DISCUSSION OF RESPONSES TO "BETA ANALYSIS OF BRITISH TELECOMMUNICATIONS: UPDATE JUNE 2005"

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1 Introduction and Summary

Ofcom has asked The Brattle Group to respond to the comments made on our recent report[1] by Professor Ian Cooper[2] and Telewest.[3] Our report updated our best statistical estimate of BT's beta, which had dropped from 1.29 to 1.0 as of June 2005. Professor Cooper seems to misconstrue our recent report as recommending that Ofcom depart from its previous beta estimate, revising it down to 1.0 or to whatever the most recent two-year estimate would suggest. Ofcom did not ask us for an opinion on the merit of reducing the beta. Such an opinion would have required us to consider the precedential value, if any, of Ofcom's previous beta estimate and other issues such as the betas of other regulated telecommunications companies that are similar to BT. We understand that Ofcom will address these issues separately, and we focus instead on the statistical issues associated with BT's beta.

In our last report the one-year and two-year betas gave similar results: a beta of approximately 1.0. Since then, updated data indicate different results depending on the choice of a one-year or two-year data window. The most recent two-year estimate is now 0.86. Assessing the reduction in the two-year beta would require additional consideration and analysis that lie beyond the scope of this response. Our response instead considers whether an estimate of 1.0 is now likely to understate BT's actual beta significantly. Since the most recent two-year beta is now below 1.0, we would not expect any estimate of 1.0 to understate the true BT beta.

Professor Cooper has raised some statistical points that we address below:

- Professor Cooper argues that Ofcom should identify a fundamental change in BT's business risk before reducing the beta below 1.3. However, BT's business risk is not the only ingredient that determines BT's beta. Beta measures the relationship between the risk of investing in BT and the risk of investing in the market. BT's beta can change if the risk of the market changes or if investor preferences change, even if the business risks faced by BT remain constant. Elsewhere in his report, Professor Cooper acknowledges that shifts in market volatility can change BT's beta independently of BT's business risk.

- It is reasonable to check for specific changes in the business environment that can explain large changes in statistical results. However, the business environment is inevitably complex, and betas can change within reasonable limits without the emergence of a clear dominating business factor to explain the change. Professor Cooper has not placed the perceived change in beta within context. The beta of 1.29 was a previous best estimate of BT's beta in 2003, but a standard statistical technique called a "Blume" adjustment would recognize that betas tend to converge toward 1.0. At the time that we measured a beta of 1.29, a Blume adjustment would have predicted a beta going forward of 1.19. In our experience, the gap between a

[1] "Beta analysis of British Telecommunications: update." *The Brattle Group.* June 2005.

[2] Annexe 1 to "Ofcom's approach to risk in the assessment of the cost of capital." *Professor Ian Cooper*. 22nd July 2005.

[3] "Telewest's response to Ofcom's consultation on equity beta." *Telewest.* July 20th 2005.

predicted 1.19 and 1.0 is not something that would signal the presence of some large external shock capable of clear identification.

- Professor Cooper argues that Ofcom should ignore beta estimates that are based on data that exhibit outliers or that have heteroscedastic residuals. However, the data in April 2005 that supported a beta of 1.0 did not contain as many outliers as the earlier data that produced the estimate of 1.29. Recent, lower estimates of beta also display less heteroscedasticity.

- Professor Cooper suggests that a recent but transient period of low market volatility may have contaminated the lower beta estimates of 1.0. However, if the volatility of BT's stock was also quite low recently, we would have no reason to suspect that reduced market volatility was introducing a net bias to the estimates. We show that the volatility of BT's stock has indeed dropped. We also show that the level of volatility is roughly constant throughout all the data-windows on which we based our June 2005 estimates.

- Professor Cooper also cautions against using the 2-year beta estimate, which he claims has recently become unstable. He focuses on stability in the most recent three months, but the choice of the last three months lacks any support. Significantly different results could flow from a rule of choosing the beta that seemed most stable over the last one year or over the last one day. Moreover, if we applied Professor Cooper's methodology then our estimates of beta could oscillate significantly – something that Professor Cooper claims he is trying to avoid. A common statistical measure of volatility shows that the 2-year beta estimate is the most stable.

- Professor Cooper makes additional observations regarding the validity of some of the statistical tests we performed, and the specification of our All World regression. Professor Cooper's comments do not affect our conclusion: an estimate of 1.0 would not understate the true BT beta.

