity beta.

damaging. We need to consider what disaggregation is desirable, and note that this could vary depending on the purpose for which it is used (e.g. whether to demonstrate the principle that risk varies across different parts of BT's business, to enable robust calculation of different betas, or to be implemented in the regulatory regime).

- The key issue that emerges is whether estimates of disaggregated betas can be robust enough to justify their use. Ofcom's consultation document acknowledges that its preliminary analysis could be improved on, although some respondents consider it sufficiently robust to inform its regulatory decisions. BT states that if Ofcom insists on disaggregation, then the least damaging approach would be to adopt a slightly lower beta for the copper access network, but no further disaggregation. However, BT does not state that there is evidence to show that this is appropriate, other than acknowledging that non-experts would believe the copper access business to be of lower risk, and Professor Ian Cooper suggests that it is not possible to obtain sufficiently reliable evidence. We need to look at what further evidence is available and set out the extent to which it can be considered robust (see Sections 4 to 6).
- Ultimately, given that the principle of disaggregation is generally accepted, if there is directional evidence to suggest that one (or more) of BT's regulated activities does have a beta that is different from that of the group, then this would suggest that there is a trade-off between the desirability of using a different beta on the one hand, and the risks associated with using an estimate that is not fully robust on the other. This would require the exercise of judgement by Ofcom, but we also examine relevant precedents that may help inform that judgement (see Section 3).

3 Analysis of different parts of BT's business

This section considers the different parts of BT's business, including the copper access business, and suggests that there is some evidence that they differ in their systematic risk profiles. We believe that although this evidence does not allow any quantification of disaggregated betas, it is nevertheless valuable because it gives directional evidence of potential differences in betas. This may be of relevance to Ofcom if it is required to exercise judgement in deciding whether or not to apply beta estimates where the practical, quantitative evidence could be considered to be less than fully robust.

In order to inform our assessment in this section we first consider the economic characteristics of the different BT businesses, what these imply for systematic risk and beta, and whether there are good pure play comparators²² for any of the parts of BT's business (a "first principles" analysis). We then augment this with evidence on income elasticities, and some analysis of historic trends in BT's beta. Finally we look at the approaches to the issue of beta disaggregation adopted by other telecommunications regulators internationally.

3.1 First principles assessment

3.1.1 Disaggregation of BT's business

As some respondents to Ofcom's consultation document point out, there are a number of different ways in which BT could potentially be separated into different businesses for the purposes of calculating different betas. For the purposes of our first principles assessment we identify different business streams that we believe are likely to be relevant to our task – that is, identifiable businesses with distinct activities that may differ in the degree to which they expose BT's shareholders to systematic risk²³. We divide BT into the following separate businesses and where possible seek to identify pure play comparators for each:

- Wholesale copper access.
- Wholesale core network.
- Retail (predominantly calls, access, mobile and other value added services).
- Information and Communications Technology (ICT).
- Other.

3.1.2 First principles assessment of BT's copper access wholesale business

BT's copper access network consists of the copper wires, trenches and ducts that run from local exchanges into individual homes and businesses. These assets were put in place a number of decades ago, although BT incurs significant expenditure each year in maintenance and replacement of parts of the network. This network provides a wholesale access product to retail telecommunications providers (including BT's own retail businesses). If this network were separated from BT its revenues would consist of a stream of rental payments from retail telecommunications businesses, originating from end-user customers using the copper wire

²² A pure play comparator is a f loated company wholly engaged in a single business activity. Its beta can be used as an estimate for the beta of another similar company, or for a business division of a multi-activity company which is engaged in a similar business activity.

²³ We acknowledge that there is more than one way to disaggregate BT Group. For the purposes of our analysis we believe that precision in identifying and distinguishing between all of BT's different activities is less important than broadly identifying its main activities that have different risk characteristics.

to their home or premises in order to access a range of telecommunications services. Its costs would consist largely of replacement and maintenance costs.

As set out in Section 2, beta is a measure of systematic risk, so a first principles assessment of the size of the beta for the access business needs to consider the extent to which variations in the profits or cash flows of the business are correlated with variations in general market returns. The key determinant of this is the degree to which revenues vary across the economic cycle, growing more quickly in economic upturns and performing less well in downturns. Strictly, we are interested in the forward-looking expectations for these correlations, as these will govern the movements in market values upon which betas are based, but it is still insightful to consider the actual relationships for profits and cash flows more generically.

Based on a first principles assessment, it seems reasonable to conclude that the revenues accruing to BT's copper access business do not exhibit strong correlation with fluctuations in general economic conditions. For there to be a strong correlation, it would be necessary to believe that the number of end-user customers choosing to connect to the copper access network would grow significantly in times of strong economic growth, and grow less strongly or contract in times when economic growth is weaker.

This does not seem plausible. The copper access network gives customers access to a range of telecommunications services provided both by BT and other operators, including traditional fixed line voice telephony services, dial-up internet services, and broadband internet services. Significant disconnection and reconnection across an economic cycle would imply that in the face of economic slowdown end-users would react by curtailing their access to telecommunications services only to reconnect in better times. It is more plausible to regard access to telecommunication services such as traditional fixed line voice telephony as an essential, mature service that will be retained even in times of relative low growth or economic hardship.

One factor which might contribute to revenues fluctuating over the economic cycle is variation in the number of lines as opposed to the number of connections. This is more likely to vary directly with economic performance. In an economic upswing, for example, a business might decide to invest in an additional line to reduce instances of customers being unable to make contact, and more businesses may start up. In an economic upturn, growing personal incomes might lead to more private customers acquiring an additional line to reduce instances where different members of a household are unable to make or receive calls at the same time. In a downturn these lines might be disconnected.

This appears to have the effect of implying a positive correlation of access revenues with the economic cycle, with demand for additional lines increasing for businesses in a general economic upswing, and the ability of both businesses and private customers being able to afford additional lines also increasing with faster economic growth. Chart 1 below shows that total lines grew significantly between 1994-95 and 1999-2000, with the largest growth being in the number of business lines. This could be explained as reflecting economic growth. Since then the number of lines has been relatively flat, which again may suggest some correlation with a worsening economic situation.



Chart 1 UK Business and Residential Lines (all operators)

Source: Ofcom

Overall, there is some evidence of cyclicality. However, as discussed below, other parts of BT's business are exposed to revenue risk associated with fluctuations in call and data volumes, not just fluctuations in lines. It seems reasonable to anticipate that call volumes will fluctuate more in response to changing economic circumstances, because businesses and individuals are more likely to react to changes in business activity and incomes by altering their immediate pattern of consumption of telecommunications services than by changing their consumption of access. Chart 2 below shows some evidence to support this view, although there have been other factors which have driven lines and call volumes in the UK in recent years.²⁴



Chart 2 UK telephone lines and call volumes (all operators)

Source: Ofcom and ONS

There are a number of complicating factors that do not change this broad conclusion of an income stream for the copper access business that is relatively stable across the economic cycle. The first is the available alternative of connection via cable providers. This alternative means that disconnection from BT's copper access network does not automatically imply

²⁴ For example, the rise and decline of internet dial-up call volumes within overall call volumes may have more to do with technological cycles than economic cycles.

disconnection from the ability to access fixed line voice telephone or other telecommunications services, since cable can provide an alternative access method. However, this simply implies that BT's copper access network business faces competition – it does not necessarily imply that it is a cyclical business. For this to be the case it would be necessary that in an economic upturn customers would tend to switch from cable providers to BT, with the reverse happening in an economic slowdown. There does not seem to be any reason to think that this is the case²⁵. The fact that the cable providers introduce competition does not necessarily affect an analysis of beta.

A second complicating factor is the available alternative of mobile connection. This also potentially provides an element of competition to the copper access network because in principle customers could choose to disconnect from fixed line services altogether in favour of using a mobile network for all telecommunications services.

Again, the presence of competition does not necessarily affect the value of beta. Indeed, it might even be argued that this introduces an element of inverse sensitivity to the economic cycle for copper access rental revenue. The logic would be that, as economic growth increases and people become wealthier, increasing numbers of customers feel sufficiently affluent to rely on their mobile phones for all telecommunications, despite the higher average costs of calls this implies.

This leads on to the third complicating factor, broadband access. For private customers and small businesses, broadband internet services are available either through cable connections or through the copper access network with ADSL enhancement. This has two potential implications for the systematic risk of the copper access network. Firstly, the availability of broadband via the copper network reduces the desirability of replacing copper fixed line access with mobile access, reducing further any possible inverse cyclicality effect from mobile access, customers have an incentive to install an additional line in order to be able to make and receive calls at the same time as accessing the internet. Broadband eliminates the need for an additional line. This reduces or removes one potential incentive effect that could have implied that copper access revenue are cyclical – that in an economic upturn, more people would demand dial-up internet services, increasing the complementary demand for additional lines²⁶.

Overall, this first principles assessment of copper access wholesale business revenue suggests that it is relatively uncorrelated with the economic cycle compared with most of BT's revenue streams, given that demand for fixed network access is relatively stable. The main element of cyclicality appears to be introduced by demand for multiple lines and business use. As we will explain below, other parts of BT's business are exposed to call/data volume risk as well as connection and line number risk, and this suggests that copper access business revenue is likely to contribute less to systematic risk than the revenue of other parts of the business.

As noted earlier, the largest component of the copper access network ongoing costs are for maintenance. There may be some element of discretion in the timing of this expenditure, but in general terms these costs are fairly fixed in nature across the economic cycle. These costs tend to be less avoidable when volumes change, compared to some retailing costs which are more directly avoidable (for instance invoice production). This tends to increase beta through the effect of operational leverage.

Finally, it is also of potential relevance that the access network is a regulated business. The effect of regulation on beta is a complex issue and beyond the scope of this report. We note

²⁵ This would be the case if, for example, BT access is a "luxury good", being more expensive and being the preferred method of access when individuals and businesses are more wealthy.

²⁶ This also implies that, given that customers are replacing dial-up connections with (more expensive) broadband connections, existing additional lines might be disconnected, implying a potentially counter-cyclical effect.

that the literature on the effects of regulation is mixed, so for our purposes we do not distinguish between regulated and non-regulated parts of BT's businesses when commenting on likely differences in their asset betas from a first principles approach.

The wholesale access business does not have any obvious direct pure play comparators, because most telecommunications companies have integrated wholesale and retail operations. The only other UK companies providing access are the cable companies, whose beta will also be impacted by their cable TV operations.

3.1.3 First principles assessment of BT's core network wholesale business

BT's core network wholesale business is responsible for BT's network infrastructure with the exception of the local copper access network. It therefore includes exchanges, the trunk network and BT's private circuits business. This business sells its capacity to wholesale and retail telecommunications operators – either the BT retail business or to other retail and wholesale businesses which interconnect with BT's core network. This business is increasingly exposed to competition from alternative networks. It appears to have the following apparent risk characteristics:

- Its revenue stream is exposed to call/data volume risk. Instead of recovering costs through rental charges, which only vary with lines connected, this business is dependent on call/data volume related charges (whether paid by BT's retail business, or received directly from interconnecting operators). It seems reasonable to believe that the volume of demand for calls/data is likely to vary more directly with the economic cycle than either connections or the number of lines, implying that the revenue stream of this business is more exposed to systematic risk than is the revenue stream of the copper access business.
- The core network and particularly the private circuits business is more intensively utilised by businesses than residential customers. Business demand tends to be more responsive to changes in general economic conditions than residential demand and typically increases systematic risk.
- It appears to be exposed to relatively high operational gearing, because of the fixed nature of the costs of maintaining the core network across the economic cycle.

Because it is exposed directly to call/data volume related demand risk it seems reasonable to conclude that BT's core network wholesale business has a higher beta than that for the copper access business.

There are some UK companies which provide alternative telecommunications networks (altnets) in competition to BT, although none of these are a perfect match to BT. Those who have made substantial investments in their own UK telecommunications networks include Colt, Energis, Thus and Cable and Wireless (C&W). All are heavily focused upon the business market and C&W has significant other international business interests, so none of these can be regarded as good comparators for BT's core network business.

3.1.4 First principles assessment of BT's fixed line retail business

BT's fixed line retail business handles the line rental, call and other billing and customer service activities for BT's end-user customers, with the exception of ICT activities. Most of the revenue paid by end-users is passed directly on to BT's wholesale business, or to other interconnecting telecommunications businesses, with the retail business retaining a proportion to cover its costs, including a profit element. It is facing increasing competition from other retailers of telecommunications services which may or may not use BT's wholesale network. This business has the following apparent risk characteristics:

- Its revenue risk profile mirrors the demand for access and calls experienced by the wholesale parts of BT. As the access part depends on the number of customers choosing to connect to telecommunications services using BT's copper access network this business is exposed to the same disconnection/reconnection risk as the wholesale copper access business. Its revenue will also fluctuate with call/data volumes and uptake of BT's Broadband products, thus exposing the business to the systematic risk associated with this.
- It is also exposed to the same competition as copper access wholesale, in terms of customers choosing between BT copper access and cable or mobile access. It is not greatly more exposed to fixed line competitors than wholesale access as most fixed line competitors to BT currently rely on BT's retail business to carry out line rental billing²⁷.
- Compared with its wholesale equivalent the retail business is probably less exposed to operational gearing, because it is likely to have a smaller proportion of fixed costs.²⁸
- The retail business has far less capital employed per pound of revenue (compared to the network side of the business). It has smaller profit margins, which means that it is more sensitive to both specific and systematic risks.

