BETA ANALYSIS OF BRITISH TELECOMMUNICATIONS: UPDATE

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1 Introduction and Summary

1.1 Introduction

OFCOM has asked us to update our estimate of the financial beta for BT group (henceforth referred to as BT) contained in our February 2004 report.[1] This paper describes how we believe the beta for BT has changed since then, and discusses the issues surrounding our latest estimates.

Our previous analysis used data up to and including the 31st December 2003. For this analysis we extend our data series to 11th April 2005.

1.2 Summary of Results

Table 1 summarises our estimates of the current BT beta against a domestic and world index.

Table 1: Summary Results

	Beta Estimate	Standard Error
FTSE All Share		
2 Years of Daily Data, 12/4/03 - 11/4/05		
Unadjusted Estimate	1.01	0.09
+-2 Dimson Adjustments	0.61	0.19
-2 Dimson Adjustments	0.63	0.15
FTSE All World		
1 Year of Daily Data, 12/4/04 - 11/4/05		
Unadjusted Estimate	0.49	0.09

We believe that the best estimate of BT's current beta is 1. The Dimson adjustments suggest a lower beta, but we have concerns that the Dimson adjustments are insignificant over most of the period examined, and only achieve significance in the final two months. BT's beta is also less than 1 when measured against the FTSE All World, but we are concerned that the low beta reflects the temporary effects of the war in Iraq, which are already dissipating.

Our estimates of BT's beta against both the All Share and All World indices have decreased since our February 2004 report. A historical analysis of beta estimates since 1st January 1997 shows that both our current and previous estimates are consistent with recent trends in BT's beta.

[1] *Financial Analysis of British Telecommunications. The Brattle Group. February 2004.*

2 Methodology

2.1 Introduction

Beta is an estimate of a firm's non-diversifiable risk, calculated by regressing the returns on the stock against returns on the market. OFCOM has commissioned a number of reports from us discussing issues in beta estimation for fixed and mobile telecommunication companies. In our initial July 2002 report, we identified three critical methodological issues to resolve before calculating an accurate estimate of beta:

- The *sampling frequency* of the data used. For example, should stock and index price observations be taken on a monthly, weekly, or daily basis;
- The *data window* to be analysed. For example, should beta be estimated using the past 12 months, 3 years, or 5 years of data;
- The use of *Dimson Adjustments*.[2]

We also note that estimators may use either a UK based index, such as the FTSE All Share, or a global index, such as the FTSE All World, to estimate beta against.

2.2 Sampling Frequency

In our July 2002, December 2003, February 2004, and April 2004 reports we discussed the choice between monthly, weekly or daily sampling intervals. We found strong evidence that a daily sampling interval produced the most robust results. We see no reason to change this approach, and continue to use daily sampling intervals in the current analysis.

2.3 Data Window

There is no mechanical statistical method for determining the correct data window: longer data windows lower the standard error of beta estimates, but increase the danger of including data that reflect fundamentally different market conditions. Nonetheless, we have developed a number of statistical tools to help assess the correct data window:

- *Tests of statistical difference:* We test to see if beta estimates at different dates are statistically distinguishable. If they are, then the fundamental beta may have changed;
- *Chow tests of structural stability:* Chow tests determine whether certain regression results differ before and after a specified 'break point';[3]
- *Beta development graphs:* Plotting beta estimates over time provides useful context for deriving conclusions.

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[2] For a discussion how Dimson Adjustments are applied, and what data problems they are used to correct, see *Financial Analysis of British Telecommunications. The Brattle Group. February 2004.*

[3] Chow tests examine if the sum of the residual sum of squares of two unrestrained regressions before and after a hypothesised break point are statistically distinguishable from the residual sum of squares of a single regression spanning the whole period.

2.4 Dimson Adjustments

In each of our reports we derive beta estimates under multiple Dimson adjustment assumptions. Where these estimates are statistically significant we include them in our range of recommended estimates. Statistically significant Dimson-adjusted estimates often diverge from the unadjusted estimate by a substantial amount.

3 Previous Estimates

Our February 2004 report recommended estimating beta using 1 year of daily data, corrected as necessary for autocorrelation and heteroscedasticity. We applied no Dimson Adjustments. When recommending this methodology we noted that:

- The betas for BT appeared to have changed significantly over the previous two years;
- The Dimson adjustments were rarely statistically significant, and exhibited no reliable pattern.

We calculated beta estimates against both the FTSE All Share and the FTSE All World indices. We did not recommend either estimate as superior. Table 2 summarises our results.