Telewest's submission raises a similar issue as Professor Cooper: urging Ofcom to identify a clear and compelling business factor before reducing beta. As we explained above, the previous estimate of 1.29 implied a predicted going-forward beta of 1.19 using the standard Blume adjustment. The discrepancy between 1.19 and 1.0 is not of the scope that would typically involve a clearly identifiable external shock. We also explain that Telewest supported its argument in part by misquoting our previous report in a misleading fashion.

2 Response to Professor Cooper

2.1 Professor Cooper's comments

Professor Cooper believes that "there is no strong evidence on which to base a significant revision of the earlier beta estimate of 1.3"[4] for three reasons:

- No explanation is given as to why the fundamental risk of BT has changed;

[4] *Loc.cit. footnote 2*. p 3.

- The data responsible for the recent decline in estimates of the 'two-year' beta is unreliable. Hence Ofcom should ignore recent lower estimates of beta;
- While two-year betas were historically stable at around 1.25, the stability of betas estimated using a two-year data window has "ended".

If Ofcom uses an estimate lower than 1.3, Professor Cooper recommends an estimate derived from a one-year data window since he believes the two-year estimates are "volatile, indicating unreliability."[5]

Professor Cooper makes a number of other points, though they have little effect on his, or our, recommended beta estimate:

- The Chow test, and the related Test for Statistical Significance are meaningless without a 'break point' associated with a specific event;
- Non-normality of residuals reduces the likelihood that Dimson adjustments are significant;
- The regression used to measure beta against the All World index may be mis-specified.

We address Professor Cooper's points below.

2.2 Evidence of a change in beta

Relationship between BT's business risk and its beta

Professor Cooper in effect demands corroborating non-statistical evidence before adopting any change in beta. To some extent, this demand may reflect a personal preference for a strong burden of proof to ensure regulatory stability. Any expert opinion on the policy ramifications of changing the beta estimate would entail broader issues that Professor Cooper does not discuss, and which we did not address in our previous report. Professor Cooper may have misconstrued our previous report as a recommendation for Ofcom to reduce the beta to 1.0. However, our task in that case was to report our best estimate of BT's recent beta. We would not make a recommendation for a change without considering the type of broader factors that Ofcom is considering in this consultation, such as the trade-off between regulatory stability and flexibility, and the betas of other regulated telecommunications companies. Professor Cooper's response does not provide any guidance on these issues.

Professor Cooper's demand for corroborating non-statistical evidence also raises statistical and conceptual issues, which we address below.

He argues that, in the absence of reasons for a change in the risk of BT's business operations, changes in the observed beta are likely to be a "statistical artefact".[6] However, beta measures the relationship between a company's risk and the risk of the market. The beta can

[5] *Ibid*. p 17.

[6] *Ibid*. p 11.

change if the risk of the market changes, even if the company's risk stays constant. One prominent finance textbook explains:[7]

> "If you want to know the contribution of an individual security to the risk of a well-diversified portfolio, *it is no good thinking about how risky that investment is if held in isolation* – you need to measure its market risk, and that boils down to measuring how sensitive it is to market movements. This sensitivity is called beta."

Changes in the *relationship* between the risk of the stock and the risk of the market affect beta. The risk of the operations of the business itself may stay constant, but if the relationship between that risk and the market risk changes, then so will beta. BT's beta can change even if BT's business risk does not.

For example, in times of trouble investors often 'fly to quality', which increases the value of treasury bonds and income stocks. The correlation between returns on a particular stock and returns on the market will change as investors refocus their portfolios, and the changed correlation can persist for some time. Elsewhere in his report, Professor Cooper acknowledges that beta can change even as a company's business risk remains constant. He expresses concerns that a transient drop in market volatility has reduced BT's beta. He identifies four reasons why beta may fall,[8] none of which relate to the business risks of BT, and most of which relate to changes in the market as a whole. There is no reason to presume that a changed beta estimate reflects a mere statistical artefact in the absence of a change in BT's business risk.

If a change in the market can change BT's beta, the next question is the best way to identify and measure such changes. Professor Cooper would seem to demand the identification of a clear and compelling market change, in essence a non-statistical "story", before revising the beta estimate. However, many different factors affect the market at any point in time. Changes can occur within reasonable ranges without the emergence of a clear story. Non-statistical methods are not reliable for detecting and quantifying market changes and their effects on a company's beta. Statistical analyses provide the best indicators of such changes.