Overall, therefore, it seems difficult to conclude whether this business has a different risk profile compared to BT as a whole.

The best comparators to BT's retail operations are telecommunications resellers, who provide their services through other telecommunications network providers, such as Onetel, Alfa Telecom and Tele2. Many resellers are small companies (relative to BT retail), or are part of bigger retailing groups and employ different retailing techniques (for example the use of prepaid calling cards) to different customer groups (who are typically more price sensitive than BT's customers). They cannot be viewed as good pure play comparators. Carphone Warehouse retails mobile and fixed telephone services, but its network of high street shops means that its cost structure is likely to be different to that of BT retail.

3.1.5 First principles assessment of BT's mobile and value added retail business

This is a relatively small part of BT's business which competes with many other service providers and retailers.²⁹ Its revenues are likely to be more exposed to systematic risk than other retail products as demand for these value-added services is likely to be more discretionary and therefore more correlated with the economic cycle.

3.1.6 First principles assessment of BT's ICT business

The ICT business is BT's business services and solutions division, providing services to business customers ranging from desktop and network equipment and software, transport and connectivity, IP-based e-business solutions, managed network services and systems integration to consultancy for complex global requirements.

It seems likely that demand for these services will fluctuate considerably across the economic cycle, with businesses having some discretion over their demand for such services. Although operational gearing may be relatively low, we would expect this business to have a relatively high beta.

²⁷ The Wholesale Line Rental (WLR) product is likely to increase the number of competitors who will not rely on BT to retail the access line.

²⁸ As an indication as to the extent of fixed costs, capital costs represent a higher proportion of total costs for the network side of BT's business compared to the non-network side of the business.

²⁹ For a range of BT's other retail products see www.bt.com/shop.

We are able to check this view by examining the betas of some pure play ICT comparators. The table below compares the asset betas of five ICT comparator businesses with the asset beta for BT group as a whole.

Company	Monthly	Weekly	Daily
CapGemini SA	2.59	1.72	1.77
HIQ International AB	2.81	1.61	1.58
Unisys Corp	1.61	1.43	0.96
Getronics	2.47	2.58	2.34
Logica plc	2.14	2.86	2.14
Average	2.32	2.04	1.76
BT Group	1.05	0.43	0.72

Table 1 ICT comparable asset betas³⁰

As with most exercises where the betas of comparator companies are used as a proxy for another company, there are likely to be differences in the precise composition of the activities of the different comparators. Notwithstanding this, in our view the pure play comparators available to benchmark BT's ICT activities are significantly more reliable than those for other parts of BT's business, and are as reliable as comparators generally used in many business applications, such as business valuations. As the table indicates, the ICT asset betas of our sample of comparable ICT businesses were significantly higher than that for the BT group at the end of 2004.

The average ICT asset beta, calculated on a monthly basis, is 2.32; on a weekly basis the figure is 2.04 and on a daily basis it is 1.76. For illustration purposes, simply averaging across these different measures, the ICT business average asset beta is 2.04. The average BT asset beta from the information in this table is 0.73. Assuming the ICT business accounts for between 10% and 20%³¹ of BT's group business this implies the rest of the business has an asset beta of 0.4 to 0.59. Relative to the group asset beta this is around 0.14 to 0.33 lower³².

This represents the simplest form of beta disaggregation available to us, stripping out the effects on the group beta of one of BT's activities that appears to have a markedly different beta. This simple calculation, using the approach set out in Section 2.1.3, provides a basis for deriving a beta for BT's UK telecommunications activities. Whilst this is not a full disaggregation down to copper access activities, it is a partial disaggregation, and may represent an improvement upon the group figure. In the rest of the report we assess whether further decomposition can yield reliable results.

3.1.7 First principles assessment of BT's other businesses

This consists of the rest of BT's businesses, and is thus a mixture of different activities. It is difficult to say anything very clear about the beta of these activities, but they are a small proportion of BT's overall business and thus do not affect our analysis.

³⁰ Monthly beta calculated using five years of data to 30 April 2005. Weekly and daily beta calculated using one year of data, up to the latest financial year-end. All betas calculated with reference to local market indices and excluding any additional adjustments (such as the Blume adjustment towards 1). This is consistent with our later work.

³¹ Defining exactly the composition of BT's ICT revenue is subject to interpretation. BT's 2004 Annual report discloses ICT revenues of £2.6bn compared to total revenues of £18.5bn.

³² In order to refine this high-level disaggregation, a valuation of the ICT part of BT Group's business should be performed. Shares of revenue or profits serve only as an approximation.

3.1.8 Conclusion of first principles assessment

Overall we believe that, from a first principles perspective, it is reasonable to conclude that the copper access business is less exposed to systematic risk than other parts of BT's business. Unlike most other parts of BT's mainstream telecommunications businesses it is only exposed to revenue risk associated with changes in the number of connections and lines rather than the volume of calls and data. Evidence suggests that the other main part of BT's business, the ICT business, appears to have a higher asset beta than that for the BT group as a whole.

We acknowledge that this result must necessarily be tempered by the uncertainty of attempting to infer betas from fundamental analysis, particularly as it appears that the copper access business is likely to be relatively highly operationally geared and the impact of regulation on beta is not certain. Nevertheless, as discussed in Section 2, BT acknowledges that this is unlikely to be a controversial view to the non-expert, and that if any disaggregation of beta is imposed by Ofcom the least damaging approach would be to differentiate between the copper access business and the rest of BT. However, BT also suggests that any disaggregation is artificial as all parts of its business are exposed to the common risks of the telecommunications market, and there are complex inter-relationships between the different parts that mean risk is spread and not meaningfully differentiated.

We note BT's view that the beta for the copper access business will be affected by factors which are common to many (if not all) parts of its business. To the extent that this is true, this would influence the actual figure for beta applied to the access business. However, one of the benefits of conducting a first principles assessment is that it enables the particular costs and revenues attributable to a particular activity to be considered separately, and it seems clear that the access business is less directly exposed to cyclical fluctuations affecting the telecommunications sector than other services provided by BT because of the relative stability of demand for copper access. To the extent that all BT's activities are exposed to common systematic risks, these will be reflected in the group beta, but the first principles analysis provides directional guidance that within this overall group beta there is reason to believe that the beta for the copper access business is lower.

In explaining why it believes it is wrong to proxy the copper access business's beta by the betas of other UK utilities BT also suggests that its network is more exposed to risk because of uncertainties caused by technological change – it mentions the threat to the copper access network of competing networks and actual, emerging or potential threats from cable, mobile, IP-based telephony over broadband connections, wireless local loop, wireless broadband, and fibre-based access. However, these are not factors that should necessarily be primarily reflected in beta, as they relate to the specific risk faced by the business rather than the systematic risk. As such, these factors should be taken into account in generating regulated cash flow projections relating to each technology, but we believe that they do not affect our analysis of the relative size of the asset beta for the copper access business.

3.2 Evidence from differences in income elasticities

The Ofcom consultation document refers to large number of studies ³³ carried out over three decades in North America and Europe which show that, on average, *"the income elasticity of demand for access is significantly lower than the corresponding elasticities for various call types*³⁴ and there is little that we can add to this evidence. The average income elasticity for access in these studies was 0.44, whereas the average long-run calling elasticity was 0.89 for local calls and 1.22 for long distance calls. Some of these studies are now somewhat dated, however, and the telecommunications industry has evolved so that calling prices are now

³³ For example, see summaries in L D Taylor *"Telecommunications demand in theory and practice"*, 1994 and Stephen Trotter, *"Demand for telephone services"*, Applied Economics 1996.

³⁴ Ofcom's consultation document, paragraph 5.38.

substantially lower than before and access to telecommunications networks provides far more services than used to be the case.

It is therefore likely that income elasticities for both access and calls have fallen, and more recent research by Katharina Gasner³⁵ has shown that access elasticities may have fallen:

"The income elasticity of access is 0.14 for our overall sample. This is lower than the average estimate of 0.5 reported in studies surveyed by Taylor (1994)".

While the income elasticity of demand is only one of many possible drivers of beta, this evidence is suggestive of a beta for the access business that is lower than that for a telecommunications group providing both access and call services. This evidence provides support to our first principles finding that the access business is less exposed to revenue fluctuation risk across the economic cycle because it is not exposed to call/data volume risk.

3.3 Evidence from historical changes in BT's group beta

The composition of BT's business has changed significantly over the past two decades. As a newly privatised company in 1984 its main business was the provision of highly regulated telephony services to UK homes and businesses. In 1991 the effective duopoly (with Mercury Communications) was ended and there has been a subsequent increase in competition and reduction in regulation. During the late 1990s and early 2000s, BT's international presence grew through an alliance with MCI, the creation of the Concert joint venture with AT&T, and a significant number of international joint ventures and investments. BT's business mix also changed during this period with the significant growth of its mobile arm Cellnet³⁶, growth in other business lines such as the Yell international directories business, internet service provision, business value-added services, and interests in the converging telecoms and media space such as British Interactive Broadcasting.

However, this expansion left the company with a large debt burden, which peaked in 2000, and the company strategy throughout 2001 was to restructure and reduce debt by selling off non-core businesses and raising additional equity funding through a rights issue. The AT&T Concert agreement was unwound, Yell was sold and mmO_2 floated separately, so that by 2002, BT had returned to a predominantly UK focussed, fixed line communications business. More recently, BT has returned to a growth strategy, focussing on its "new wave" businesses and its networked ICT services capability.

We consider whether it is possible to infer the contribution to the group beta of the different parts of BT's business from changes in BT's historic beta as the composition of its business has changed. To do so we need to identify different phases in BT's development. Based on a review of BT's accounts, we identify four broad phases in BT's history:

Phase	Broad date range	Supporting quotes from BT's Annual Reports				
 Regulated UK telecoms utility 	1984 to mid 1990s	"Operating one of the largest telephone networks in the world, British Telecom's principal business is the provision of inland and international telecommunications services to its customers "				

Table 2 Phases of BT's history

³⁵ Katharina Gasner "An Estimation of UK Telephone Access Demand Using Pseudo-Panel Data", 1998.

³⁶ Originally a joint venture with Securicor PLC, but wholly owned from November 2000, changing its name to BT Cellnet and later mm0₂.

Phase	Broad date range	Supporting quotes from BT's Annual Reports				
		1986 Annual Report				
2. International and product diversification	Mid 1990s until the TMT bubble burst at the end of 2000	"Telecommunications is now, we believe, too narrow a word to sum up the wide range of things we do and want to do "				
		1999 Annual Report				
 Back to UK fixed telecommunications 	End 2000 until Oct 2003	"Our first priority is to repay a significant amount of this debt. We have made a good start with the agreed sales of investments in Japan, Spain,				
		Switzerland and Malaysia"				
		2001 Annual Report				
4. Growing new wave and ICT	Oct 2003 to current	"We have eight strategic imperatives, five of which are focused on generating new wave revenues"				
		2005 Annual Report				

We acknowledge that this is a highly stylised view of the phases in BT's development over this period, and that the dates in the table are indicative. Nevertheless, our view is that is important to understand whether an analysis of this sort can be instructive in helping to understand possible differences in asset betas. The charts overleaf present the profile of BT's equity beta and asset beta over time. We present betas using Bloomberg data on a weekly, daily and monthly basis, without making any additional adjustments³⁷.

³⁷ For example, adjustments such as the Blume adjustment towards 1, which is provided by Bloomberg.

Chart 3 BT Group's equity beta over time³⁸



BT Group Plc Unadjusted Equity Beta

Source: Bloomberg

³⁸ The betas in Chart 3 are presented on a monthly rolling basis, but their calculation varies between using 5 years of monthly data (monthly), 1 year of weekly data (weekly) and 1 year of daily data (daily). They are calculated using Bloomberg's beta function. We also looked at betas provided by Barra, Datastream and LBS, which were broadly consistent with the Blooomberg figures.

Chart 4 BT Group's asset beta over time



BT Group Plc Unadjusted Asset Beta

Source: Bloomberg

Chart 3 shows that BT group's measured equity beta has fluctuated significantly over the past fifteen years, and also that the method of calculating beta leads to significantly different results. Chart 4 shows that this fluctuation is also exhibited by the underlying asset beta, which suggests that changes in financial leverage cannot fully explain the movements in the equity beta.