Table 2: Estimates of the Equity Beta

Market Index	Equity Beta Estimate
All Share (1st January 2003 - 31st December 2003)	1.29 (0.09)
All World (1st January 2002 - 31st December 2002)	1.03 (0.11)

Note: All World estimates calculated over 1st January 2003 – 31st December 2003 showed both autocorrelation and heteroscedasticity.

4 Updated Estimate

In this report, we update our analysis to 11th April 2005.

4.1 Data Window

Tests of Statistical Difference

Using data from 12 April 2003 to 11 April 2005, Table 3 analyses whether the results obtained in the first and second half of the previous 2 year, 1 year, or 6-month periods are statistically distinguishable. If the results are statistically distinguishable, then the underlying beta may have changed. We show results for six-month data windows to evaluate statistical stability, and do not recommend estimating beta over such a short period. We believe that data windows less than a year are highly unlikely to produce accurate estimates of beta that are resilient to short-term effects.

Table 3:Analysis of Changes in Beta

		FTSE All Share			FTSE All World		
		2 Year [A]	1 Year [B]	6 Month [C]	2 Year [D]	1 Year [E]	6 Month [F]
Regression Results							
Regression results from 1st half of period							
Initial Estimate	[1] TBG	1.02	0.85	1.41	n/a	0.48	0.33
Variance	[2] TBG	0.01	0.02	0.05	n/a	0.01	0.04
Regression results from 2nd half of period							
New Estimate	[3] TBG	1.01	1.38	1.32	0.49	0.51	0.73
Variance	[4] TBG	0.01	0.04	0.12	0.01	0.02	0.04
Test Statistic							
Estimate Difference	[5] [1]-[3]	0.01	-0.53	0.09	n/a	-0.03	-0.39
SE	[6] ([2]+[4])^0.5	0.16	0.24	0.41	n/a	0.18	0.28
Test Stat	[7] |[5]/[6]|	0.08	2.23	0.23	n/a	0.16	1.42
Result							
Crit. Value at 95% Significance	[8] TBG	1.96	1.96	1.96	n/a	1.96	1.96
Result (H_0: 1st half beta = 2nd half beta)	[9] TBG	Do not reject	Reject	Do not reject	n/a	Do not reject	Do not reject

Betas estimated against the All Share for the first and second halves of the past year (column [B]) are distinguishable at the 95% confidence level. This implies that BT's beta has been volatile over the past year. In contrast, BT's beta appears to have been relatively stable when comparing the first and second halves of the last six months; and very stable when comparing the first and second halves of the past two years.

Estimates of BT's beta against the All World index displayed both heteroscedasticity and autocorrelation during the first half of the past two years. Estimates across the past year appear relatively stable. Beta estimates across the past six months show some volatility, though the results are not statistically distinguishable due to their large standard errors.

Chow Tests

We have no *a priori* reason for hypothesising a structural break, and most econometric texts caution against conducting Chow tests without an empirical foundation for a suggested

'break' point.[4] For completeness, we show the results for Chow tests hypothesising structural breaks 3 months ago, 6 months ago, and 1 year ago. We do not recommend placing substantial weight on the results.

Table 4: Chow Tests of Structural Stability

	Test [A] [See Note]	RSS_r [B] [See Note]	RSS_{ur}^1 [C] [See Note]	RSS_{ur}^2 [D] [See Note]	RSS_{ur} [E] [C] + [D]	k [F] [See Note]	$(n_1 + n_2 - 2k)$ [G] [See Note]	Test F-Stat [H] (([B] - [E]) / [F]) / ([E] / [G])	P-Value [I]
All Share	2 Year	0.068	0.045	0.023	0.068	2	520	0.69	50%
	1 Year	0.023	0.011	0.012	0.023	2	260	2.36	10%
	6 Month	0.012	0.005	0.007	0.011	2	125	2.79	7%
All World	2 Year	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	1 Year	0.027	0.012	0.015	0.027	2	260	0.18	84%
	6 Month	0.015	0.008	0.007	0.014	2	125	2.80	6%

Notes:

[A], [B], [C], [D]: Date Range of Restricted and Unrestricted Regressions	Test	RSS_r	RSS_{ur}^1	RSS_{ur}^2
	2 Year Regression	13/04/2003 - 11/04/2005	13/04/2003 - 11/04/2004	12/04/2004 - 11/04/2005
	1 Year Regression	12/04/2004 - 11/04/2005	12/04/2004 - 10/10/2004	11/10/2004 - 11/04/2005
	6 Month Regression	12/10/2004 - 11/04/2005	11/10/2004 - 11/01/2005	12/01/2005 - 11/04/2005