When a beta estimate changes dramatically over a short period, then a corroborating story can help dispel fears that the change reflects a mere statistical aberration. In our June 2005 report we said that "a drop in the All Share beta from 1.29 in December 2003 to 0.61 in April 2005 seems unrealistic without compelling evidence of a fundamental change in either the riskiness of BT Groups operations, or the ability of investors to diversify this risk." We found it difficult to believe that the non-diversifiable risk of BT had halved in the period. Such a change would typically signal the existence of an external shock capable of clear identification.

In contrast, a decline from 1.29 to 1.01 does not signal the existence of a clear external shock, and does not create fears of a serious statistical aberration. In 2003 we estimated the prevailing beta at 1.29. A standard Blume adjustment would have predicted a 1.19 beta going forward, based on evidence that betas tend to revert to a mean of 1.0. In our experience, the gap between a predicted beta of 1.19 and our April 2005 finding of 1.0 is not surprising. Such a change over eighteen months would not be unusual, and would not be associated with market movements of sufficient intensity to present a clear, compelling business explanation.

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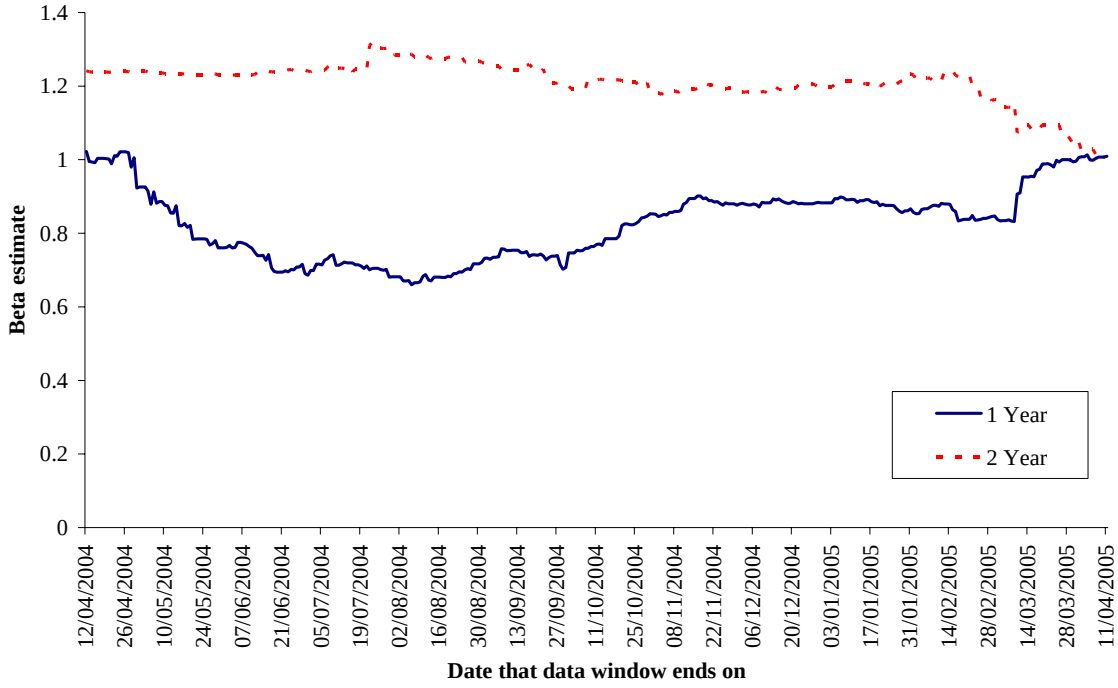
[7] "Principles of Corporate Finance (6th Edition)" *Brealey and Myers*, p. 173 (emphasis added).

[8] *Loc.cit. footnote 2*. p16.

Statistical reliability of recent estimates

Estimates of beta based on two years of historical data have declined over the last few months preceding April 2005. Figure 1 illustrates.

Figure 1: beta development graph



Professor Cooper claims that the data in the last two months are unreliable for three reasons:

- The regression residuals display heteroscedasticity;
- The regression residuals are not normally distributed;
- Stock market volatility has steadily decreased over the past two years.

We address each of these concerns in turn below.

Heteroscedasticity

We checked our beta estimates for heteroscedasticity using the standard White test, and corrected the standard errors by the method proposed in the same paper.[9] Heteroscedasticity affects an estimate's standard error, but does not introduce bias. A regression coefficient will remain the best possible estimate of beta despite the presence of heteroscedasticity. We did not detect evidence of heteroscedasticity significant at the 95% level in either the one-year or the 6-month estimates. We detected, and corrected for, heteroscedasticity when reporting the standard error of the two-year estimate.

