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Beta Estimates for:

Scottish Power
Scottish & Southern Energy
Viridian Group
Centrica
International Power
National Grid Transco
United Utilities
Kelda Group
Severn Trent

provided to Ofgem

by

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Beta Estimates for Ofgem

1. Summary

This note reports on estimation results of the CAPM beta for the following nine companies:

Scottish Power
Scottish & Southern Energy
Viridian Group
Centrica
International Power
National Grid Transco
United Utilities
Kelda Group
Severn Trent

Estimation was carried out using monthly, weekly and daily data from the early 1990s onwards (where available). The market proxy used is the FT All Share Index ; we also examine for comparative purposes the impact of using a broader based market index. Returns on both individual companies and the market are measured as log excess returns over the safe rate, with base rates used as the proxy for the safe rate, converted appropriately for the relevant frequency (see Appendix for details of data and estimation results).

Table 1 overleaf gives the relevant estimates, together with both OLS standard errors and Newey-West robust standard errors. In general estimates from samples of different frequencies are fairly similar; though there is one conspicuous exception (International Power) which is discussed in more detail below. As is to be expected, daily estimates appear significantly better determined. Using daily data, all companies have betas well below unity.

We have also calculated Bayesian adjustments to our beta estimates, that correct for the known downward bias in OLS coefficients, and for the prior information that the average firm must have a beta of unity. These (which are shown in Table 2) typically make little difference, since the beta estimates are generally very well determined. Table 2 shows that using the broader market index also has a minimal impact on beta estimates.

"Alpha" coefficients are all insignificantly different from zero (as theory would predict).

To examine the important issue of possibly time variation in company betas, we have also run rolling regressions at all frequencies, and have carried out parameter stability tests. These point to possible parameter instability in a number of cases that should point to a degree of caution in concluding that beta estimates are in all cases as well-determined as might appear from simply looking at whole-sample estimates.

In the rest of this document we examine the estimation results in more detail. An appendix provides detailed regression output and other detailed information.

Table 1: Beta Estimates for the Full Sample Periods, Using FT All Share as Market Index

	Beta	OLS standard Errors	White s.e.	Newey West s.e.	No. Observations
Scottish Power					
Monthly	0.7311	0.1694	0.2493	0.2881	149
Weekly	0.6861	0.0815	0.0933	0.1212	648
Daily	0.6978	0.0358	0.0412	0.0781	2967
Scottish & Southern					
Monthly	0.4596	0.0767	0.0875	0.1900	147
Weekly	0.6349	0.1724	0.2676	0.3475	641
Daily	0.4872	0.0344	0.0478	0.0844	2967
Viridian					
Monthly	0.3141	0.1660	0.1749	0.2035	126
Weekly	0.1870	0.0777	0.1034	0.0689	548
Daily	0.1842	0.0300	0.0359	0.0430	2660
Centrica					
Monthly	0.7618	0.1806	0.1743	0.1733	82
Weekly	0.6959	0.0927	0.0973	0.0979	358
Daily	0.6794	0.0430	0.0500	0.1225	1738
International Power					
Monthly	2.2121	0.2823	0.3493	0.3111	38
Weekly	1.1602	0.1545	0.1869	0.1319	168
Daily	0.7099	0.0664	0.0793	0.0731	819
National Grid					
Monthly	0.4659	0.1378	0.1435	0.1140	97
Weekly	0.5504	0.0693	0.0929	0.1004	422
Daily	0.6304	0.0307	0.0358	0.0486	2045
United Utilities					
Monthly	0.5409	0.1057	0.1152	0.1857	161
Weekly	0.5466	0.0638	0.0832	0.1309	701
Daily	0.5907	0.0291	0.0461	0.0718	2967
Kelda Group					
Monthly	0.5287	0.1345	0.1670	0.2000	149
Weekly	0.3719	0.0767	0.1101	0.1436	650
Daily	0.3020	0.0340	0.0515	0.0676	2967
Seven Trent					
Monthly	0.4180	0.1274	0.1378	0.2339	149
Weekly	0.3639	0.0689	0.0964	0.1869	650
Daily	0.4419	0.0292	0.0442	0.0875	2967