[F]: Number of coefficients in unrestricted regression.
[G]: Degrees of freedom of unrestricted regression (number of datapoints - number of coefficients in total)
[I]: Testing H_0: $RSS_{ur} = RSS_r$

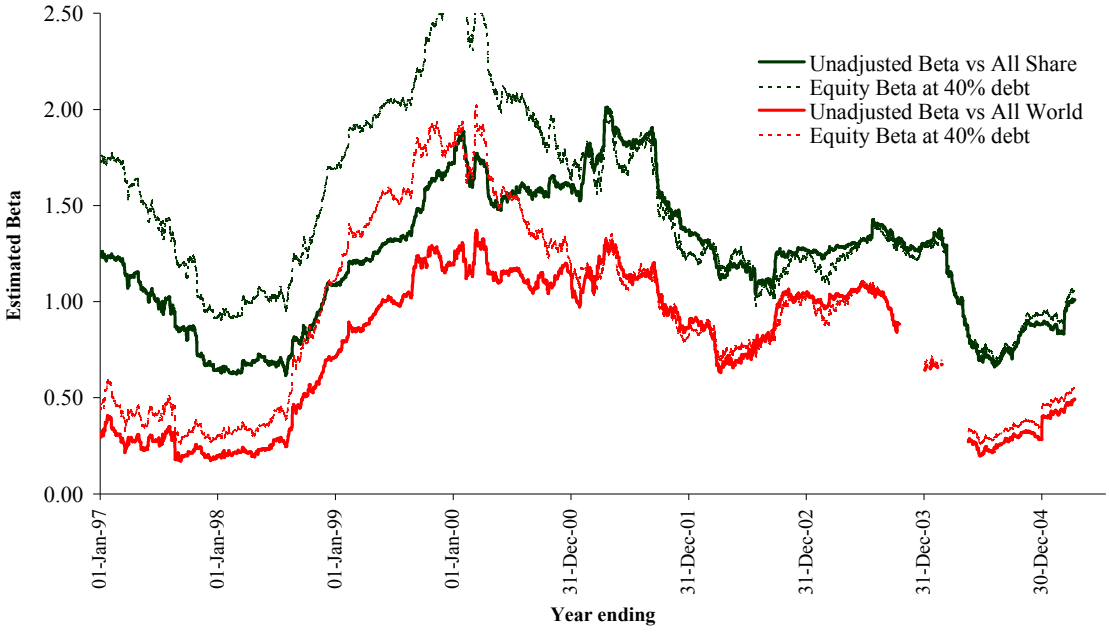
OFCOM could conduct more detailed statistical tests of structural stability, such as the tests proposed by Hansen (1992) or Brown, Dublin and Evans (1975). The computational complexity of these tests is some way in advance of the basic Chow test, and while the results will certainly be informative, there is no guarantee that they will be conclusive.

Beta Development

Figure 1 shows estimates of BT's beta against the All Share and the All World indices. We derive the estimates using 1 year of daily data. During this period, the leverage of BT Group has changed significantly, and we also estimate what the equity beta would have been at current leverage, assuming a debt beta of 0.1.

[4] "The Chow test…is based on a rather definite piece of information, namely, when the structural change takes place. If this is not known or must be estimated, then the advantage of the Chow test diminishes considerably." *Econometric Analysis, 4th Edition*. William H. Greene. P 294.

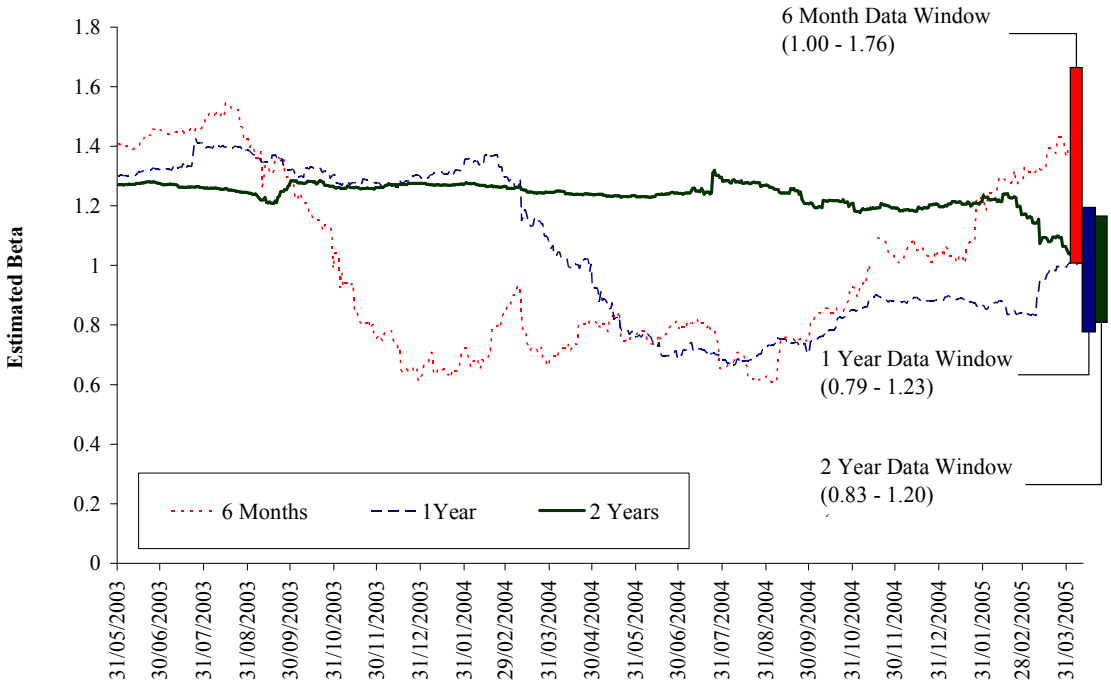
Figure 1: Development of beta over the past 7 years