[9] "A Heteroscedastic-consistent covariance matrix estimator and a direct test for heteroscedasticity." *White. H.* Econometrica, 48, 1980b. pp 817-838.

Observed heteroscedasticity as measured by the White test is lowest in estimates using the most recent data, as shown by Table 1. If Professor Cooper would assign more weight to estimates that exhibit low heteroscedasticity, then the estimates using older data warrant the least reliance. In other words, using the most recent data points (which result in a drop in beta) actually *reduces* heteroscedasticity. If Professor Cooper's concern is to reduce heteroscedasticity, he should support the estimates made using the most recent data.

Table 1: White Test Statistics for Heteroscedasticity

	Data Window		
End Date	2 Year	1 Year	6 Month
31st December 2003	19.32*	5.93	0.64
11th April 2005	6.82*	5.21	2.33
21st July 2005	0.64	3.54	0.88

Note:
* statistically significant at 95% confidence interval. Critical value for all regressions is 6.0.
Higher numbers indicate greater heteroscedasticity.

Distribution of residuals

Professor Cooper notes that the regression residuals are not distributed perfectly normally. This affects the assumptions behind the Chow test, the test for Statistical Difference, and the tests for the statistical significance of the Dimson adjustments. However, non-normally distributed regression residuals do not, in any way, affect the statistical validity of the beta estimate itself. As Professor Cooper acknowledges, the estimates remain the "best linear unbiased estimates"[10] available.

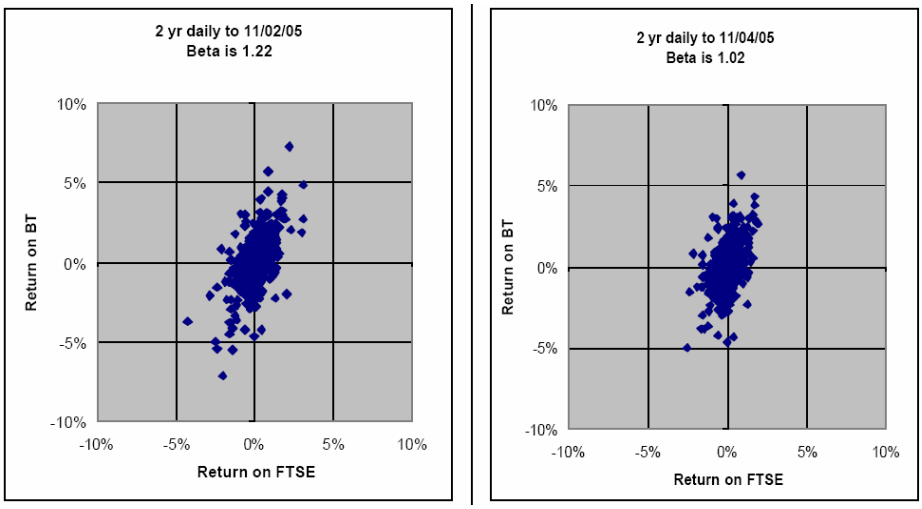
Professor Cooper also notes that 'outliers' in the data "make estimates volatile and unreliable".[11] Professor Cooper compares calculating a beta using two-years of data ending on 11th February 2005, rather than using two-years of data ending on 11th May 2005. Professor Cooper's preference for the data window ending on 11th February 2005 increased the beta estimate from 1.02 to 1.22.

However, Figure 5 in Professor Cooper's report, reproduced below as Figure 2, shows that the number of outliers actually *decreased* between February and May 2005. In other words, the data window ending on 11th May 2005 has less outliers than the data window ending on 11th February 2005. If our concern is to reduce the number of outliers in the data set, then using two years to the 11th May 2005 is preferable. Of the estimates presented by Cooper in Figure 5, the beta estimate with the least outliers in its data set is 1.02, not 1.22.

[10] *Loc.cit. footnote 2.* p 11.

[11] *Ibid*. p 15.

Figure 2: Professor Cooper's *Figure 5.*



Stock market volatility

Professor Cooper claims that stock market volatility has been low by historical standards, perhaps depressing BT's beta. Independent of any heteroscedasticity effect, it is not clear if low market volatility has any implications for beta. Beta measures the correlation between BT's stock price and the market as a whole. If the relative volatility of the two is constant then there is no reason why the change in volatility should necessarily affect beta. Table 2 compares this actual volatility of the FTSE 100 and BT stocks across the periods used to estimate beta in our February 2004 report and our June 2005 report.[12] In both periods, the volatility of the FTSE 100 is approximately half the volatility of BT's stocks.