The monthly betas are calculated using five years of data so they generally provide more stable estimates³⁹. However, for the purpose of assessing BT's beta over time, the shorter-term weekly and daily betas, which are both estimated using one year of data, are more likely to pick up the movements in BT's systematic risk.

The monthly equity beta estimate is broadly stable in the earlier part of the period, declining to below 0.5 at the end of the 1990s and then increasing to above 1.5 throughout 2003 and 2004. It has recently started to decline.

The weekly and daily equity beta estimates remain broadly around 1 until 1999, when they both rapidly increase, in the case of the weekly beta, to above 2 at the time of the boom in the share prices of telecommunication, media and technology companies (the TMT boom). Following the bursting of the TMT bubble, both the weekly and daily estimates drop back to a range around 1, with a particular dip in the weekly estimate through the latter part of 2001 and early 2002.

We have analysed BT's beta by breaking it into the four different phases identified above. The results are shown in the table below, where the average level represents the average value of the asset beta over each phase of BT's history and the average change per month compares the value for BT's asset beta at the beginning of the phase and the end of the phase and calculates the average change over the phase.

Phase	Dates	Mon	thly	We	ekly	Daily		
		Average Level	Average change per month	Average Level	Average change per month	Average Level	Average change per month	
 Regulated UK telecoms utility 	1984 to Dec 1995	0.75	0.001	0.85	0.002	0.98	0.005	
 International and product diversification 	Dec 1995 to Dec 2000	0.60	0.007	1.18	0.019	1.15	0.004	
3. Back to UK fixed telecommunications	Dec 2000 to Oct 2003	0.87	-0.005	0.57	-0.044	0.86	-0.024	
 Growing new wave and ICT 	Oct 2003 to current	1.08	0.008	0.49	-0.005	0.60	-0.009	
Whole period		0.75	0.002	0.88	-0.002	0.99	-0.002	

Table 3 BT group's asset beta during different phases

Note: our data only extends back to 1990

Over the whole period the different estimates of BT's asset beta range from 0.75 on a monthly basis to 0.99 on a daily basis, but there is significantly more variation within the different time periods. These variations are not consistent; for example the monthly beta estimate is highest in the "growing new wave and ICT" phase, and the daily and weekly betas are highest in the "international and product diversification phase". These results may be impacted by a number of factors:

³⁹ In order to calculate reasonable monthly beta estimates, 5 years of data are required to provide enough observations for the regression. This means that the 5 year beta is relatively stable, because only a small amount of information is changing in moving from one month to the next.

- The selection of time periods is somewhat uncertain.
- The beta is calculated over an extended time period (one year for the weekly and daily estimates and five years for the monthly estimate). This means that it takes a full year (for weekly and daily estimation) or five years (for monthly estimation) for a change between the different phases to be fully reflected.
- It is the expectations of future business activities, rather than the current business mix that ultimately impacts beta.

However we can make a number of potentially useful observations:

- International and product diversification appeared to increase BT's beta, as measured using one year of weekly and daily data.
- During the "back to UK fixed telecommunications" period, the value of the asset beta falls using weekly and daily data, and the rate of change of beta, as measured from the daily, weekly and monthly estimates, is negative for all three measures. This suggests that in a period when BT was restructuring its business back to one more rooted in UK telecommunications its beta was falling.
- Growth in new wave and ICT business does not appear to have had a positive impact upon the daily and weekly estimates. This is contradictory to our findings from earlier on in this section.

We suspect that there are too many complicating factors to enable us to draw any firm conclusions from this analysis. We conclude that if we are to make any inferences from historic data we need to investigate the time series movements in a more robust manner. We return to this in Section 6, where we explore whether there is a statistical relationship between BT's group beta and the proportion of its business accounted for by non-access activities.

3.4 Evidence from precedents in international telecommunications regulation

Telecommunications regulators often need to set a cost of capital for a regulated part of a company that also carries out other regulated and non-regulated activities. This subsection looks at international precedents for regulators choosing to use a beta for regulated telecommunications activities different to the group beta.

In the 2000 Price Control Review⁴⁰, Oftel felt that "Given the growing importance of the unregulated part of BT [it is considered] appropriate to make some adjustment to the group equity beta of BT in arriving at an estimate of a beta for the regulated activities". Oftel consulted on adjusting LBS's beta estimate down from 0.95 to 0.85 to take account of this. However in the final proposals issued in 2001⁴¹ Oftel adopted its current position of not adjusting the BT group beta.

In Australia, the Australian Consumer and Competition Commission (ACCC) reviews Telstra's undertakings to provide PSTN origination and termination services to other telecommunications providers. In assessing the appropriate cost of capital to use in 2000 the ACCC considered *"that returns to the regulated parts of Telstra's business, such as the*

⁴⁰ Oftel, "Price Control Review: A consultative document issued by the Director General of Telecommunications setting out proposals for future retail price and network charge controls", October 2000, paragraph C20.

⁴¹Oftel, "Proposals for Network Charge and Retail Price Controls from 2001," February 2001, paragraph E.17.

*PSTN, are likely to be less risky than other parts of its business*³⁴². The ACCC chose an asset beta of 0.5, from a range of 0.4 to 0.8. This was different to the estimates of Telstra's overall beta, which were towards the top end of the range.

In regulating interconnection activities for Telecom New Zealand (TCNZ), the New Zealand Commerce Commission (CC) came to the opinion that: *"Telecom's overall equity beta is likely to be higher than Telecom's fixed PSTN equity beta"*⁴³ and with regard to setting the compensation for assets used by the Telecoms Service Provider (TSP), currently TCNZ, to deliver service obligations (TSO), it again came to the view that: *"the asset beta for the TSP will be lower than that of an otherwise unregulated telecommunications firm"*.⁴⁴ In both instances the CC chose a value for beta that was below TCNZ's overall group asset beta of 0.8 to 1. For TSO purposes an asset beta of 0.3 was chosen, and for interconnection an asset beta of 0.65.

In Europe there is less disclosure surrounding this topic, but the Swedish telecoms regulator, PTS, sought guidance from its advisors Andersen Management International (AMI), who took the view that *"one could also argue that the cost of capital rates for a stand-alone access and core network could be different due to different capital structures and risk profiles associated with the different services"*. Ultimately AMI suggested using a different cost of capital for mobile and fixed telephony, but the same cost of capital for the core and access networks, which is what the regulator chose to do.

In summary, there is some limited precedent among international telecommunications regulators for using a cost of capital for regulated activities that is lower than that for the group as a whole. In the next section we review the methodologies used to support the lower figures that have been applied.

3.5 Conclusion

This section has found some directional, qualitative support for believing that:

- Different parts of BT's business are exposed to different levels of systematic risk, and hence in principle their betas should also be different.
- In particular a first principles analysis of the copper access business suggests that it is likely to be exposed to lower systematic risk than the group as a whole, because it is not directly exposed to call/data volume risk. This finding is supported by the evidence available on income elasticities, and the adoption of lower betas for this type of business by some regulators outside the UK.
- There is also evidence to suggest that BT's ICT activities have a higher beta than for the group as a whole. The evidence here is more direct as there are floated pure play comparators that enable us to obtain a direct estimate of what the beta would be for this business if it was separated from the group.

Using the direct evidence of the beta of ICT activities we are able to disaggregate to the level of ICT and non-ICT and our analysis suggests that the beta for BT's non-ICT activities could be between 0.14 and 0.33 lower than the beta for the group. Beyond this level of

⁴² ACCC, A Report on the Assessment of Telstra's Undertaking for the Domestic PSTN Originating and Terminating Access Services, July 2000.

⁴³ New Zealand Commence Commission, *Draft Determination on the Application for Pricing Review for Designated Interconnection Services*, April 2005.

⁴⁴ New Zealand Commerce Commission, *Determination for TSO Instrument for Local Residential Service for period between 20 December 2001 and 30 June 2002, December 2003.*

disagregation we have good directional evidence that the beta for BT's copper access business is lower than that for the other parts of BT (excluding the ICT activities). In the next section we examine possible methodologies available to us to support this directional analysis and to quantify any differences in betas at a more disaggregated level.

4 Possible approaches to estimating different betas for different parts of BT's business

In this section we consider possible approaches to the calculation of disaggregated betas and set out in broad terms the two main methodologies we choose to adopt, based on the robustness of different approaches and the data available to us. A detailed description of how we implement these methodologies, and our results, are given in the following two sections.

4.1 Precedents from other regulators

Regulators are often required to set the cost of capital for regulated activities in a business that also contains non-regulated activities. This means that the observed group beta of the overall firm is not necessarily an appropriate figure to use.

In UK regulation, where regulators have used a different beta to the observed beta they have typically relied upon either finding pure play comparators, or eliminating the effect of the non-regulated business by finding pure play comparators for the non-regulated portion. This is consistent with the suggestions of the joint UK regulators' report on the cost of capital: *"We need an estimate of the overall company beta and then a separate estimate of the beta of the non-regulated bit. Then we ... work out the beta of the regulated assets based on the relative weights of the assets used in the regulated part of the company to all its assets."*

This was a clear need for Ofgem in the transmission price control review of National Grid in 2000⁴⁶, when its telecoms subsidiary Energis represented a significant share of NGC's business: "The main difficulty in using the observed beta for NGC's shares to calculate a beta for NGC's electricity transmission business is that there are a number of other components to NGC. There is no reason to suppose that the hypothetical beta for NGC's electricity transmission business is that for NGC's other businesses." In this case Ofgem relied upon three techniques to set the cost of capital for NGC's transmission business:

- Beta decomposition: estimate for NGC's equity beta by removing the effects of Energis.
- Comparator companies: calculate the implied asset betas for comparator companies using the equity betas.
- Regulatory precedents: other regulators' determinations of the equity betas for the network utilities which they regulate.

Ofgem was successfully able to use beta decomposition in this case, because the beta of the main unregulated activities could be directly observed from market data – Energis was separately listed. By knowing the value weights of Energis (17%) and the remainder of NGC (83%), the overall NGC equity beta (0.56) and the Energis equity beta (1.25), Ofgem could infer the non-Energis beta (0.42) using the formula presented in paragraph 2.1.3.

This approach to beta decomposition is not available to us, because the non-access portion of BT is not separately listed. Ofgem also used comparator pure play companies to help form its judgement. Again, as discussed earlier, we are limited by the lack of obvious access-only pure play standalone quoted companies.

Regulators have used analysis of the fundamental risk profile of different entities to inform their judgement on different betas. Ofgem carried out an analysis as part of its electricity price

⁴⁵ Smithers and Co, "A review of certain aspects of the cost of capital - Joint report commissioned by U.K. economic regulators (CAA, OFWAT, OFGEM, OFTEL, ORR, OFREG) and the Office of Fair Trading", 2003.

⁴⁶ Ofgem, "The transmission price control review of the National Grid Company from 2001", June 2000.

control reviews in 1999 and "found no conclusive evidence that the Scottish transmission companies were, in financial terms, significantly different from the electricity distribution companies. Given the similarity in transmission and distribution activities, Ofgem does not consider that different cost of capital considerations should apply to the Scottish transmission companies compared to the electricity distribution companies"⁴⁷⁷. The implication of this is that had the risk profiles different risk profile for different activities has led to regulators adopting a beta different to a market observed beta are provided below.

In setting airport charges the Civil Aviation Authority and the Competition Commission have considered the beta for setting BAA's and Manchester Airport's charges, when market beta information is only available from the wider BAA Group (which includes other commercial activities), and limited other pure play quoted companies. The Competition Commission, in setting price caps in 2002⁴⁸, used a range for beta that was higher than the existing beta estimate for BAA. It is difficult to determine the Commission's precise methodology for this uplift, but the main argument used by BAA was that this was justified by the increase in operational gearing (as proxied by the ratio of capital expenditure to capital expenditure plus operating costs) and financial gearing following the Terminal Five investment. This suggests differences in operational gearing across different parts of a business are one factor that regulators have taken into account when setting beta.

The New Zealand Commerce Commission used a wide range of approaches and considerations to set the regulated beta at a different level to the group beta for both the TSO instrument and setting interconnection charges⁴⁹. It used comparisons, drawn predominantly from the USA, and assessed the impact of different risk characteristics within each regulatory activity. This involved separately quantifying the separate insurance mitigation of the TSO, and the impact of regulation on beta. This considered work by Alexander et al⁵⁰ into the impact of the regulatory regime, and the Monitor Group⁵¹ which used regression techniques to assess the impact of regulation and industry on beta.

In Australia, the ACCC drew upon a wide range of estimates to select the beta used to set Telstra's interconnection charges in 2000⁵². These estimates were mostly other regulatory decisions or pure play examples. The ACCC applied judgement in adopting a figure towards the bottom end of its range because it considered "*that returns to the regulated parts of Telstra's business, such as the PSTN, are likely to be less risky than other parts of its business*".