Estimate Volatility

Figure 2 shows the volatility in unadjusted beta estimates using 2 year, 1 year, and 6-month data windows. We also show 95% confidence intervals for the most recent estimates. Estimates calculated across a 6-month data window are the most volatile and have an especially large confidence interval, causing concern over using too short a data window. However, we note that both our point estimates using 1 and 2 years of data are within the 95% confidence interval of our 6-month estimate.

Figure 2: Volatility of beta estimates



Conclusions

Estimates of BT's beta against the All Share appear to have changed significantly over the past year. The wide confidence interval and the volatility of the six-month estimates suggest the presence of statistical noise. Figure 2 further supports the presence of noise, as does the high structural stability of betas over the past two years shown in the Chow tests. Figure 1 shows that the one-year beta has decreased recently, but at a value of 1 still remains within a reasonable range of past results.

Our estimates using 1 or 2 years of data are statistically indistinguishable. We have no reason to suspect that unusual events in the first year of the 2-year data window bias the results. Figure 2 confirms that the 2-year beta is the most stable of the estimates. We recommend a 2-year beta to maximise the statistical accuracy of the result. For comparison with our previous estimates, we continue to report results using a 1-year data window.

We recommend a different data window for estimates of beta against the All World. A one-year data window is ideal since estimates appear to be relatively stable across the period, and using a two-year window occasionally causes both autocorrelation and heteroscedasticity.

4.2 Dimson Adjustments

All Share

Figure 3 and Figure 4 detail the development of the statistical significance of the Dimson Adjustments against the All Share index with 1 and 2 year data windows respectively.

Figure 3: T-Stats of Statistical Significance against the All Share index. 1 year of daily data.