Table 2: Comparison of observed volatility

	FTSE [A]	BT [B]	Ratio [A] / [B]
February 2004 (1st Jan 2003 - 31st Dec 2003)	0.011	0.022	0.52
June 2005 (12th Apr 2003 - 11th Apr 2005)	0.007	0.013	0.50

Note: Higher numbers imply greater volatility

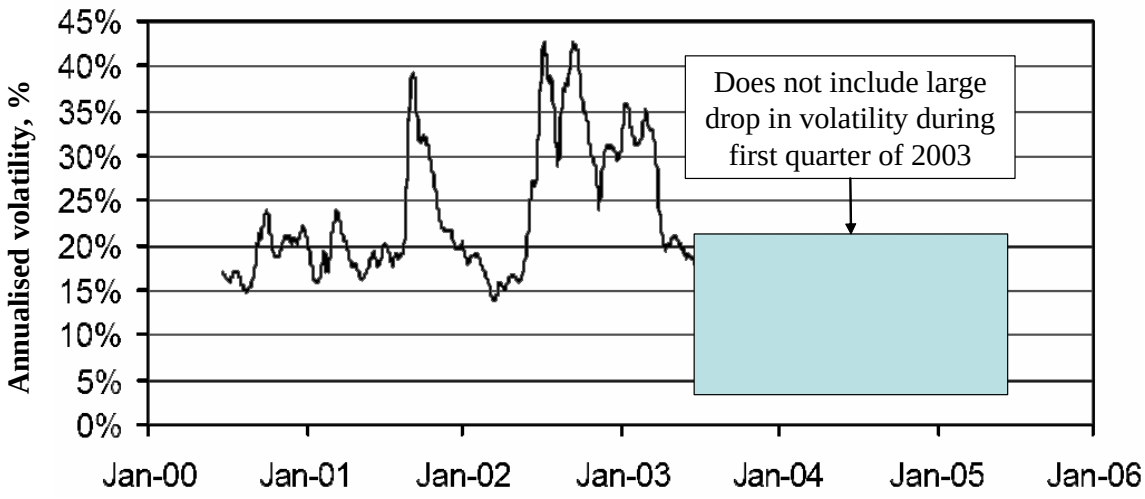
In particular, we see no reason to believe that low market volatility "makes beta estimates relatively uninformative." Professor Cooper argues that recent levels of volatility are abnormal, and estimates based on recent data should be given relatively little weight. Professor Cooper references work by Professor Julian Franks that recommends assigning a low weight to periods of abnormal volatility.[13] However, the abnormal period of volatility identified by Professor Franks was related to a specific event and was, at the most, only one month long. This is in stark contrast to the period of 'abnormal' volatility identified by Cooper which is 26 months

[12] The volatility of a time series, *v*, is measured as $stdev\left[v_t / v_{t-q} \right]_{t=x}^{y}$. "Investments", *Bodie, Kane and Marcus*. Mc-Graw Hill 2002.

[13] "US/UK Arbitration concerning Heathrow Airport User Charges", *Franks, Julian R*, 1995, International Law Reports vol. 101, 216-583.

long at present, shows no sign of ending, and is not associated with any identifiable set of events. We do not accept Professor Cooper's description of the recent period of low volatility as "abnormal."[14] Further, all of our recent beta estimates are based on data that exhibit a relatively constant level of volatility. Figure 3 reproduces Professor Cooper's Figure 4 describing market volatility. A two-year data-window ending in mid 2005 does not include the large drop in volatility observed in the first quarter of 2003. There is no reason to prefer the one-year beta because over the two-year beta since neither cover a period in which the volatility of the data changes substantially. If Professor Cooper prefers a beta estimated using a data set uncontaminated by changes in volatility, then he should give more weight to recent two-year beta estimates rather than the older estimates of around 1.3, which included data spanning the sharp drop in volatility seen at the start of 2003.

Figure 3: Professor Cooper's Figure 4, with recent 2-year data window highlighted



Stable two year estimate

Professor Cooper notes that the 2-year estimate remained relatively constant at around 1.25 from March 2003 until January 2004. For the reasons stated above, he believes that the recent drop (to 1.0 as of 11th April 2005, and 0.8 as of 21st June 2005) is a "statistical artefact".[15]

As discussed earlier, the level of heteroscedasticity and the number of outliers observed in the regression residuals is lower in the recent two-year estimates of beta. As such, we see no reason to believe that the recent drop in our two-year beta estimate is merely a statistical artefact.