Table 2. Alternative Beta Estimates (Daily Data)

	OLS Estimate using FTAS	Bayesian-Adjusted	OLS Estimate using Broader Market Index
Scottish Power	0.6978	0.7008	0.6999
Scottish & Southern	0.4872	0.4918	0.4761
Viridian	0.1842	0.1898	0.1874
Centrica	0.6794	0.6839	0.6796
International Power	0.7099	0.7194	0.7343
National Grid	0.6304	0.6331	0.6455
United Utilities	0.5907	0.5933	0.6023
Kelda Group	0.3020	0.3082	0.3057
Seven Trent	0.4419	0.4455	0.4502

2. Detailed Estimation Results: General Observations

Table 1 provides beta estimates over all available data (the number of observations is given in the last column of the table). The table also provides three alternative measures of the "standard error" of the beta estimate: the larger the standard error, the more imprecisely the parameter is estimated. Standard errors can be used to construct "confidence intervals" for beta estimates, as shown the charts in Section 3 for individual companies. The standard errors using the standard Ordinary Least Squares (OLS) formula are known to understate the true degree of uncertainty, particularly in high frequency data; the alternative measures take this into account, and are typically significantly larger, implying in turn wider confidence intervals.

Table 2 compares three different beta estimates, again derived from all available daily data. The first is as given in Table 1. The second includes a "Bayesian Adjustment". This takes into account the fact that the beta of the average firm must be one. Thus if we had no data at all our best guess would be that all firms would have a beta of one. Our statistical estimates will typically lead us to move significantly away from this first guess, but, since our beta estimates are not known precisely, the Bayesian adjustment pushes beta towards one, to a greater extent, the less precisely beta is estimated. Since, using daily data, beta is quite precisely estimated, the adjustment has only a very minor effect (the same does not apply in the case of monthly estimates – discussed below in relation to beta estimates from the London Business School).

In Section 3, some commentary is provided on individual beta estimates. These are accompanied by charts of rolling beta estimates (at all three frequencies) and associated 95% confidence intervals.[1] In each case, the beta estimate shown is for a five year sample ending in the period shown: thus the first point shown in the plot of the daily beta estimate is for the earliest available five year sample (which varies from company to company); the last point comes from a sample running from December 1998 to December 2003. The bottom panel of each chart also shows (on a log scale) the relevant share price and the FT All Share Index, to put the beta estimates in historical context.[2]

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[1] The confidence interval is a range above and below the point estimate that we can be 95% certain contains the true (but unobservable) value of beta. It is constructed by adding or subtracting 1.96 times the coefficient standard error from the point estimate.

[2] Note that the time axes of the charts are not directly comparable, since the bottom panel includes all available data.

It should be noted that our rolling monthly beta estimates are not directly comparable with those produced by the LBS. Theirs are also rolling estimates, typically using monthly data over five years. However, they also apply the Bayesian adjustment on a rolling basis, which tends to push resulting beta estimates towards one. The adjustment is larger, the more imprecisely beta is estimated. Since the rolling samples contain only relatively few observations, the monthly beta estimates are not very precisely estimated, and as a result the Bayesian adjustments applied by LBS for some companies push rolling betas quite significantly towards one. When we compare our monthly beta estimates on a rolling Bayesian-adjusted basis with those of the LBS the results are very similar indeed, and show an almost identical pattern over time.

The Appendix provides details of data transformations, full estimation results for the estimation using daily data[3], and plots of CUSUM and CUSUMSQ statistics[4] that provide diagnostic tests of parameter instability.

Before proceeding to examine individual company results, a few general observations are in order, since there are a number of common features across the companies.