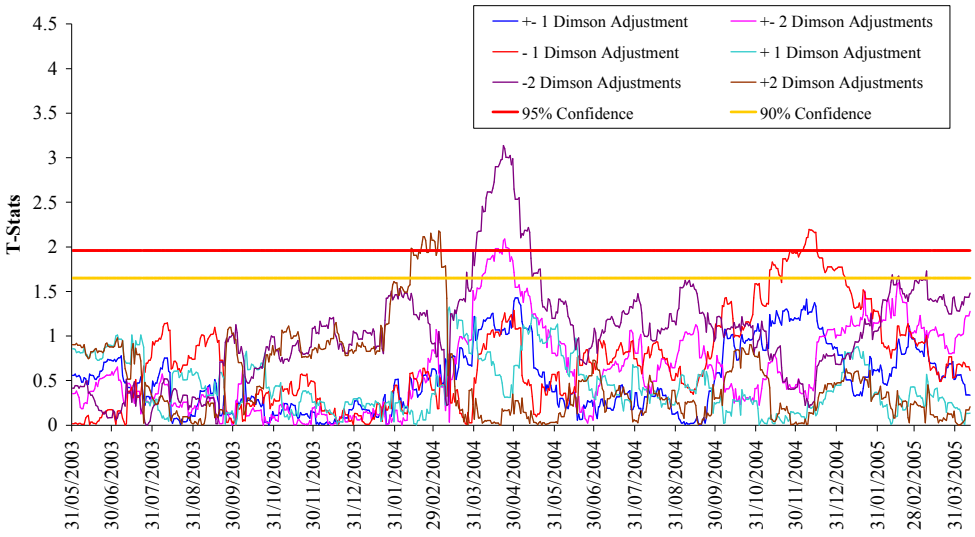
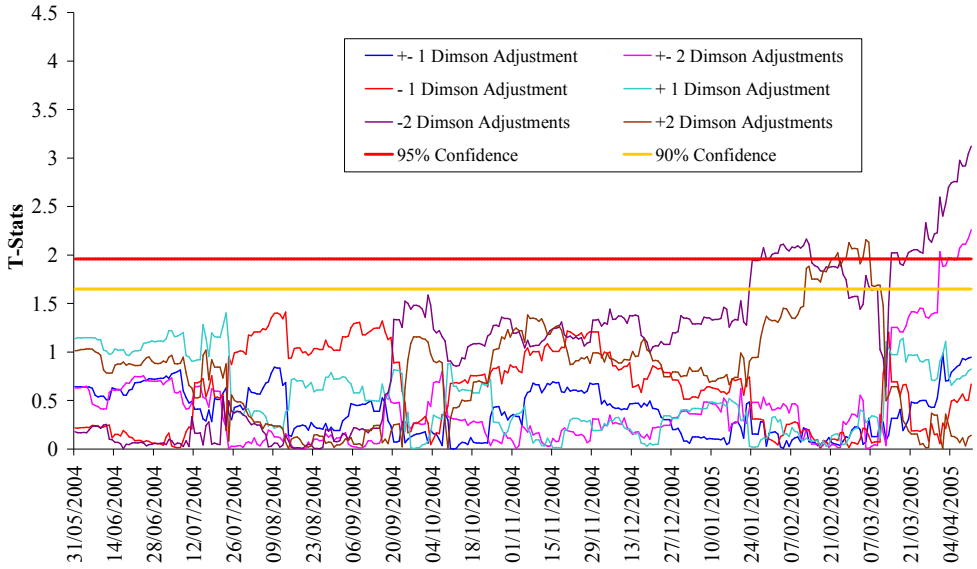


Figure 4: T-Stats of Statistical Significance against the All World index. 2 years of daily data.

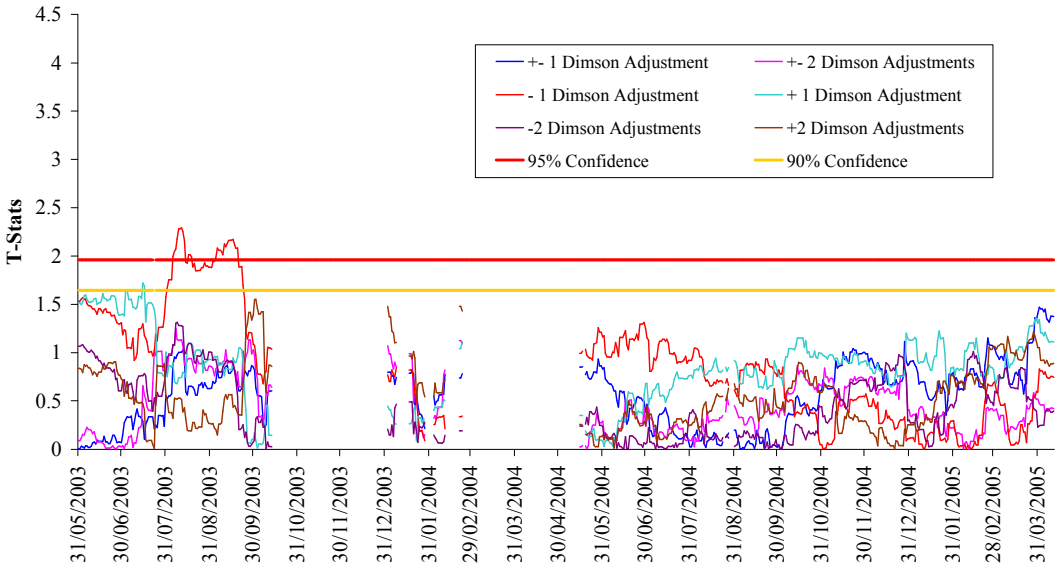


Using one year of data, none of the adjustments are significant at either the 90% or the 95% confidence intervals. Both the ±2 and -2 Dimson adjustments are significant when using two years of data.

All World

Figure 5 details the development of the statistical significance of the Dimson Adjustments against the All World index. We omit estimates that exhibit both heteroscedasticity and autocorrelation.

Figure 5: T-Stats of Statistical Significance against the All World index.



At the date of estimation, none of the adjustments is significant at either the 90% or the 95% confidence intervals. We do not include any Dimson adjustments in our estimated range for beta.