However, the Irish regulator Comreg, when assessing the beta for the regulated activities of Telecom Éireann (TE), stated that *"ideally a separate beta for TE's interconnection services should be estimated"*, before deciding that *"due to the practical difficulties of doing this, a beta for the company should be used instead"*⁵³. Indeed this has been Ofcom/Oftel's position since 2001.

⁴⁷ Ofgem, "Transmission price controls and BETTA Final proposals and impact assessment", December 2004.

⁴⁸ Competition Commission, "BAA plc: a report on the economic regulation of the London airports companies (Heathrow Airport Ltd, Gatwick Airport Ltd and Stansted Airport Ltd)", November 2002.

⁴⁹ New Zealand Commerce Commission, "Draft Determination on the Application for Pricing Review for Designated Interconnection Services", 11 April 2005.

⁵⁰ Alexander, I., Mayer, C. and H. Weeds, "*Regulatory structure and risk: An international comparison*", Prepared for PSD /PPI, World Bank, 1996.

⁵¹ The Monitor Group Report, "Comments on beta and on the risk-free rate when using the CAPM to calculate WACC for NZT", 2003a.

⁵² ACCC, "A report on the assessment of Telstra's undertaking for the Domestic PSTN Originating and Terminating Access services", July 2000.

⁵³ Telecom Éireann's Reference Interconnect Offer Decision Notice D12/99.

In similar vein, the Competition Commission highlighted the methodological difficulties of beta disaggregation when investigating the UK commercial banks' SME banking activities ⁵⁴ in 2002. The banks generally believed that their SME businesses, if considered on their own, were more risky than the business of the whole bank, and therefore the cost of equity should be higher for the SME banking business than for the bank as a whole. Ultimately the Competition Commission used banking holding company betas to assess profitability because it *"could not observe"* an SME specific beta, and it *"could not be certain that the returns for SME banking business was more risky, this increased risk would more than likely be attributed to increased default risk which would be reflected in the allocation of capital rather then necessarily being the determinant of a higher cost of equity".*

In general, this is a difficult area, but when the group beta has not been considered as an appropriate figure to use for regulatory purposes, regulators have first attempted to find close pure play examples to the regulated activity. Where disaggregation is possible by using reliable estimates of the non-regulated portion of the firm's activities, this is used. When pure play comparators cannot be found, and where a sound conceptual basis for using a different beta can be supported by some empirical and/or econometric evidence, it has sometimes been used to inform the judgement of the regulator. Finally regulators will also look to each others' decisions for precedent.

Ultimately, most regulators do not rely on one method and typically take both qualitative and quantitative evidence to provide them with a likely range for beta, and then use their judgement of the risk of the regulated activity to select a single figure from within this range. This can be toward either end of the range.

4.2 **Professor lan Cooper's views on available methodologies**

As discussed in Section 2, Professor Ian Cooper suggests five possible methods⁵⁵ for estimating the asset beta of BT's copper access network:

- Identify pure play, traded copper access business comparators which face the same risks as BT's access business.
- Identify pure play, traded companies that operate only in the non-copper access business activities of BT, and infer the copper access business beta from their betas and the BT group beta.
- Identify traded companies that have operations in copper access assets with the same risks as BT, and operations in other assets for which the betas can be identified, and infer the copper access beta by comparing these other activity betas with their overall beta.
- Use accounting data to estimate either the absolute or relative level of risk of the copper access network (an "accounting beta").
- Estimate beta based on theoretical arguments or fundamental analysis of the business.

As noted in Section 2, Professor Cooper suggests that there is no available evidence to allow a copper access network beta to be calculated using any of the first four methods, and that the fifth method is fundamentally unreliable. He therefore concludes that there is no reliable methodology for calculating an asset beta for BT's copper access network.

⁵⁴ "The supply of banking services by clearing banks to small and medium-sized enterprises", Competition Commission, 14 March 2002.

⁵⁵ BT's response, Annex 2, "The risk of the copper access network", by Professor Ian Cooper, pages 6-7.

4.3 Our approach

We agree broadly with Professor Cooper's description of the methodologies available to us in seeking to calculate a beta for BT's copper access network. However, we do not agree with his view that, based on an inspection of the information likely to be available, it can be concluded that none of the methodologies has value in this case. Professor Cooper appears to base his conclusion on his view that there are no comparator businesses that provide reliable guides to the beta for BT's copper access business. Whether or not one or more of these methodologies can be considered valuable ultimately depends on judgement regarding the reliance that can be placed on evidence from comparator businesses that are not self-evidently exposed to the <u>identical</u> risks as parts of BT's, but nevertheless can reasonably be argued to be exposed to <u>similar</u> risks. Professor Cooper's view appears to be that the differences are so great as to render any implementation of the methodology worthless; we believe that it is worth attempting some calculations before taking a view as to the reliability of the results.

We agree with Professor Cooper's rejection of the first pure play methodology on the grounds that adequate pure play comparators do not currently exist for BT's copper access business. However, because of the presence of good ICT comparators, as discussed in the previous section, we are able to conduct some disaggregation using the second pure play methodology. This does have some value, although it is limited because pure play comparators are not available for all of BT's non-copper access activities.

We believe that the third methodology, with slight variations, has the potential to produce helpful results. This methodology does not rely on pure play comparators, but on comparator companies which include a copper access business within their overall business. This widens the scope of potential comparators available to us.

We conduct two analyses based on this third methodology. The first takes data for a number of international telecommunications businesses, and performs a statistical analysis seeking to explain the variations in their current overall betas based on the shares of the different types of activities in which they are engaged. By doing this we hope to be able to infer the beta associated with that element relating most closely to the copper access business (we refer to this as our cross section analysis).

The second variant on this methodology looks at how BT's beta has changed over time and performs a statistical analysis seeking to explain variations in its beta over time based on the proportion of BT's business accounted for by activities other than access. This effectively uses BT at different points in time as the comparators, allowing the contribution of the copper access network to beta to be inferred (we refer to this as our time series analysis).

Professor Cooper's reason for rejecting his version of the third methodology is that *"there are no traded companies that have copper access assets identical in risk to those of BT"*⁵⁶. He does not expand on what he means by this but we infer that he believes that the only credible comparator for BT's copper access network is one that is exposed to the risk of the UK market and possibly UK regulation.

We accept that in an ideal world we would have data for more direct comparators, but believe that telecommunications companies are sufficiently similar to make it worthwhile undertaking such an analysis. We note that in many business applications it is difficult to find a significant number of good comparators for beta estimation, but conducting such analysis on less than perfect comparators is generally preferred to not conducting the analysis at all. We also note that <u>any</u> calculation of beta involves a degree of judgement (for example, concerning what measure of beta to use, which comparators to consider etc.). There is, for example, no precise, accepted estimate of BT's group beta available to Ofcom, but nevertheless Ofcom

⁵⁶ BT's response, Annex 2, *"The risk of the copper access network"*, by Professor Ian Cooper, page 7.

needs to adopt a figure in order to apply the CAPM framework in setting regulated prices, and therefore uses its judgement of the best figure, given the available, imperfect evidence.

Our time series analysis is based on a business that clearly faces the identical risks faced by BT, since all the observations relate to BT itself. This analysis faces the potential problem that, if the risks associated with the copper access business or other parts of the group have changed during the course of our estimation period, then this will affect the results.

Nevertheless, we feel that both approaches have the potential to yield valuable directional results. We report on these methodologies and our results in Sections 5 and 6. The regulatory precedents suggest that our methodology might provide more directional evidence for adopting different betas for regulatory purposes, rather than choosing a particular level for BT's copper access beta.

5 Quantitative analysis of the betas of a cross section of telecommunications businesses

This section describes our cross section analysis, in which we attempt to infer betas for different parts of typical telecommunications businesses, by examining how overall group betas vary between telecommunications companies which differ in the proportions of their businesses made up by different types of activity.

5.1 Our methodology

As discussed in Section 4, it would be most desirable to estimate betas for different parts of BT's business by directly observing listed pure play comparators for those businesses. Unfortunately pure play comparators do not exist for many, if not most parts of the group. However, as discussed in Section 2, a company's overall equity beta is a weighted average of the betas of the various separate investments or activities in which the company is engaged:

 $\beta = W_1\beta_1 + W_2\beta_2 + \dots + W_n\beta_n$

where the company's overall beta is β , and the company is comprised of n different investments or activities with different betas, whose shares of the business are denoted by the weights $W_1...W_n$. For telecommunications businesses like BT, the different investments or activities comprise those activities which can be identified as being subject to different degrees of systematic risk, such as copper access, other telecommunications services, and ICT activities.

By collecting data on a number of telecommunications businesses comprising similar activities in different proportions, it is possible to use regression analysis to explain differences in their group betas in terms of the differences in the composition of their businesses, thus inferring what the individual activity betas are.

We created a sample of 56 companies across 29 countries in Europe, Asia-Pacific, the USA and Canada. A list of the companies is included in Appendix 1. Based on the analysis of different parts of BT's business in Section 3, we conclude that it is desirable to identify the relative proportions of these businesses comprising copper access, ICT activities, and other. In fact data is not available to allow us to identify access separately, so instead we include the proportion of the fixed line business. This business contains call/data volume-related and broadband activities as well as copper access, so in principle we would expect it to have a higher beta than a pure copper access business (based on our findings in Section 3). Because many of the companies in our sample operate a mobile network business we also include this in our equation, together with the proportion of ICT activities and the share of other businesses. We also include other pure play companies that operate solely in one of the activities carried out by BT. This helps to separate the effects of the different activities.

In order to take into account the effects on financial leverage, and hence equity betas, of different levels of gearing across our sample of companies, we calculate asset betas ⁵⁷ and use these in our analysis. Using our sample of companies, we therefore conduct regression analysis to estimate equations of the form:

 $\beta_a(\text{company}) = \beta_a(\text{fix})^*S_{\text{fix}} + \beta_a(\text{mob})^*S_{\text{mob}} + \beta_a(\text{ICT})^*S_{\text{ict}} + \beta_a(\text{other})^*S_{\text{other}} + \text{other variables}$

⁵⁷ See Section 2.

where β_a denotes the asset beta and S denotes the share of a particular activity in the overall activities of the business. As already noted, in principle the weighting factors (S_{fix}, S_{mob} etc.) should be calculated as the contribution to the total market or economic value made by each investment or activity. Because of the lack of data we use revenue shares instead, and this may affect the reliability of our results⁵⁸. We include in our sample some pure play mobile network and ICT activity companies in order to improve the estimation. The estimated equation includes other explanatory variables in addition to shares of different types of business. Variables which we consider include dummy variables for different geographical regions (Europe, the USA, Asia-Pacific, emerging markets) and a company size variable (market capitalisation).

A key issue is which measure of beta to use for our dependent variable. In addition to the normal issues of which service provider to use (we use Bloomberg), the date at which to apply the calculation (we used the latest financial year end of each firm), what frequency for each observation in the beta regression and the overall time period for calculating the beta (we use three approaches – 5 year monthly, 1 year weekly and 1 year daily) we face the issue of which market index to use as the basis for the beta regressions – the local market for each company, or a single global market index (the Morgan Stanley Capital index, all industries). We show the effects on our results of applying each of the different possible data sources, implying six sets of results (the three frequency/duration calculations combined with both the local and global market approaches).

5.2 Our results

We estimate our equations using the STATA software package⁵⁹. The table below gives our estimated equations for each of the six approaches to estimating group betas. The coefficients for each variable relating to a business activity (S_{mob} etc.) represent the asset beta for each disaggregated business line, so for example the mobile business asset beta using daily beta regressions calculated with reference to each company's local exchange index is 1.009.

Variable	Monthly Local	Monthly Global	Weekly Local	Weekly Global	Daily Local	Daily Global
S _{mob}	0.936	1.03	0.909	0.72	1.009	0.816
s.e	(.171)	(.25)	(.09)	(.139)	(.137)	(.128)
S _{fix}	0.665	0.758	0.571	0.46	0.489	0.441
s.e	(.17)	(.248)	(.155)	(.138)	(.136)	(.127)
S _{ict}	2.416	3.298	2.108	1.862	1.844	1.746
s.e	(.227)	(.331)	(.31)	(.184)	(.182)	(.169)
Sother	1.461	2.001	0.82	1.047	0.866	1.046
s.e	(.291)	(.425)	(.344)	(.236)	(.233)	(.217)
emerging	-0.098	-0.498	0.034	-0.197	0.067	-0.33
s.e	(-0.172)	(.251)	(-0.149)	(-0.14)	(-0.138)	(.128)
N Adj. R ²	53 0.47	53 0.516	53 0.437	53 0.479	53 0.419	53 0.511
RMSE	0.482	0.704	0.441	0.392	0.386	0.36

Table 4 Results of the asset beta disaggregation analysis

⁵⁸ It is possible to conduct intermediary regressions of the revenue weights on the enterprise value to revenue multiples to convert the revenue weights into proxies for value weights. This does not materially impact our results and may suggest the revenue price multiples are broadly consistent across the different lines of business.