- In virtually all cases, there is a clear ranking of the precision of the beta estimates, with higher frequency data increasing precision, even using robust standard errors.[5]
- Results using a broader based market index (with a weighting of 70% on the FT All Share, and 30% on the MSCI global index, converted to sterling) are also very little changed.
- As noted in the summary, “alpha” coefficients (the constant term in the CAPM equation) are all insignificantly different from zero, consistent with theory. It is worth noting, however, that for some companies the implied additional element in the return on these companies was economically, if not statistically quite significant.
- Beta estimates derived from daily data appear very well-determined. As a result, Bayesian adjustments make a very small difference to beta estimates, pushing them only marginally closer to unity.
- A crucial statistical caveat, however, is that the relatively small standard errors of the beta estimates are predicated on the assumption that the true value of beta has been constant. For a number of companies there is strong evidence of parameter instability shown by rolling regressions.

This last issue, of parameter instability, is potentially a very crucial one. It should be borne in mind that the standard errors attached to beta estimates are predicated on the assumption that the true beta is constant. Their validity is seriously undermined if there is evidence (as there appears to be for several companies) that beta has drifted over time.

In the most pessimistic interpretation, if beta can be expected to continue to drift indefinitely, the associated true standard errors must increase the further we look into the future. As an (admittedly extreme) example, if a given firm’s beta were modelled as a random walk, its variance would increase as a linear function of the forecast horizon. [6] Over the relatively long time horizons over which regulatory decisions are made, this would imply that the true required Bayesian adjustment would become much larger, since the further ahead we look, the less the history of beta tells us

[3] The focus is on daily data results because these appear to provide the most reliable beta estimates.

[4] See Appendix C for an explanation of these tests.

[5] Which are definitely required, since as the appendix shows, the properties of the residuals in daily estimation are very far from satisfying the white noise assumption required to use OLS standard errors. We have a preference for the Newey-West robust standard errors, since these correct for a wider range of non-white-noise error problems.

[6] A random walk would be the most extreme assumption because it would imply that at an infinite horizon a company’s beta could take literally any value, which is not plausible: if this were the case the cross-sectional variance of beta across companies would also be infinite, which it clearly is not.

about its future value, and the more we would need to rely upon the unconditional expectation that the average firm must have a beta of unity.

Such a negative response would however probably be a little too pessimistic, since for most of the companies showing signs of parameter instability, this appears largely to have been a problem relatively early in their sample. In particular, it is striking that for those six companies for which data are available from the early 1990s onwards, there is a distinct common pattern: rolling beta estimates appear to fall in the early years of the sample, and then stabilise roughly in those samples that terminate from early 2000 onwards (and thus are based on data running from roughly 1995 onwards).

There are two possible explanations of this phenomenon that spring to mind.

The first is that in the early years a number of these companies were relatively new, and their properties were therefore relatively unknown; whereas by the later sample periods, they had become more familiar to the markets, and therefore their betas began to settle down.

A second possible explanation is unrelated to the companies themselves, but relates to the nature of broader market developments. Early 2000 was of course the peak in global stock markets, and was followed by a significant bear market. It is possible that a number of these companies were viewed as having a particular advantage as relatively safe investments in the bear market, and that this brought down their betas. However, while there may be something to this story, it is unlikely to be the sole explanation, since it should be borne in mind that most beta estimates appear to have stabilised across a range of subsequent samples, in which the proportion of the sample made up by the bear market period changed significantly, without apparently changing the resulting beta.

If we fall back primarily on the first explanation, that beta estimates have stabilised as the firms have become better known, then there is relatively less reason to worry about parameter instability. But it would also suggest that estimates based on all available data should possibly be adjusted somewhat to be more in line with estimates from the later, more stable, samples. In most cases where instability has been a problem, this would result in slight downward adjustments to beta estimates.