4.3 Beta Estimates

All Share

Figure 6 and Figure 7 detail the development of our estimate of beta against the All Share index. We show Dimson adjusted estimates even when they are not statistically significant.

Figure 6: Beta estimates against the All Share index. 1 year of data.

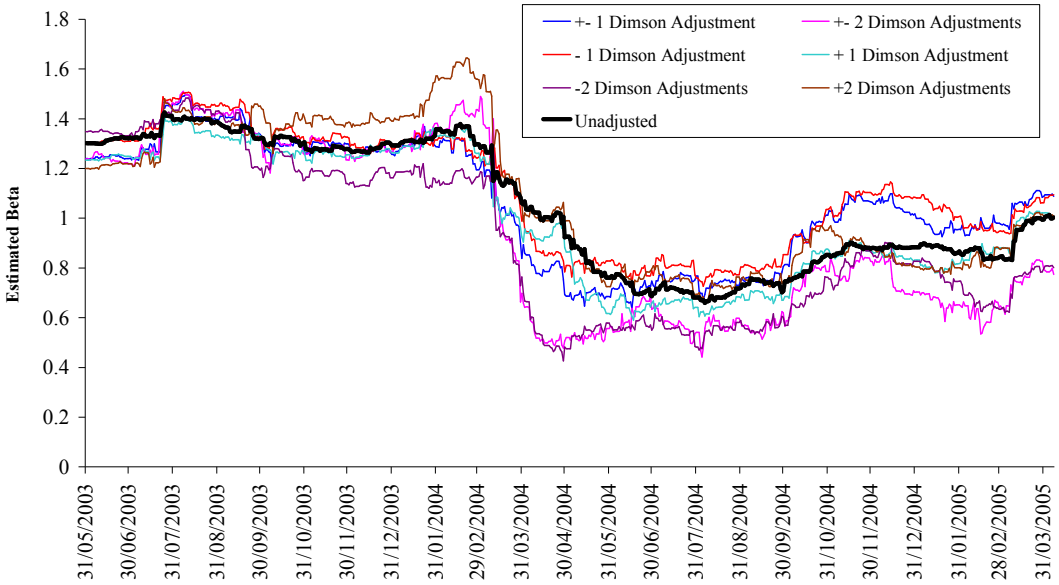
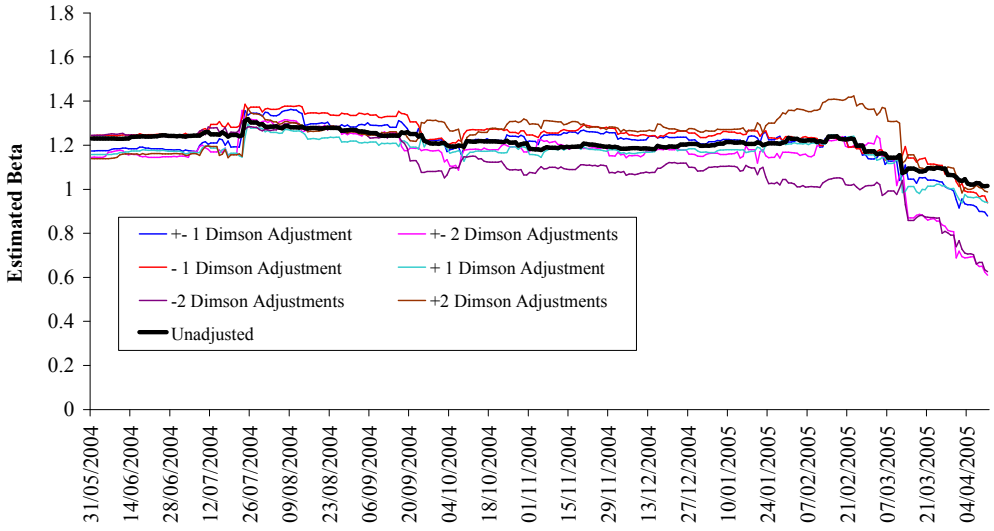


Figure 7: Beta Estimate against the All Share Index. 2 years of daily data.