Conclusion on the reliability of recent data for estimating beta

BT's beta can change even without a change in the business risk of BT. None of the data issues raised by Professor Cooper affect the status of the two-year beta, based on a data window ending on 11th May 2005, as the best estimate of BT's true beta. Recent data, which Professor Cooper rejects, actually exhibit fewer outliers, and lower heteroscedasticity.

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[14] *Loc. cit. footnote 2.* p 18.

[15] *Ibid*. p 11.

2.3 Use of a one-year data window

Professor Cooper cautions against the use of a two-year beta because "the estimates are volatile, indicating unreliability. The period of stability of the two year estimates is over."[16] Professor Cooper implies that the recent "instability" in the two-year beta makes it unreliable, despite its greater historical stability. This gives undue weight to the stability of the last part of the data. The problem becomes more apparent when taking his approach to extremes. No reasonable analyst should prefer a one-year beta if it was more stable than a two-year beta only on the last day analysed, with the two-year beta exhibiting greater stability over the entire previous year.

Table 3 shows volatility, calculated in the same way as in section 2.2, for the three time-series shown in Figure 5. The two-year estimate is less volatile than the one-year estimate, which itself is less volatile than the six-month estimate. Intuitively, the greater number of data points in the two-year estimate make it less sensitive to the addition of each day's new data. In effect, the longer 'tail' of data dilutes the effect of each additional day of data, making the beta more stable. If we are concerned that volatile estimates are unreliable then this evidence supports using a two-year data window rather than the one-year window favoured by Professor Cooper.

Table 3: Standard deviation of day-to-day differences in beta estimates

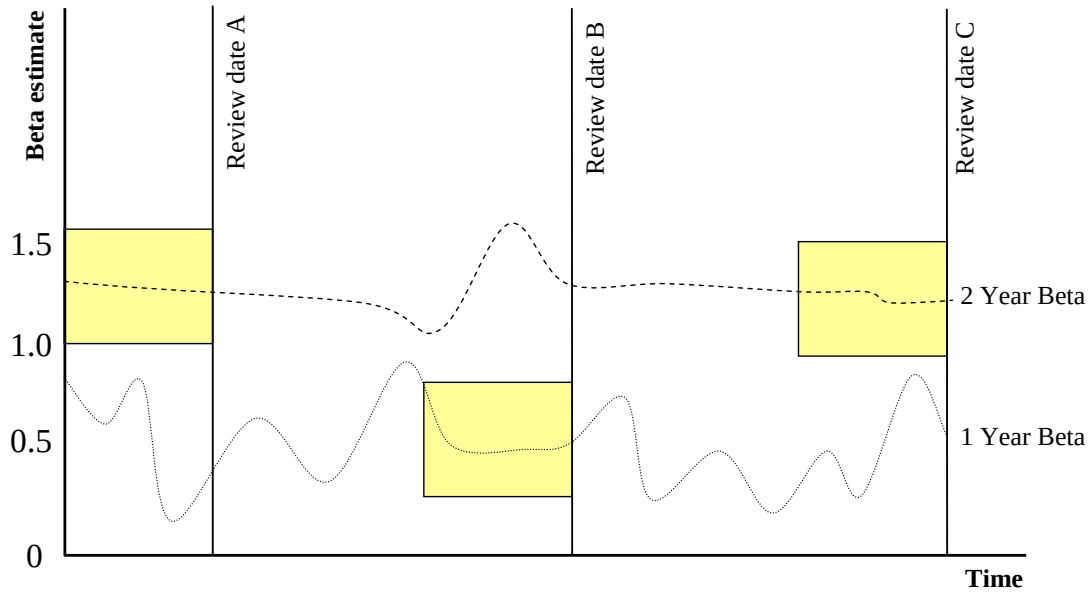
	2 Year	1 Year	6 Month
Stdev of day to day differences (22/7/04 - 21/07/05)	0.008	0.011	0.020

Note: High values indicate greater volatility.