To summarise on this crucial issue of parameter instability, we are left with two key factors that need to be weighed up in considering beta estimates. Unfortunately, they point in opposite directions for a number of companies under examination:

- Other things being equal, evidence of parameter instability makes beta estimates more uncertain as we look further into the future, and thus should lead us to set relatively more weight on the unconditional expectation of unity. For all the companies examined, this would point to an **upward** adjustment to beta estimates (since all are below unity, on daily data);
- On the other hand if we are prepared to believe that early instability related to markets learning about these companies, more recent, and lower beta estimates would point to a **downward** adjustment to estimates derived from the whole sample.

We are not in a position to weigh the relative importance of these two factors on statistical grounds alone, although in two specific cases (Viridian and Centrica) the balance of evidence does appear to be tilted fairly clearly in the direction of an upward adjustment. In the remainder, however, we trust that Ofgem's superior knowledge of the companies will help in this assessment.

3. Details on Individual Companies

3.1 Beta Estimates for Scottish Power

Whole-sample beta estimates shown in Table 1 appear quite well determined, with little disagreement between estimates at different frequencies. All suggest a point estimate of around 0.7, with a 95% confidence interval of roughly 0.15 either side (using conservative Newey-West standard errors).

Panels a, b and c of Chart 1, which show rolling estimates of beta, suggest strongly that beta has not been constant over time. The Appendix shows that the evidence in Chart 1 is supported by the CUSUM and CUSUMSQ statistics that are used to diagnose parameter instability: both of these breach 95% bounds by a significant margin in the earlier samples. However if the two tests are carried out only on the last five years' worth of daily data, the CUSUM test no longer rejects (this can be seen from the fact that in the chart in the appendix the CUSUM statistic does not continue to diverge from the 95% lower bound after roughly the first 1000 observations) and the CUSUMSQ test is distinctly more marginal. The resulting point estimates for beta over these shorter samples are around 0.6.

Thus if it is plausible to assume that the beta of Scottish Power may have stabilised in recent years, we can be fairly confident that its true beta lies fairly close to 0.6. Some supporting evidence for this view can be drawn from the bottom panel of Chart 1, which suggests that at the start of the sample, Scottish Power's share price appears to have led something close to a life of its own (presumably affected strongly by idiosyncratic factors linked to its initial formation); it was during this period that most of the out-performance of the market occurred. In contrast, from the late 1990s onwards it appears to have behaved much more like a "typical" stock, with no particular tendency to out- or under-perform.[7]

[7] The log scale in this panel of the chart means that if any gap between the two series remains constant, they are moving by approximately equal percentage amounts.

Chart 1a. Scottish Power Monthly Rolling Beta Coefficient (5 yr window)

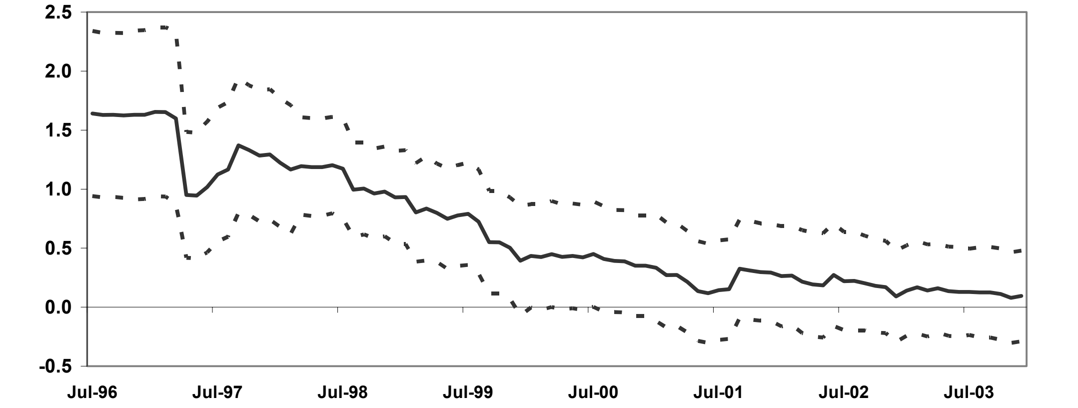


Chart 1b. Scottish Power Weekly Rolling Beta Coefficient (5 yr window)