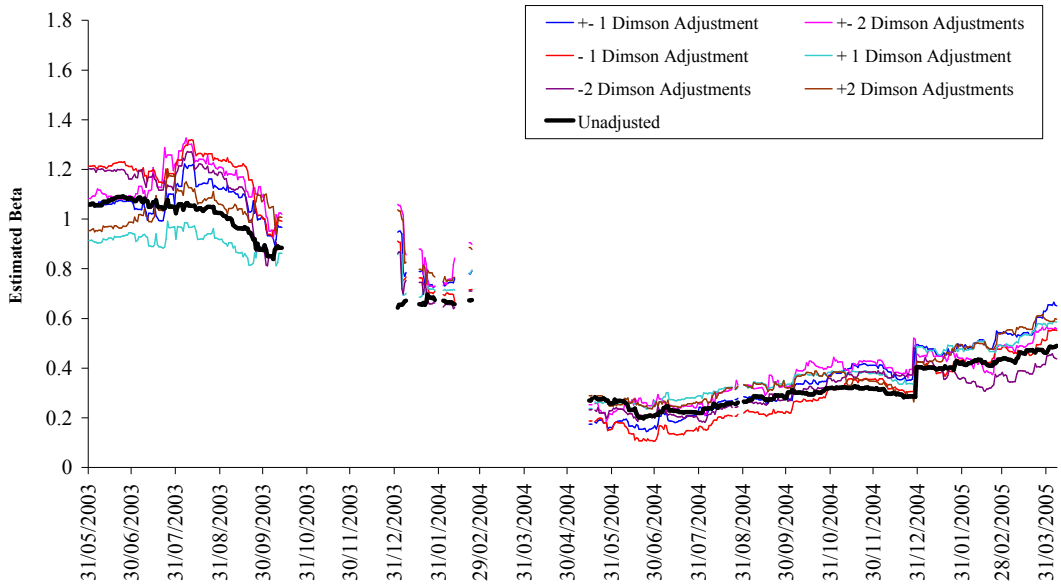


Both the significant and insignificant Dimson adjustments are below the unadjusted estimate.

All World

Figure 8 details the development of our estimate of beta against the All World index. We show Dimson adjusted estimates even when they are not statistically significant. We omit estimates that exhibit both heteroscedasticity and autocorrelation.

Figure 8: Beta estimates against the All World index.



We are concerned that recent international events may have temporarily shifted the risk profile of domestic firms in relation to the global market. Beta estimates as low as 0.2 cannot represent a serious medium-term assessment of the risk of investing in BT. Since mid 2004, estimates of beta across the preceding 12 months have slowly climbed to 0.5. We suspect this may represent the data window covering a diminishing amount of time when international investors had concerns linked to the invasion of Iraq.

Summary

Table 5 details our results.

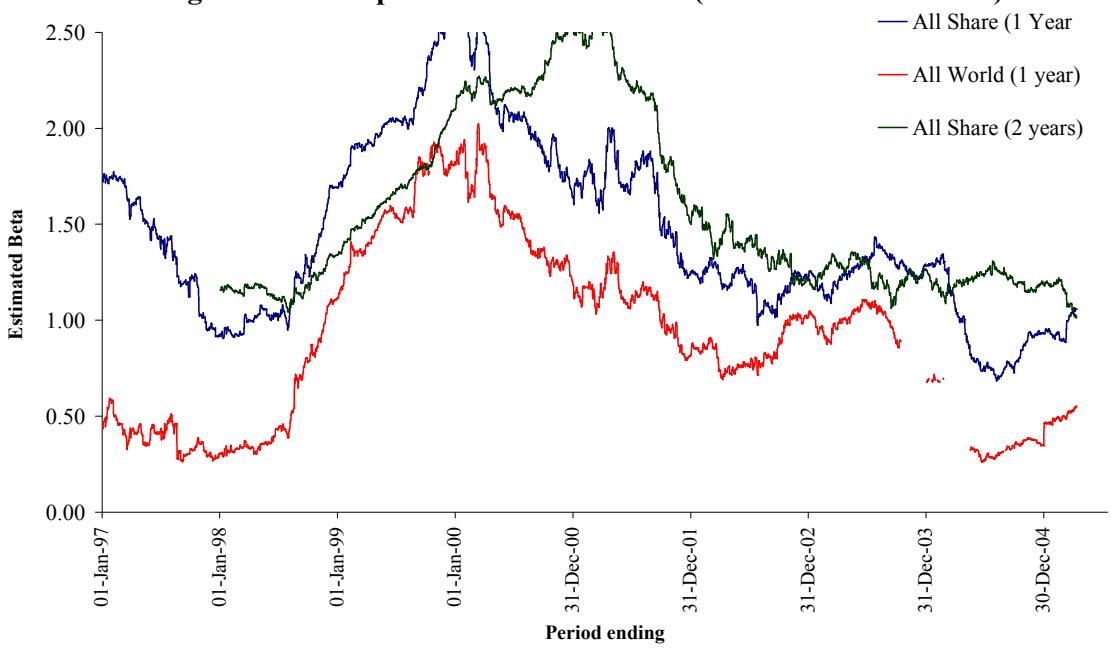
Table 5: BT Group Beta Estimates (series ending 11 April 2005)