⁵⁹ Because the equation we want to estimate does not include a constant term we use the *"reg"* command with the *"hascons"* extension. The share splits are treated together as the constant of the analysis. We performed the White heteroscedasticity test for the regressions and estimated robust standard errors when needed.

Figures in brackets are standard errors. Each of the asset betas is statistically significantly different to zero, but this is not surprising given the specification of the regression. We later test whether they are significantly different from each other. Coefficients of non-significant variables are represented in Italics.

The asset betas are charted below:



Chart 5 Disaggregation of betas in cross section analysis

Measurement basis

In all the equations the estimated asset beta for the ICT activities business is the highest of the four betas estimated, and the asset beta for the fixed line business is the lowest. We use Wald equality tests to determine whether the betas of the different business lines differ significantly from each other. The table below contains the p-values of the performed tests. A figure of less than 0.05 in the table below suggests that the asset betas for different activities are statistically different to each other at the 5% confidence level.

Test	Monthly Local	Monthly Global	Weekly Local	Weekly Global	Daily Local	Daily Global
S _{fix} = S _{mob}	0.3041	0.5463	0.0731	0.2603	0.0151	0.1104
S _{fix} = S _{other}	0.0425	0.0443	0.5095	0.0760	0.1957	0.0694
S _{mob} =S _{other}	0.1251	0.0649	0.8293	0.2490	0.5982	0.4150
S _{fix} = S _{ict}	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000
S _{other} =S _{ict}	0.0207	0.0270	0.0142	0.0131	0.0028	0.0163
S _{mob} =S _{ict}	0.0000	0.0000	0.0008	0.0000	0.0008	0.0001

Table 5 Tests for equality

We find that the asset beta for ICT activities is significantly higher than for the other businesses, and that the estimate of the asset beta for the fixed line business is sometimes statistically significantly different from the estimates of asset betas for the other two businesses (mobile and other).

The estimates of asset betas vary significantly between the different equations – for example, the estimate of the asset beta for the fixed line business varies from around 0.44 to 0.76 depending on which measure is used. This illustrates the difficulty of trying to draw inferences on the disaggregated beta when there is already significant uncertainty concerning the fundamental calculation basis for group betas (compounded in our cross section analysis by the issue of global versus local market indices).

The inclusion of the dummy for emerging markets makes little difference to the results; it is statistically significant at the 10% level in only the monthly and daily global regressions. Inclusions of USA and/or Asia-Pacific dummies were also not significant.

5.3 Interpretation of our results

The commentary in the previous sub-section emphasises that the absolute estimates of beta vary widely depending on which method of calculating group asset betas is used. These are important caveats to bear in mind in this sub-section, which interprets the implications of using the equations which have been estimated.

Given the significant variation in the absolute values of beta resulting from the different source beta calculations, in order to interpret the results it is first necessary to decide on which of the equations to place most emphasis. In our view, the equations based on monthly data are the least reliable as the five year estimation period smoothes over any changing composition of the businesses in the sample.

There are advantages and disadvantages of the weekly and daily estimates. The weekly estimates suffer from the problem of different results depending upon which day of the week on which to run the regressions, and when estimated over a period of one year only rely upon a somewhat limited 52 observations. The daily regressions, with more data points, can suffer from problems of heteroscedasticity and non-trading bias, although this should be limited for large, frequently traded companies. Examination of the weekly and daily estimates suggests that weekly data causes more erratic results, especially when using the global index. We therefore prefer to place more emphasis on the daily equations⁶⁰. We have no strong preference regarding the use of the local or global index – as capital markets become more globally integrated there are good arguments for using the betas calculated on global indices, but there can be a lack of synchronicity issue across different time zones. The former tends to give better specified beta regression equations, but can be affected by the problem of the company being a significant proportion of the overall market index in some countries (tending to bias the equity beta estimate towards one).

If we take the daily beta estimated against the local index as an example of our output, the table shows that the fixed network has an asset beta of 0.49, with other parts of the business having higher betas than the group. The estimate of the ICT activities beta may seem extremely high at 1.84, but as table 1 in Section 3 shows we have identified some pure play ICT comparators with betas of at least this magnitude. The implied group asset beta, using BT's revenue weights, is 0.72, which is very close to BT's actual beta calculated on the same basis. However, for some of the other regressions there is difference between BT's predicted and actual beta.

We place less emphasis on the absolute beta estimates in the table as opposed to the direction and indicative size of the differences between individual business segments and the overall group. To the extent that the statistical and other limitations of this exercise allow, the

⁶⁰ We note that this is Ofcom's preferred approach in calculating its own estimates, although it tends to put weight on estimates from a number of sources.

results suggest that ICT activities have a significantly higher beta than other activities undertaken by BT. This implies that some other part of the business must have a beta lower than the group.

The fixed network consistently has the lowest beta in our equations, and in some equations, but not all, the estimate for this is statistically different from mobile and other services. In interpreting this it should be noted that (a) the fixed network accounts for 75% ⁶¹ of BT's activities on the revenue basis used in our analysis, so by arithmetic tendency the fixed network beta cannot be too different from the overall group beta and (b) as discussed in Section 3, there are reasons to believe that the beta of the copper access business is lower than the beta for the fixed network as a whole.

5.4 Conclusions from cross section analysis

There are many issues and difficulties associated with our cross section analysis that make the absolute results unsuitable for the purpose of quantifying a beta estimate:

- Ideally cross section comparators would be exposed to the same regulatory environment as BT. This is not true of a set of international telecommunications businesses.
- There are likely to be differences between companies in our sample in the precise composition of the businesses we have identified as fixed, mobile, ICT activities and other. For example, most of the companies in our sample operate a mobile network, whereas BT's mobile business is a service provider. The "other" category is likely to vary in its composition across the sample. There are ambiguities in the data sources we use and so we have had to apply judgement in allocating activities to the different categories.
- Because of lack of readily available data we use revenue weights instead of share of economic value weights.
- Again because of the lack of data we use the fixed line business as the closest proxy available for a copper access business.
- The different methods of calculation of beta available to us (monthly, weekly, daily measures against the local and global market indices) give a wide variation in the dependent variable data, implying very different results from our regression analysis. There is considerable variability and judgement required in calculating group betas even before attempting to disaggregate.

Having set out these important caveats to our analysis, the results indicate the following:

- Regardless of which measure of beta is used, estimated asset betas are highest for ICT activities and lowest for the fixed network business. However, only the higher ICT asset beta is consistently statistically significantly different from the other activities. The lower fixed network business asset beta is only statistically significantly different from other activities in some of the equations.
- Using the daily local measure of beta, our estimated equation suggests that for a BT group asset beta of 0.7, divisional asset betas vary widely from 1.8 for ICT activities, 0.9 for other activities, 1.0 for mobile, and 0.5 for the fixed network.

⁶¹ As BT does not operate a mobile network, and therefore has a very small part of its business associated with mobile services, the mobile coefficient is less relevant to us.

Given the caveats and limitations of our analysis (set out at the beginning of this sub-section), the main value of the cross section approach is to strengthen our earlier findings concerning the direction of difference in divisional betas. It confirms other evidence that ICT activities have a higher beta than that of the group. It also suggests that the beta for the fixed network may be lower than the average of all the non-ICT businesses, but not by a large amount, and the result is not always statistically significant. Subject to the caveats, the actual equations may give some indication of the magnitude of differences between divisional betas, but cannot be used to quantify differences with any precision.

6 Quantitative analysis of BT's beta over time

This section describes our time series analysis. This seeks to infer the beta for BT's access business by examining fluctuations in BT's group beta over time, attempting to find a correlation between changes in the group beta and changes in the proportion of BT's business accounted for by the access business compared with other businesses. It expands on the initial qualitative analysis of historical trends in BT's beta given in Section 3.

6.1 Our methodology

In Section 3 we conclude that there are some grounds for believing that the beta associated with the copper access part of BT's business is lower than that for the group as a whole. If this is indeed the case then this implies that at times when the copper access business has been a relatively greater (smaller) proportion of BT's overall business, the BT group beta should have been lower (higher). This suggests that it may be possible to estimate the implied beta for BT's copper access business by examining the statistical evidence for a correlation of historical movements in the group beta with changes in the share of the access business within the overall group.

6.1.1 Use of regulatory asset values

In order to perform the calculation we need to have a measure of the proportion of BT's business accounted for by the copper access business. We are able to observe the total value of BT's business over time by examining changes in the market capitalisation and adding to this net debt in order to calculate enterprise value. However, we do not have a source for the market value of the copper access business. The best information available to us is BT's regulatory accounts which provide regulatory asset values (RAVs) for both "access" and "core" separately. Neither of these corresponds exactly to the business we wish to examine. The access figure includes retail elements associated with access (this is how BT's regulatory accounts were segmented before 2001), whereas ideally we would wish to know the value of the wholesale access business, as we are most interested in the beta for wholesale copper access. We conduct two analyses, one narrowly using the access business figures ("access"), and the other using a wider definition by including the core network to analyse the broader fixed network ("access & core").

Nevertheless, we believe that the RAVs for access or access & core are helpful for our analysis. In particular, including line rental retail in the access measure does not distort the figures greatly as our analysis in Section 3 suggests that this business may have a similar systematic risk profile to the wholesale access business.

The actual variable that we include as an explanatory factor for movements in BT's beta in our regression analysis is the proportion of BT's business that is accounted for by the parts of the business that are not access or are not access & core, defined in a regression as:

$$\boldsymbol{b}_{t} = \boldsymbol{a}_{1} + \boldsymbol{a}_{2} \left(\frac{EV_{t} - RAV_{t}^{access/access\&core}}{EV_{t}} \right) + \boldsymbol{e}_{t}$$

Because our directional findings suggest that access/access & core has a relatively low beta, we would expect this variable to have a positive coefficient where it is used to explain movements in BT's group beta (i.e. a bigger proportion of the business which is not access or access & core results in a higher beta).

A problem that we encounter in using the RAVs is that the regulatory accounts are published annually so we only have annual figures for the RAVs, which does not provide us with enough data points to conduct statistical analysis⁶². However, the equity component of the enterprise value is permanently adjusting to investor's perceptions of market value, so we can increase the number of observations by mixing annual data for the RAV and debt with monthly data for the enterprise value. Whilst this is not ideal there are two factors that give us some reason to believe that this is not a significant problem.

Firstly, the RAVs do not fluctuate much. The graph below shows movements in the three RAV measures of interest over the ten year period we look at.



Chart 6 Profile of BT's regulatory asset values

In one variant of our analysis we interpolate the RAV figures from month to month, rather than using a step change at the end of each regulatory accounting year. The results are not sensitive to this adjustment.

Secondly, whilst in principle it is possible that the market value attached to access/access & core by investors in BT could fluctuate by more than suggested by the regulatory accounting estimates of RAV, such deviations should be constrained by regulatory practice⁶³. The RAVs form the basis for Ofcom's regulatory price setting framework. As such, investors' estimates of market value in relation to the RAV are constrained by the knowledge that Ofcom's objective from one regulatory cycle to another is to regulate the business to earn a normal return on the RAV. This is equivalent to setting the ratio of the market value to the RAV to one.

Notwithstanding these points we consider what the implications would be if use of RAV figures were to imply that we are applying artificially stable estimates of the value of the access/access & core businesses. Although there are other possibilities, a feasible situation if this were the case is that in fact the market value of access/access & core tends to increase and fall in tandem with the market value of other parts of BT's business, so that, for example, when there is an increase in BT's overall value this is also associated with an increase in the value of access/access & core and not just other parts of the business. Later in this report we set out the results of simulating this effect as a sensitivity to our results.

⁶² If we use only annual data the number of observations (ten) is too small to obtain statistically significant results. This is also true where we use semi-annual data (which would minimise any distorting effect of combining static annual RAVs with fluctuating market enterprise value figures).

⁶³ In our experience of market valuations in the water and energy sectors, the ratio of the enterprise value to the regulated capital value moves within a range of 0.8 to 1.4.

6.1.2 The underlying relationship between the proportion of non-access & core and beta

The figure below shows the relationship since 1995 between BT's unadjusted asset beta (measured on a weekly basis) and the proportion of BT's business that is accounted for by those parts of the business that are neither the access nor the core network businesses.



Chart 7 BT's beta and the proportion of non-access & core business within the group

The figure appears to show some positive correlation between the two series, as suggested by our initial hypothesis based on the directional evidence in Section 3. This is further illustrated in the scatter diagram below, where a simple fitted regression line shows a positive relationship between asset beta and the proportion of BT's business which is not access & core.