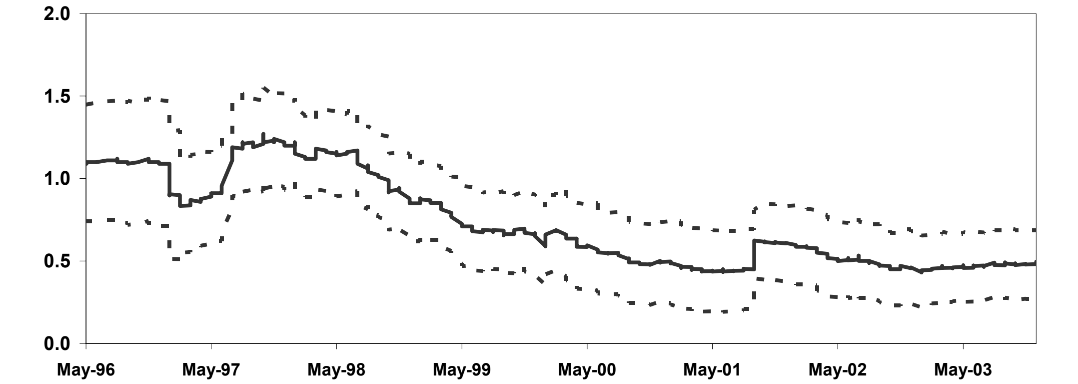


Chart 1c. Scottish Power Daily Rolling Beta Coefficient (5 yr window)

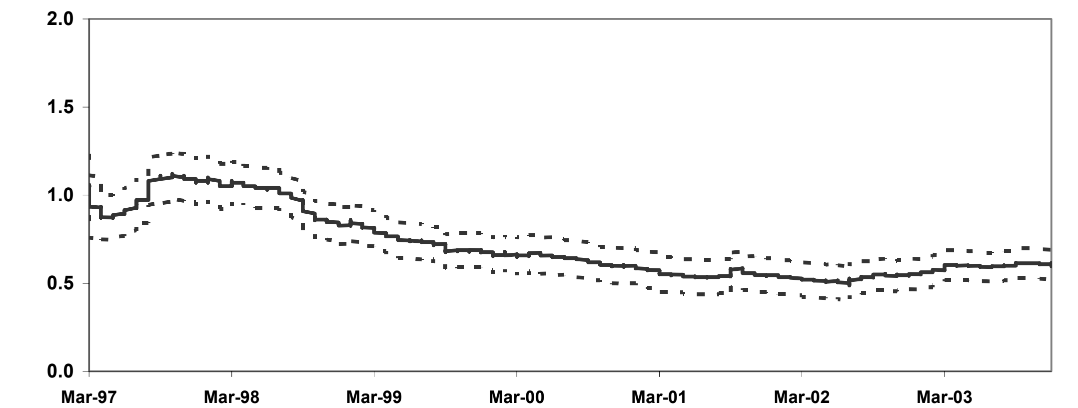
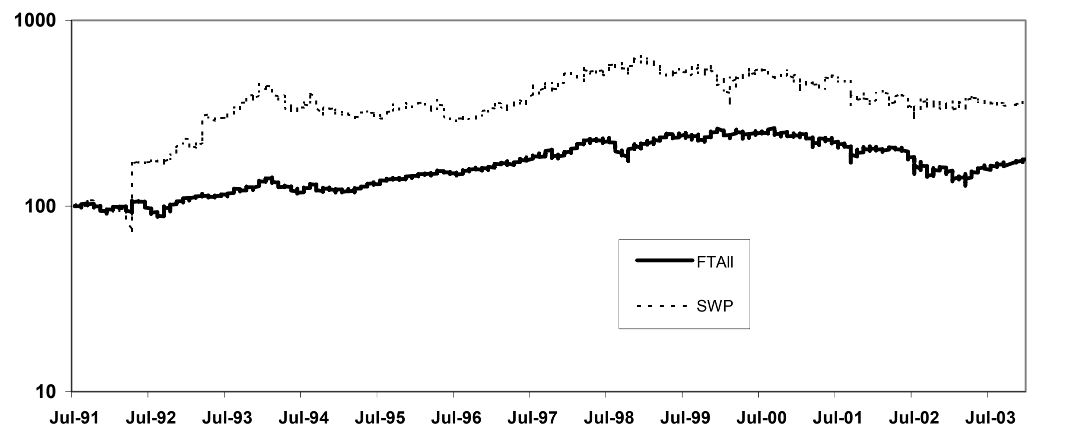