		1 Year of Data				2 Years of Data			
		Beta Estimate	SE	Dimson T-Stat	Dimson P-Stat	Beta Estimate	SE	Dimson T-Stat	Dimson P-Stat
FTSE All Share	**Unadjusted Estimate**								
	Unadjusted Estimate	1.01	0.11			1.01	0.09		
	Dimson Adjustments								
	+- 1 Dimson Adjustment	1.07	0.20	0.34	26%	0.88	0.15	0.95	66%
	+- 2 Dimson Adjustments	0.74	0.26	1.28	80%	0.61	0.19	2.26	98%
	- 1 Dimson Adjustment	1.09	0.17	0.61	46%	0.94	0.12	0.67	50%
	+ 1 Dimson Adjustment	0.99	0.17	0.13	11%	0.94	0.12	0.83	59%
	- 2 Dimson Adjustments	0.80	0.20	1.48	86%	0.63	0.15	3.12	100%
	+ 2 Dimson Adjustments	0.97	0.20	0.21	16%	0.99	0.15	0.14	11%
FTSE All World	**Unadjusted Estimate**								
	Unadjusted Estimate	0.49	0.09						
	Dimson Adjustments								
	+- 1 Dimson Adjustment	0.66	0.15	1.37	83%				
	+- 2 Dimson Adjustments	0.57	0.20	0.42	32%				
	- 1 Dimson Adjustment	0.56	0.12	0.74	54%				
	+ 1 Dimson Adjustment	0.58	0.12	1.11	73%				
	- 2 Dimson Adjustments	0.45	0.15	0.40	31%				
	+ 2 Dimson Adjustments	0.60	0.15	0.89	63%				

Comparison to previous estimate

We compare beta estimates at 40% debt using both 1 and 2 year data windows in Figure 9.

Figure 9: Development of beta estimates (relevered to 40% debt)



Neither our current nor our previous estimates are outliers, and both are consistent with the general trend in BT's beta. As discussed in our previous report, using a two-year data window in February 2004 would have included information contaminated by the fall out from the dot-com bubble.

We note that our current estimate of beta is higher than any estimate produced in the past 12 months using only one year of data, and is comparable with estimates of BT's beta prior to the turn-of-the-century boom.

5 Conclusion

5.1 Summary Results

Against the All Share Index, the unadjusted beta appears to have decreased from approximately 1.29 at the time of our last estimate on 31st December 2003, to 1.01 using both 1 or 2 years of daily data ending on 11th April 2005. Estimates of beta using one year of data have varied widely, hitting a low of 0.66 when sampled on August 6th 2004. Estimates of beta over two years have been more stable, decreasing slightly over the last three months.

We also note that the –2 and ±2 Dimson adjustments on the 2-year regression are statistically significant at the 95% level and are some way lower than the unadjusted estimate. We therefore present a range of estimates for the two-year regression.

Against the All World, the unadjusted beta appears to have decreased from approximately 1.01 at the time of our last estimate, to 0.49 using a year of daily data ending on 11th April 2005. Estimates have also varied widely, reaching just 0.2 on the 23rd June 2004.

Table 6 summarises our current beta estimates.

Table 6: Current beta estimates

	Beta Estimate	Standard Error
FTSE All Share		
2 Years of Daily Data, 12/4/03 - 11/4/05		
Unadjusted Estimate	1.01	0.09
+-2 Dimson Adjustments	0.61	0.19
-2 Dimson Adjustments	0.63	0.15
FTSE All World		
1 Year of Daily Data, 12/4/04 - 11/4/05		
Unadjusted Estimate	0.49	0.09

5.2 Discussion

The range in estimates presented is large. In particular, we believe that a drop in the All Share beta from 1.29 to 0.61 between December 2003 and April 2005 seems unrealistic without compelling evidence of a fundamental change in either the risk of BT Groups operations, or the ability of investors to diversify this risk. In addition, the unadjusted estimates using 1 and 2 years of data are almost identical. This apparent stability in beta over the past two years leads us to recommend adopting an estimate at the top of the suggested range.

The beta measured against the All World is significantly lower. BT is likely to be a less risky investment than many international opportunities not included in the All Share, and the ability to diversify that risk is likely to be larger with the wider range of investment opportunities available. However, we suspect that recent international instability has contaminated the results against the All World index by temporarily shifting investors' risk profiles. We caution against assigning much significance to the current low estimates calculated using international indices.