Chart 8 Relationship between asset beta and the proportion of non-access & core business within the group



In order to analyse this apparent relationship we conduct regression analysis. This raises a number of significant issues concerning data and functional form:

- We need to choose the period and frequency over which to measure BT's group beta. We do not use monthly data as, for the purposes of this analysis where we are examining time series movements over a ten year period, the inclusion of five years of data in each observation makes it far more difficult to pick up changes in BT's activities. We perform our analysis using both daily and weekly data.
- We need to choose what definition of the RAV to use in our analysis. In principle we
 would expect the access definition to give the bigger effect, but access is smaller in
 relation to the overall size of BT, so we perform analysis using the larger RAV for both
 access & core. In the tables below we concentrate on the results using access & core but
 describe the main sensitivities if access only is used.
- We need to choose whether to fit an equation that explains BT's asset beta or its equity beta. Where it is the latter, we include a gearing term as an explanatory variable. We show results using both approaches.
- We note in the data that the value of beta departs significantly from the average for the whole sample period from late 1999 to mid 2002. We have reason to suspect that this may be associated with the boom in telecoms and technology asset values in 2000⁶⁴, and a reversal of this which was also coincident with the period after the terrorist attacks in September 2001. The following chart and table compares the volatility of BT relative to the FTSE Telecoms Index and the All Share Index. Prior to March 1998, the Telecoms index has slightly lower volatility than the FTSE All Share. The TMT boom period (March 98 October 99) witnessed increasing volatility, and The TMT bust period (November 99 August 01) has the highest volatility throughout our sample period ⁶⁵. During the period post-September 11 2001, volatility in BT falls perhaps due to being identified as a "safe haven" stock in a period of uncertainty and high terrorist risks while the volatility in telecoms remained higher than the FTSE All Share Index.⁶⁶. In order to fully take account of the September 11 effect, the second dummy runs until August 2002, because we are using beta estimates calculated with one year of data.

⁶⁴ A number of studies have attempted to assess the impact of the TMT boom on measured betas. See, for example, Andre Annema and Mark H Goedhart, "*Better Betas*", McKinsey on Finance, Winter 2003, pp10-14 and Hern, R. and Zalewska, A, "*Recent Evidence on Beta and the Cost of Capital for UK Electricity Companies*", *NERA Topics*, *October 2001*.

October 2001. ⁶⁵ It is necessary to distinguis h between the TMT boom and bust, as statistically as explanatory variables they cannot be represented as significant, i.e. Mar 98 – Aug 01 will be not significant as an explanatory variable, while Mar 98 – Oct 99 and Nov 99 – Aug 01 together will also be insignificant. However, individually they are significant, i.e. either Mar 98 – Oct 99 or Nov 99 – Aug 01 will be significant as an explanatory variable, and therefore at least one of these should be included as a dummy. We have included the latter, as it has a higher t-statistic, as well as reflecting the more important period in terms of beta deviating from the sample mean.

⁶⁶ The exact cut-off points are likely to be subjected to debate, but for the purpose of the regression analysis we have performed sens itivity analysis that suggests that changing the cut-off dates does not change our results significantly.



Chart 9 FTSE All Share, FTSE Telecoms Index and BT's Share Price

Table 6: Volatility of BT share price

Standard Deviation as a % of Sample Mean	FTSE Index	FTSE Telecom Index	BT Share Price
Jan 90 - Feb 98	19%	13%	12%
Mar 98 - Oct 99	10%	37%	34%
Nov 99 - Aug 01*	8%	63%	64%
Sep 01 - Aug 02*	9%	19%	10%
Aug 02 - Dec 04	9%	9%	3%

* The periods which we have represented using dummy variables.

- In some of our regressions we include a one month lag term for beta. The rationale for this is that as our betas are calculated using one year of data, adjacent monthly observations have highly overlapping time periods⁶⁷. Including a lag term helps to ensure that the other coefficients in the equation explain the movement in beta in the particular month. We present results both with and without lags.
- In our regressions where we use the equity beta as the dependent variable we prefer to take the natural logarithm (In) of the equity beta. The reason for this is that we wish to explain how BT's equity beta has fluctuated, but because gearing is one factor that should influence this we should include it as an explanatory variable. Within the CAPM framework there is a non-linear (multiplicative) relationship between the equity beta and gearing and by taking logs, we transform this to a linear relationship, allowing us to perform ordinary least squares regression analysis⁶⁸. We use the log of enterprise value (market capitalisation plus net debt) divided by market capitalisation as our measure of gearing and show the sensitivity of our equations to using logs.

6.2 Our results

Table 7 overleaf shows the results for six of our simplest regressions – relating the asset beta to the proportion of non-core & access, without time dummies, with time dummies, and with dummies and a lagged asset beta term, based on both daily and weekly data.

⁶⁷ An alternative approach to using lag terms would be to use one-month daily beta. However, calculation of beta based on only 20+ observations is also likely to be subject to noise.

⁶⁸ This differs from the approach in the cross section analysis. There we are unable to take logs of the equity betas because there are some negative equity betas in the sample. We therefore use asset betas and do not include gearing as an explanatory variable.

Table 7 Time series regressions for BT's asset beta. Dependent Variable: Unadjusted Asset Beta													
120 Observations			Dai	ily	Weekly								
Version Acces		Access & Core		Access & Core with Dummies		Access & Core with Dummies & Lags		Access & Core		Access & Core with Dummies		Access & Core with Dummies & Lags	
Independent Variable	Coeff	t-stat	Coeff	t-stat	Coeff	t-stat	Coeff	t-stat	Coeff	t-stat	Coeff	t-stat	
Lag1.Asset Beta					0.951	30.78					0.877	20.48	
Proportion of Non-A or Non-A&C	0.713	3.29	-0.158	-0.81	0.063	0.97	1.329	4.31	0.406	1.80	0.233	2.21	
Dummy – Nov 99 – Aug 01			0.687	8.82	0.023	0.68			0.922	10.32	0.045	0.74	
Dummy – Sep 01 – Aug 02									-0.682	-6.73	-0.182	-3.43	
Constant	0.613	4.86	0.976	9.17	0.005	0.11	0.148	0.82	0.565	4.74	-0.013	-0.2	
Adjusted R-squared	0.0	76	0.441		0.939		0.129		0.686		0.932		
RMSE	0.3	66	0.285		0.094		0.52		0.312		0.145		
Effect of Non-core/Access	Positive S	Significant	Negative Insignificant		Positive Insignificant		Positive Significant		Positive Significant at 10%		Positive Significant		
Implied													
Asset Beta of Core & Access	Asset Beta of Core & 0.613 Access		0.976		0.1	0.107		0.148		0.565		02	
Asset Beta of Non- Core/Access	1.3	26	0.8	18	1.403		1.477		0.971		1.785		

In Table 7, for the equations without lags, the constant term can be interpreted as the asset beta for a business comprising only access or access & core activities. The sign of the "Non A or Non A&C" variable shows whether non access/access & core activities increase beta (positive sign) or decrease beta (negative sign). In the equations without lags, adding together the constant term and the coefficient for the proportion of non access/access & core gives the beta for a company solely engaged in non-access/access & core business. When using the lag of beta this must be included to derive the divisional asset betas for both parts of the business. It can be interpreted that, using these simple equations:

- There is a general instability and sensitivity of the asset betas calculated to changes in the data used and the precise specification of the regression. Across the six equations reported in Table 7, there is a range for the access & core asset beta of -0.10 to 0.98, and for the non-access & core asset beta of 0.82 to 1.79. The average implied asset betas from these equations are 0.39 for access & core and 1.30 for non-access & core.
- Of these six equations, five give a positive coefficient for the share of non-access & core. Three of these five are statistically significant at the 5% level, and one of the others at the 10% level.
- This coefficient is smaller and less statistically significant if daily data is used compared with weekly data.
- The coefficient estimates vary significantly depending on whether dummies are included for the TMT boom/decline. We believe that there is good reason to support the inclusion of these dummies. Later in this section we examine the sensitivity of our estimated equations to changes in the precise specification of the dummies used.
- Including a lag term has a large effect on the measured betas. For example, the implied asset beta for the access & core business is around 1.0 based on the regression using daily data and including the TMT boom dummy, but this falls to 0.1 when a lag of the asset beta is included. The corresponding asset beta for non-access & core increases from 0.82 to 1.40. We believe that it is appropriate to include the lag variable.

When we use the equity beta as the dependent variable we believe it is appropriate to specify the equation in log form, for the reasons stated above. The results derived from using the log of the equity beta as the dependent variable are included in the table overleaf.

Table 8 Time series regressions for BT's equity beta.											
			Dependent Verichles I.n. (Weekly Bet			Preferred	d Equation	_			
120 Observations	Depend	Dependent Variable: Ln (Daily Beta)				nt variabl	e: Ln (wee	KIY Beta)	Dependent Variable: Change in Ln (Weekly Beta)		
Version Access & Core with Dummies		& Core ummies	Access & Core with Dummies & Lags		Access & Core with Dummies		Access &Core with Dummies & Lags		Access & Core with Dummies & Lags		nies &
Independent Variable	Coeff	t-stat	Coeff	t-stat	Coeff	t-stat	Coeff	t-stat	Independent Variable	Coeff	t-stat
Lag 1.Ln(Equity Beta)			0.96	34.18			0.691	13.42	Lag 1. Ln(Equity Beta)	-0.315	-6.11
% of Non-A or Non-A&C	-0.104	-0.65	0.111	2.27	0.195	0.91	0.254	1.9	Lag 1. % of Non- A&C	0.265	1.96
Ln (Gearing)	0.174	2.33	-0.01	-0.45	0.122	1.16	0.162	2.47	Lag 1. Ln (Gearing)	0.137	2.17
Dummy – Nov 99 – Aug 01	0.471	7.12	0.001	0.04	0.678	7.93	0.165	2.5	Dummy – Nov 99 – Aug 01	0.163	2.48
Dummy – Sept 01 – Aug 02					-1.351	-12.77	-0.581	-6.63	Dummy – Sept 01 – Aug 02	-0.571	-6.55
Constant	0.11	1.24	-0.055	-2.03	-0.218	-1.87	-0.182	-2.49	Constant	-0.183	-2.51
Adjusted R-squared	0.3	334	0.9	94	0.7	744	0	.9	Adjusted R- squared	0.2	28
RMSE	0.2	234	0.0	07	0.2	296	0.1	85	RMSE	0.1	86
Effect of Non-core/Access	Neg Insign	ative ificant	Positive S	Significant	Pos Insign	iitive iificant	Positive S at 1	Significant 0%	Effect of Non- core/Access	Positive Significa	
Implied									Implied		
Asset Beta of Core & Access	1.1	16	0.2	253	0.8	304	0.5	554	Asset Beta of Core & Access	0.5	59
Asset Beta of Non- Core/Access	1.0)06	4.0)29	0.9	977	1.2	261	Asset Beta of Non-Core/Access	1.2	295

Table 8 shows that again there is a large degree of uncertainty around the estimated coefficients, implying a wide range in the estimated asset betas suggested by these regressions, with the far right columns presenting our preferred equation The range for the access & core asset beta is 0.25 to 1.12, and for the non-access & core of 0.98 to 4.03. The overall average asset betas across all ten separate regression equations in Tables 4 and 5 are around 0.5 for access & core and 1.5 for non-access & core.

The above tables illustrate the degree to which the precise results vary depending on the data used and the specification chosen. This gives an indication of the uncertainty associated with this exercise. However, the great majority of the results give a positive coefficient (eight out of the ten independent equations set out⁶⁹), half of the eight are significant at the 5% level and six of the eight are significant at the 10% level, and the two negative results are not significant at the 5% level.

Whilst the range and uncertainty of results is important we derive a preferred regression equation on the far right of Table 8 with the following characteristics:

- We use the equity beta as the dependent variable, and hence fit a log form. We use the log of enterprise value (market capitalisation plus net debt) divided by market capitalisation as our measure of gearing.
- We actually use the change in the log of betas as our dependent variable. We do this because of the issue of non-stationarity the log beta does not have a statistically stable mean and variance in our sample range. By using percentage changes (which is what the change in the log of betas represent), we can better compare the effects of our explanatory variables. For example, a series with an upward trend is non-stationary (varying mean over time), and regressing this series against another upward trending series will spuriously infer that the two relationships are related. Using percentage changes, we will only infer a relationship when a greater percentage increase in one series corresponds to a greater percentage increase in the other. Here, in the case of log beta, the unstable mean and variance suggests that we should use an equation in changes.
- We include a one period lag of log beta as an explanatory variable for the change in log beta. We have also tested for the different lags of the proportion of non-access & core and have chosen the first lag which is statistically stronger.

We estimate our equation using both levels and change variables, but find that only level explanatory variables are statistically significant. We include the proportion of the business which is not access & core as a one month lagged variable.

The coefficient on the lagged proportion of the business which is not access & core is positive and statistically significant, suggesting that an increase in the size of the proportion of BT that is not access & core increases beta, in line with our original hypothesis. The equity beta also increases with gearing, as would be expected.

6.2.1 Interpretation of our results

For our preferred equation:

The coefficient for Lag 1. Ln(Equity Beta) is -0.315. This can be interpreted as: a 1% increase in the previous month's equity beta will result in a 0.685% increase in the current month's equity beta. This is consistent with our expectation as the 1-year equity beta is by construction serially correlated with the previous month's equity beta.