Professor Cooper prefers the one-year beta because it has been stable for the few months before Ofcom's decision date. Professor Cooper's implicit criterion for a choice of beta is that Ofcom should use whichever beta has been more stable over the last, say, three months before the review date. But if Ofcom adopted such a criterion for its choice of beta, it could be frequently changing between one-and-two-year betas. Figure 4 gives a hypothetical example with data extending over six months, with uncertainty over when Ofcom will make a decision. At potential review date A, Professor Cooper would recommend using a two-year data window and adopting a beta of about 1.25. At potential date B, Professor Cooper would recommend using an estimate from a one-year data window because it had displayed greater stability in the recent past. This would imply adopting a beta of about 0.5. At potential review date C, the two-year estimate is the most stable, and Cooper would recommend adopting a beta of about 1.25. In contrast, our definition of stability – using the full two-year data period – would make the beta estimate depend far less on the choice of review date. Professor Cooper would of course add some burden of proof concerning changes to beta in the absence of compelling business reasons, but this does not solve the problem. With a high burden of proof applied to subsequent changes, deciding on a date when beta was low could force BT to suffer financially for an extended period. Deciding on a date when the beta was high could grant BT a sustained windfall.

[16] *Ibid*. p 17.

Figure 4: Oscillating preferences



Professor Cooper's criterion lacks any underlying foundation; it is not clear why beta must be stable in the three months prior to the review date. Why not six months, or twelve?

Professor Cooper also states that the one-year estimate is a better indicator of trends. If accurate, the one-day beta would be an even better indicator of tomorrow's beta. Despite this, reliance on short and recent data windows is ill-advised since they may predict tomorrow's *observed* beta better than a longer data window, but their very high volatility suggest that they are unlikely to be a very good indicator of the *true* beta.

2.4 Other points made by Professor Cooper

Chow Test and Tests for Statistical Difference

Professor Cooper notes that the assumption of normal residuals that supports both the Chow test and the tests for statistical differences does not hold, and that this invalidates the results. He fails to mention that very few regressions exhibit perfect normality in their residuals. If test statistics are close to the critical values then we should treat the results with caution. This is the case for all the tests presented in our June 2005 paper. In our June 2005 report we cautioned against "placing substantial weight on the results", and the points raised by Professor Cooper make no difference to the validity of our conclusions.

Non-normality of residuals reduces significance of Dimson adjustments

If the Dimson adjustments are barely significant statistically, then we should treat the results with caution. We urged assigning little weight to both the Dimson adjustments considered in our June 2005 report. The points raised by Professor Cooper make no difference to our conclusion that the beta of BT group was close to 1.0.

Miss-specification of All World regression

In Professor Cooper's "opinion, the method used by Brattle to estimate the world beta is potentially misleading." Professor Cooper believes that we erroneously include the effect of currency variations in our All World beta estimate. However, we discounted our estimate of

beta against the All World index for being too low. Therefore, Professor Cooper's comments have no impact on our recommended beta estimate.

We have obtained a new dataset giving FTSE All World Total Returns in domestic currencies. This removes *all* currency conversion risk. In section 4 we show estimates against the All World using this new index.

Summary

The points raised by Professor Cooper do not affect our recommended beta estimate. The criticisms of the Chow test do not affect our conclusion that there has been no structural break in the past two years. The criticisms of the Dimson and World estimates also have no effect, since we gave them no weight in our original document.

3 Response to Telewest

Telewest's main argument is that Ofcom should not decrease its estimate of BT's beta without "a compelling economic explanation for the decline." Further, they misquote our original report and claim: "The Brattle Group stated that there is '*no compelling evidence of a fundamental change in either the risk of BT Group's operations, or the ability of investors to diversify that risk.'*"[17]

We actually said: "we believe that a drop in the All Share beta from 1.29 in December 2003 to 0.61 in April 2005 seems unrealistic without *compelling evidence of a fundamental change in either the riskiness of BT Groups operations, or the ability of investors to diversify this risk*."[18] Telewest selected a portion of our text, added a 'no' beforehand, and failed to mention that our quote was in the context of a fall from 1.3 to 0.61, rather than a more modest drop to 1.0. We discussed the importance of corroborating evidence in section 2.2.

4 Updated results

In this section, we update our results to include data up to the 21st July 2005.

4.1 All Share results

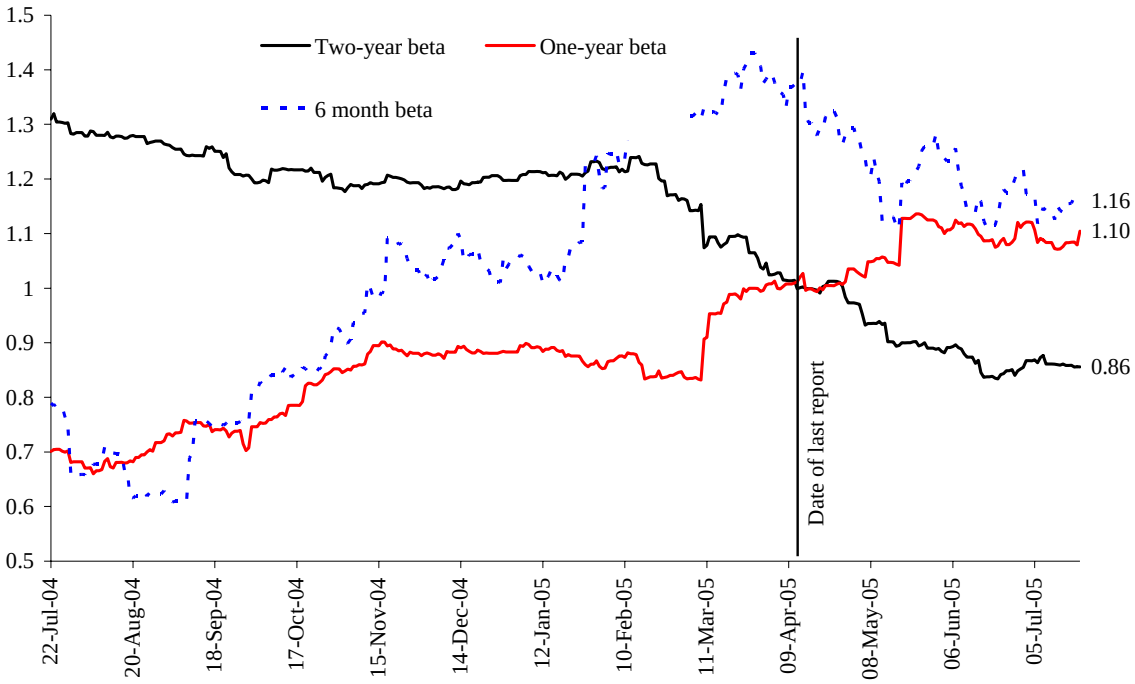
As discussed earlier, non-normality of the regression residuals affects the tests used to determine the significance of the Dimson adjustments. Since none of the Dimson adjustment test statistics are substantially above their critical value, we do not show the results.

Figure 5 shows the development of the unadjusted beta over the past year. We show the 6-month beta for comparison purposes only, and consider it too volatile to reflect the true beta of BT reliably.

[17] *Loc.cit. footnote 3.*

[18] *Loc.cit. footnote 1.*

Figure 5: Development of beta over the past year



Our estimate of beta using a 2-year data window has decreased since our last report, while our estimate using a 1-year data window is roughly the same. Discussing how and why the estimates have changed in the last few months is beyond the scope of this report. In any case, our preferred two-year estimate of beta has decreased since our last report. A beta estimate of 1.0 would not understate the true BT beta.

4.2 All World results

Due to the occasional presence of both heteroscedasticity and autocorrelation in estimates using a two-year data window, we continue to recommend using a one-year data window when measuring beta against the FTSE All World. We give our estimate of the All World beta, using our new local currencies data set, in Table 4.

Table 4: Beta estimate vs. FTSE All World

	Beta Estimate	Standard Error
FTSE All World		
1 Year of Daily Data, 22/7/04 - 21/7/05		
Unadjusted Estimate	0.92	0.14

Note: Uses index based on total returns in local currencies.

4.3 Summary Results

Table 5 summarises our results.

Table 5: Summary Results

	Beta Estimate	Standard Error
FTSE All Share		
1 Year of Daily Data, 22/7/04 - 21/7/05		
Unadjusted Estimate	1.10	0.12
2 Years of Daily Data, 22/7/03 - 21/7/05		
Unadjusted Estimate	0.86	0.08
FTSE All World		
1 Year of Daily Data, 22/7/04 - 21/7/05		
Unadjusted Estimate	0.92	0.14

Our results range from an estimate of 0.86 against the All Share using two years of data to 1.1 against the All Share using only one year of data.

Statistically, the two-year estimate remains the best estimate of BT's beta. The most recent two-year beta estimate is 0.86. In addition, our beta estimated against the All World index no longer appears unreasonably low, and Ofcom may refer to it with greater confidence. Our All-World estimate is 0.92. Evaluating fully the recent decrease in the two-year beta lies beyond the scope of this report. However, we see no reason why a beta estimate of 1.0, let alone 1.1, would seriously underestimate the current level of non-diversifiable risk associated with BT.