⁶⁹ Excluding the preferred equation as it is structurally identical to the last set of regression (Ln (Beta) with A&C with dummies and lags).

- A 1% increase in the (1-month lag) proportion of non-core/access increases the equity beta by 0.265%. A lag term suggests that the effect on equity beta can be persistent, i.e. history of high (low) non-core/access may have a positive (negative) impact on current beta.
- A 1% increase in the (1-month lag) gearing (measured by the ratio of net debt to enterprise value) increases the equity beta by 0.137%. Again, the lag term suggests gearing to have a longer-term effect on beta.
- The Nov 99 Aug 01 dummy variable is positive and significant. This suggests that during this period the equity beta has been significantly higher than its longer term trend. This corresponds to the TMT peak and bust period where the telecoms industry has generally witnessed more volatility and uncertainty.
- The Sep 01 Aug 02 dummy variable is negative and significant. This period witnessed a relatively "stable" BT as compared to the overall market. There are two possible explanations: first, this may be a correction to the previously high beta of BT a period of high betas to be followed by low betas; second, BT may be viewed as a "safe haven" stock in the period after the events of September 11 due to the uncertainty in the overall market.
- The corresponding asset beta for access & core derived is 0.56, and an asset beta for the rest of the business of about 1.30. Given the current shares of the business, the group asset beta implied by the estimated equation is around 0.9. We believe that more attention should be placed on the direction and relative size of the differences in these asset beta estimates than on the absolute figures.

We look at a number of other possible specifications for the equation in order to test the sensitivity of the results to changes in the different elements discussed above:

- If betas calculated based on daily observations rather than weekly are used the equation is less satisfactory. The coefficient on gearing is insignificant and the equilibrium asset betas implied for core & access (0.3) and the rest of the business (4.0) are implausible. As with the cross section analysis, the fact that the use of different ways of calculating beta has a significant effect on the results limits the reliance that can be placed on our analysis, but the uncertainty surrounding how to calculate beta is an inherent issue in financial economics, and such analysis can still be of value.
- In our preferred equation we use access & core as the basis for disaggregation. We also look at the implications of using just access or just core. If core is used the slope coefficient on the proportion of non-core is higher and more statistically significant. However, if access is used the slope coefficient drops and is only significant at the 10% level. It is not clear why this should be the case. Our first principles approach indicates that access should give a stronger result than either core or access & core. This tends to reduce our confidence in our results, but may be caused by the narrower definitions losing their explanatory power in the noise of the regression.
- We note above the issue concerning annual data for RAV being combined with monthly data for BT's enterprise value. As one sensitivity test, we interpolate monthly figures for RAV. This does not change the estimated equation significantly. As a further sensitivity test we assume that the movements in the value of access & core are perfectly positively correlated with movements in BT's overall market enterprise value, but that they fluctuate less widely (based on our observation that historically market to RAV ratios have fluctuated in the range 0.8-1.4 in the UK water and energy sectors). This sensitivity does not affect the results markedly, but increases the size and statistical significance of the coefficient on the share of non-core & access.

Finally, we test sensitivity to the time period covered by our telecommunications & technology boom and telecommunications downturn/September 11 dummies. We find that changing the period of coverage by a month on either side does not make any significant difference, except where September 2002 is included, because by construction the 1 year beta now excludes September 2001.

6.3 Conclusions from time series analysis

As with our cross section analysis there are a number of issues and difficulties associated with our time series analysis that mean the results must be treated with caution:

- The methodology implicitly assumes that the betas associated with the access & core business and the rest of the business do not change over the ten years of our dataset. It is clear that this is unlikely to hold (for example, the rest of the business includes Cellnet and Yell in some years, but these businesses were divested and are not included in later years).
- As with the cross section work, the analysis faces the issue that there is considerable uncertainty regarding the calculation basis for the dependent variable, beta. Similar arguments raised in the context of the cross section work for and against the use of weekly or daily estimates apply here. In this case betas estimated using weekly data appear to be better explained by the proportion of access & core within BT, but if daily data is used the estimated equation is less satisfactory.
- Again as with the cross section analysis we are unable to use the copper access business in our specification, and instead proxy it with the access & core business. This is a better proxy for copper access than is the fixed line business used in the cross section analysis. However, an issue with our results here is that access & core gives a markedly higher beta for the rest of the business than is the case if access only is applied. This is contrary to what we would expect.
- We only have regulatory accounts data, not market values, for the value of the access & core business. There are reasons to believe that this might not be a big problem, but to the extent that it does have an effect on the results we believe that the impact is most likely to be to increase the apparent beta for access & core and reduce the estimated beta for the rest of the business.
- There are many permutations for the specification of the equation, including choices over the use of log or actual betas, changes and levels, and the use of dummies. Our preferred equation is robust to sensitivity analysis we have carried out, but we acknowledge that other possible approaches have their merits as well.

Against these caveats, an advantage of the time series over the cross section approach is that all the data refers to BT and therefore we do not have the problem of comparing businesses across international business and regulatory environments.

Remembering the caveats and limitations of our analysis set out above, the results of our time series analysis indicate the following:

- There does appear to be some evidence that the beta for the access & core business is lower than that for the rest of BT's business. As an indication of the extent to which they might differ, our preferred estimated equation suggests that a group asset beta of 0.9 would be a weighted average of an access & core business asset beta of about 0.6 and an asset beta for the rest of the business of about 1.3.
- We would expect the copper access beta to be lower than that for access & core in principle. However, our analysis suggests that the beta for core is less than the beta

for access, against our expectations. This illustrates the degree of uncertainty associated with our analysis.

Given the issues associated with the basis on which to calculate beta, the use of RAV, changes in the composition and risk of BT's businesses over time, the counter-intuitive results associated with access and core, the reliance on dummy variables and the many possible ways of specifying our equation, we do not believe that too much reliance can be placed on the absolute numbers emerging from our time series analysis. They do give further directional support for a disaggregated beta where the parts of the business engaged in access or fixed telecommunications activities appear to have a lower beta than that for the rest of the business, and to the extent that the numbers are reliable at all they suggest that such deviations from the group beta could be relatively large.

7 Conclusions

Responses to Ofcom's consultation document demonstrate that there is general acceptance of the principle that incentives and efficiency are better served by applying disaggregated betas where these betas differ, as long as such betas can be calculated reliably.

We find collective directional evidence for applying a lower beta to BT's copper access business compared with the group as a whole, based on qualitative and indicative quantitative evidence from a first principles analysis, evidence on income elasticities, inspection of historical trends in BT's beta, and precedents from regulated telecommunications businesses in other parts of the world. We also find stronger, directional and quantitative evidence – based in part on an examination of the betas of pure play comparators – that the beta for BT's ICT business is higher than that for the group as a whole.

We attempt to estimate the beta for BT's copper access business through two sets of quantitative analysis, one using a cross section analysis of international telecommunications companies, the other using a time series analysis of changes in BT's group beta over time. Both approaches yield results which are directionally consistent with the qualitative and indicative quantitative evidence. Because of the many problems and issues which affect the reliability of the results reported in the previous sections it is not wise to attach much significance to the absolute figures they suggest. Nevertheless, they do reinforce the evidence that BT's ICT business is likely to have a beta that is higher than that for the group as a whole, and they also suggest that core telecommunications activities such as copper access are likely to have a lower beta. Moreover, the beta estimates, whilst subject to much error, suggest that the range could be relatively large.

Whilst none of the individual pieces of directional or quantitative evidence we examined is by any means conclusive, taken together they suggest that the ICT business beta is higher than that for the group as a whole and the copper access business beta is lower.

The remaining issue is whether it is possible to estimate sub-group betas for BT with sufficient confidence to enable them to be applied in a regulatory context. In his annex to BT's response to Ofcom's consultation document Professor Ian Cooper sets out what he believes to be the required methodologies to calculate such disaggregated betas satisfactorily, and concludes that these methodologies simply cannot be implemented satisfactorily in the case of BT's copper access business, largely because of the absence of relevant pure play comparators.

None of our evidence meets the empirical standard suggested by Professor Cooper. Whilst with more time it might be possible to refine our approach or implement other methodologies to improve the quantity and reliability of the evidence available to Ofcom, it seems to us having conducted this analysis that the disaggregation of group telecommunications betas is an inherently difficult area where the evidence is likely to remain imperfect.

We accept that in an ideal world we would have data for more direct comparators. However, we note that in many business applications it is difficult to find a significant number of good comparators for beta estimation, but conducting such analysis on less than perfect comparators is generally preferred to not conducting the analysis at all. We also note that any calculation of beta involves a degree of judgement (for example, concerning what measure of beta to use, which comparators to consider etc.). There is, for example, no precise, accepted estimate of BT's group beta available to Ofcom, but nevertheless Ofcom needs to adopt a figure in order to apply the CAPM framework in setting regulated prices, and therefore uses its judgement of the best figure, given the available, imperfect evidence.

We conclude that there is sufficient directional evidence for serious consideration to be given to applying disaggregated betas for BT, with the strongest evidence suggesting that a distinction could be made between BT's information and communications technology (ICT)

activities and the rest of BT's business. There is weaker, but almost entirely consistent directional evidence to suggest a further disaggregation between the copper access business and the rest of the non-ICT business. Because of the inherent problems associated with estimation, in our view it seems inevitable that it will be a matter for regulatory judgement whether the relatively directional evidence is sufficient to suggest that disaggregated figures should be applied in practice.

Company	Country	Beta	Beta	Beta	Beta	Beta	Beta daily
Company	Country	Local	MSCI	Local	MSCI	Local	MSCI
ALLTEL Communications	USA	0.76	0.74	0.70	0.56	0.75	0.76
AT&T	USA	0.97	0.91	1.02	0.98	0.95	0.99
BCE Inc	Canada	0.16	0.31	0.46	0.15	0.65	0.45
Belgacom	Belgium	1.25	0.68	0.87	0.47	0.63	0.39
BellSouth Corporation	USA	1.06	1.00	0.79	0.71	0.86	0.82
Bezeq Israeli							
Telecommunication Corp Ltd	Israel	0.96	0.64	0.46	0.46	0.75	0.38
BT Group	UK	1.63	1.64	0.66	0.31	1.11	0.68
Cap Gemini	France	2.25	2.82	1.50	1.47	1.54	1.40
CenturyTel	USA	0.81	0.77	0.43	0.55	0.53	0.63
	Czech						
Cesky Telecom	Republic	1.56	1.09	1.84	0.80	1.77	0.21
Citizens Communications	USA	1.31	1.32	-0.01	0.08	0.29	0.33
Deutsche Telekom	Germany	0.93	1.54	0.89	1.14	0.91	1.16
eircom	Ireland	0.62	1.21	0.43	0.44	0.07	0.25
Elisa Corporation	Finland	1.55	2.08	1.96	2.11	0.41	0.84
France Télécom	France	1.94	2.25	1.16	1.22	1.24	1.27
Getronics	Netherlands	2.39	3.96	2.49	1.77	2.26	1.95
Glocalnet (Telenordia)	Sweden	2.19	3.08	0.95	0.49	1.17	1.30
HIQ International AB	Swedish	2.33	3.67	1.33	1.63	1.31	1.49
Jazztel	Spain	3.00	3.95	0.08	0.66	0.42	0.72
Kingston Communications	UK	1.64	2.08	1.05	0.61	0.68	0.65
KPN	Netherlands	0.88	1.77	0.44	0.39	0.63	0.62
Logica PLC	UK	2.34	2.28	3.32	2.72	2.49	2.28

Appendix 1 - List of companies used in the cross section analysis⁷⁰

⁷⁰ Monthly 5-year beta as of April 2005. Weekly and daily 1-year beta as of latest financial year end for the company.

	a	Beta	Beta	Beta	Beta	Beta	Beta
Company	Country	monthly	monthly	weekly	weekly	daily	daily
Magyar Telekom (formerly	Hungon	1.20	1 15	1 16	0.07	1.05	0.22
Malav)	Hungary	1.20	1.15	1.10	0.27	1.05	0.33
MCI Inc	USA	1.10	1.06	1.43	1.69	0.58	0.90
Mobistar SA	Bolaium	0.60	1 19	1.07	0.60	1.00	0.78
Novtol Communications Inc.		0.00	2.12	1.07	1.20	1.00	1.65
	Japan	2.23	2.13	1.15	1.29	1.70	1.05
	Japan	0.97	0.72	0.98	0.00	0.90	0.85
	UK	1.34	1.58	1.12	0.83	1.29	1.37
Og Vodatone OTE (Hellenic	Iceland	0.61	0.03	0.23	0.15	0.48	0.06
Telecommunica-tions							
Organisation)	Greece	0.76	0.81	1.16	0.58	1.14	0.75
PCCW-HKT	Hong Kong	1.20	1.23	1.17	1.30	1.22	0.83
Portugal Telecom SGPS SA	Portugal	1.61	1.28	1.27	0.80	1.24	0.52
Qwest Communications	-						
International	USA	2.90	2.89	2.33	2.20	1.74	2.00
SBC Communications	USA	0.75	0.70	0.81	0.71	0.85	0.85
Singapore Telecom (SingTel)	Singapore	0.70	0.62	0.86	0.67	0.95	0.59
Sprint	USA	1.35	1.39	1.41	1.38	1.09	1.25
TDC Solutions	Denmark	1.07	1.29	1.22	1.05	1.09	1.00
Tele2 Sweden	Sweden	1.24	1.91	1.39	1.54	1.02	1.03
Telecom Italia	Italy	1.53	1.71	0.77	0.57	0.61	0.55
Telecom Italia Mobile	Italy	0.99	1.01	0.98	0.66	1.01	0.62
Telefónica de España	Spain	1.32	1.32	1.39	1.20	1.24	1.35
Telefonica Moviles	Spain	0.71	0.89	1.02	0.86	1.08	0.86
Telekom Austria	Austria	0.58	0.55	1.26	0.41	1.51	0.53
Telekom Malaysia	Malaysia	1.25	0.29	1.45	0.80	1.46	0.49
Telenor	Norway	0.88	1.50	0.80	0.72	0.98	0.78
TeliaSonera Sweden	Sweden	0.84	1.14	0.99	1.14	0.83	0.70

Company	Country	Beta monthly	Beta monthly	Beta weekly	Beta weekly	Beta daily	Beta daily
Talatra	Australia	0.01	0.24	0.12	0.20	0.56	0.14
Teistra	Australia	0.21	0.34	0.13	0.38	0.50	0.14
Tiscali	Italy	2.05	2.08	2.12	1.64	1.36	1.24
TP SA (Telekomunikacja	-						
Polska)	Poland	1.03	1.07	0.92	0.71	0.99	0.51
Unisys Corp	USA	1.79	1.73	1.59	1.68	1.07	1.25
Verizon Communications	USA	0.89	0.83	0.72	0.64	0.77	0.76
Versatel	Netherlands	0.88	2.46	1.05	0.97	1.89	1.83
Vodafone Group Plc	UK	1.19	1.09	0.63	0.53	1.19	0.96

Appendix 2 – Summary list of UK regulatory precedents

Publication/ Regulator	View on disaggregated beta	Methodology	Conclusion / Results
Oftel, "Price Control Review: A consultative document issued by the Director General of Telecommunicati ons setting out proposals for future retail price and network charge controls" October 2000.	Given the growing importance of the unregulated part of BT it is considered appropriate to make some adjustment to BT's group equity beta in arriving at an estimate of a beta for the regulated activities.	LBS beta for BT Group of 0.95 adjusted down to 0.8 to 0.9. Based on judgment.	BT regulated activities: Equity beta of 0.85, equivalent to an asset beta of 0.74 (13% gearing). Equity beta of 0.94 to 1.23 Gearing of 30 to 50%.
Oftel, "Proposals for Network Charge and Retail Price Controls from 2001", February 2001.	The financial modelling anticipates that the regulated business will be subject to similar "new economy" growth prospects and volatility as the non-regulated business, therefore no longer an obvious basis for adjusting the equity beta to allow for different betas of component activities.	Group beta of 1.09.	BT Group: Equity beta of 1.09, equivalent to asset beta of 0.95 (13% gearing) Equity beta of 1.16 to 1.45 Gearing of 20% to 40%.
CAA, "Economic regulation and the cost of capital", November 2001.	The risk faced by a regulated monopoly may be lower than that faced by commercial businesses facing competition, therefore reducing the equity beta.	Either: 1) company beta for BAA plc and other airport companies as a basis for the beta of the regulated part of BAA and Manchester Airport; or 2) betas of companies which are likely to have similar systematic-risk characteristics as the regulated parts of airports. Both are subject to judgement.	BAA's aeronautical activities: Equity beta of 0.7-0.9, mid-point of 0.8.

Publication/	View on disaggregated beta	Methodology	Conclusion / Results
BAA, "The Cost of Capital", December 4 2001, Julian Franks and Colin Mayer.	BAA's beta will reflect the risk of the Group, including both the regulated and unregulated business. For the purposes of setting the revenue requirement the beta should reflect the riskiness of the regulated business only.	Either: 1) eliminate the non-regulated component of the beta by looking at comparable unregulated business and subtracting estimates of the betas weighted by their proportion of BAA's total asses; or 2) compare the beta coefficients of similar companies directly.	Appropriate beta to consider for the price control would be that of the aeronautical activities – i.e. excluding the commercial activities.
CAA, "Heathrow, Gatwick and Stansted Airports' Price Caps, 2003- 2008: CAA recommendation s to the Competition Commission" February 2002	Heathrow is considered to be less risky than Gatwick or Stansted, in relation to both commercial and aeronautical activities, due to its captive market and hence Heathrow's equity beta under RRCB pricing is likely to be at the low end of the range (0.7-0.9) i.e. 0.7.	In relation to the regulated part of BAA: 1) Company beta for BAA plc and other airport companies' betas or 2) betas of companies which are likely to have similar systematic-risk characteristics as the regulated parts of airports Heathrow's beta is assumed to be at the low end of the range. (based on judgement)	Gatwick and Stansted: Equity beta of 0.7 to 0.9 (mid- point 0.8) Heathrow new assets: Equity beta of 1.3 Heathrow existing assets: Equity beta of 0.7
Ofgem, "The transmission price control review of the National Grid Company from 2001", June 2000.	The observed beta for NGC is not necessarily the same as that for NGC's electricity transmission business. There is no reason to suppose that the hypothetical beta for NGC's electricity transmission business is the same as that for NGC's other businesses.	 NGC's asset beta range (0.3 – 0.4) calculated from 3 sources: Beta decomposition: estimate NGC's equity beta by eliminating the effects of Energis. Comparator companies: calculate the implied asset betas for comparator companies using the equity betas. Regulatory precedents: other regulators' determinations of the equity betas for the network utilities which they regulate. 	Equity beta of 1.0 for the distribution businesses and Scottish transmission. Asset beta range of 0.3 to 0.4 Gearing of 60% to 70%.
Orgem, "Review of Public Electricity	In estimating the appropriate asset beta for the PESs distribution businesses, it is important to consider the risks the distribution business itself is exposed to, rather	Estimate an asset beta of 0.43 to 0.86 based on utility companies and assume the asset beta for the PES distribution businesses to be	Distribution business: Asset beta of 0.45 to 0.55. Equity beta of 0.9 to 1.1.

Publication/ Regulator	View on disaggregated beta	Methodology	Conclusion / Results
Suppliers 1998 – 2000", May 1999.	than the risks that might be associated with activities in the wider group.	in the bottom quartile of the range (0.45 to 0.55).	Gearing of 50%.
Ofgem, "Electricity Distribution Price Control Review", March 2004.	The observed betas of the parent company include both regulated and unregulated activities and are likely to overstate the risk of the regulated entity given that the non-distribution activities are likely to be more risky. However to decompose betas in order to obtain an equity beta for the regulatory entity is complex and would need to be based on assumptions which may not yield robust estimates given the lack of 'pure play' companies.	Group beta of 0.6 to 1.0 based on Smithers & Co. study and Ofgem's own analysis.	Group beta: Equity beta of 0.6 to 1.0. Gearing of 50% to 60%. Asset beta of 0.3 to 0.4.
Smithers & Co., "A Study into Certain Aspects of the Cost of Capital for Regulated Utilities in the U.K.", 13 Feb 2003.	If we have a good estimate of the value of the regulated assets relative to the whole and we have estimates of the beta of the assets that are used in overseas business then a simple adjustment can be made to the overall company beta to estimate regulated beta. But if there are many assets used in the domestic business for activities which are not regulated then the overseas/domestic split is not the right one.	Group beta value can be considered as a weighted average of the individual company beta values, where the weights are based on the net assets employed in each business, as a proportion of the total net assets of the group.	N/A

Appendix 3 – Summary list of International regulatory precedents

Publication/ Regulator	View on disaggregated beta	Methodology	Conclusion / Result
New Zealand, Monitor, "Comments on beta and on the risk-free rate when using the CAPM to calculate WACC for NZT", July 2003.	TSO regulation will reduce the risk of investing in TSO assets below the group risk. Can use regression analysis to separate the industry from the regulatory effects on TNZ beta, in order to predict TNZ beta after accounting for TSO regulation.	Adjust group beta of 1.12 downwards to account for TSO regulation.	Equity beta of 0.99 (group 1.12).
New Zealand, "Draft Determination on the Application for Pricing Review for Designated Interconnection Services", 11 April 2005.	The provision of interconnection services may have a higher variability than Telecom's fixed PSTN services and the equity beta for Telecom reflects the systematic risk of investments in Telecom as a whole. The income and price elasticity of interconnection services is arguably higher than access to Telecom's network services.	Estimate 1) "pure wireline" based on comparators beta which is most representative of fixed line PSTN, however this also includes broadband internet services which are arguably more risky or 2) an "integrated" beta which includes operators providing a large range of services.	Fixed PSTN asset beta is 0.5 to 0.8 (mid point 0.65). Group equity beta 1.06 to 1.18. Group asset beta of 0.8 to 1.0.
New Zealand, Commerce Commission, "Determination for TSO Instrument for Local Residential Service for period	The asset beta for the TSP will be lower than that of an otherwise unregulated telecommunications firm.	Either: 1) Telecoms own beta adjusted for TSO risk factors 2) Comparable companies 3) overseas utilities with comparable regulatory regimes. Adjustment of 0.1 to the TSO asset beta of 0.2 to 0.4 (mid-point of 0.3) based on US electricity firms subject to rate of return regulation.	TSP Asset beta of 0.3 to 0.5 (mid-point of 0.4). Group equity beta of 1.02 to 1.18. Group asset betas of 0.78 to 0.86.

between 20 December 2001 and 30 June			
2002", 17			
December 2003.			
New Zealand, Commerce Commission, "Determination for TSO Instrument for Local Residential Service for period between 1 July 2002 and	Considered the estimation of the TSO asset beta by decomposing an estimate of Telecom's PSTN beta into its constituent components.	Use a model to determine beta based on the capital value of the PSTN.	Asset beta of 0.4.
24 March 2005			
Australia CCC, "A report on the assessment of Telstra's undertaking for the Domestic PSTN Originating and Terminating Access services", July 2000.	Returns to the regulated parts of Telstra's business, such as the PSTN, are likely to be less risky than other parts of its business.	Considered a wide range of asset beta estimates from Telstra, IPART, Oftel, PBSA and Ibbotson, which range from 0.4 to 0.8. The asset beta of PSTN is likely to be towards the lower end of this range.	Asset beta of 0.5. Equity beta of 0.83. Gearing (D/V) of 40%.
Australia CCC", Final Determination for model price terms and	Returns to the regulated parts of Telstra's business, such as the PSTN, are likely to be less risky than other parts of its business.	The asset beta of PSTN is likely to be towards the lower end of this range (same as July 2000 PSTN view).	Asset beta of 0.5. Equity beta of 0.83. Gearing (D/V) of 40%.

conditions of the PSTN, ULLS and LCS services", October 2003.			
Sweden, Post & Telestyrelsen, "Estimating the cost of capital for fixed and mobile SMP operators in Sweden", Anderson Management International, 9 July 2003.	Acknowledges the potential differences in risk profile between mobile and fixed. In theory could argue that the cost of capital for a stand-alone access and core network could be different due to different capital structures and risk profiles.	 Fixed v Mobile: benchmark approach based on stand-alone mobile networks. (For the fixed network, however, PTS will to a large degree have to rely on data from integrated operators, as the majority of the fixed SMP operators also run a mobile network). Core v Access: Difficult to find the relevant market data necessary for making separate calculations due to lack of stand-alone access network operators. 	Fixed: Equity beta of 1.0 to 1.41. Asset beta of 0.85 to 1.0. Gearing of 20% to 40%. Mobile: Equity beta of 1.08 to 1.30. Asset beta of 1.0 to 1.1. Gearing of 10% to 20%. Recommends an aggregate beta for core and access.
Denmark, IT - og Telstyrelsen, August 2002.	Does not distinguish between parameters for fixed and mobile parts of the business.	Group beta. Use Bloomberg methodology to calculate TDC's asset beta of 0.70. The range based on the 2nd half of 2002 is 0.7 to 0.8.	Asset beta of 0.8. Equity beta of 1.04 to 1.36. Gearing of 30% to 45%.
Ireland, ODTR "Telecom Éireann's Reference Interconnect Offer - Decision Notice D12/99", September 1999.	Ideally a separate beta for TE's interconnection services should be estimated and used.	Group beta	Due to the practical difficulties of doing this, a beta for the company should be used instead i.e. the fixed line business.