Chart 1d. Scottish Power and FTAll Share Price Indices (July 1991=100)



3.2. Beta Estimates for Scottish and Southern Energy

A fairly similar pattern can be seen in the results for Scottish and Southern to those described for Scottish Power, albeit that the evidence points to a somewhat lower beta value. Whole-sample beta estimates shown in Table 1 suggest a point estimate of just under 0.5, with a 95% confidence interval of roughly 0.16 either side (using Newey-West standard errors).

There is however again evidence of parameter instability, of a very similar pattern, with Chart 2 showing the beta estimate declining in earlier samples, but apparently stabilising in samples that terminate roughly from 2000 onwards. This is again reflected in the CUSUM statistic, shown in the Appendix, which breaches the 95% bound quite markedly in the early samples, but then if anything moves back towards it in later samples – again indicating that in the later samples the evidence of parameter instability is distinctly weaker.

Again, the bottom panel of Chart 2 points to early out-performance of the market in the earlier years, but a much more stable relationship thereafter. Note however that this stock proved a fairly good hedge against the prevailing downward movements in the market after the peak in 2000; this is reflected in its lower beta estimate.

Again, if it is assumed that the stock has now "settled down", then its beta estimate from recent years of around 0.4 may be a better estimate than that derived from the whole sample

Chart 2a. Scottish & Southern Energy Monthly Rolling Beta Coefficient (5 yr window)

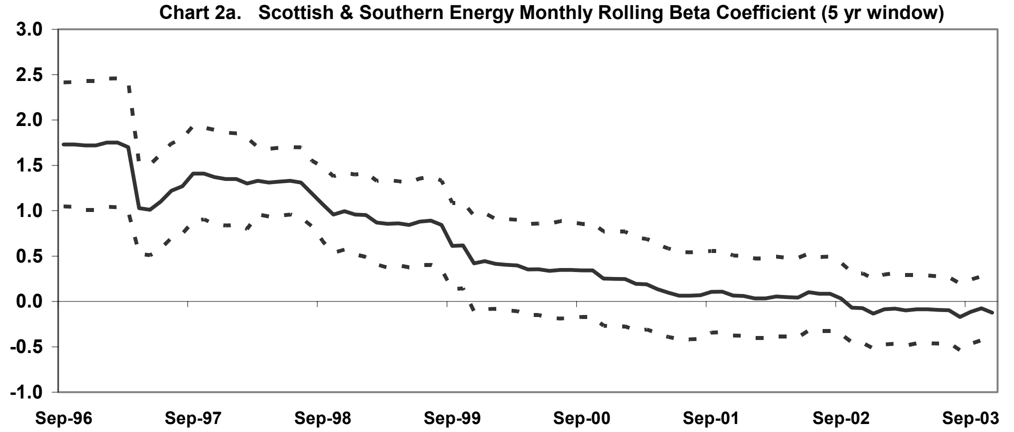


Chart 2b. Scottish &Southern Energy Weekly Rolling Beta Coefficient (5 yr window)

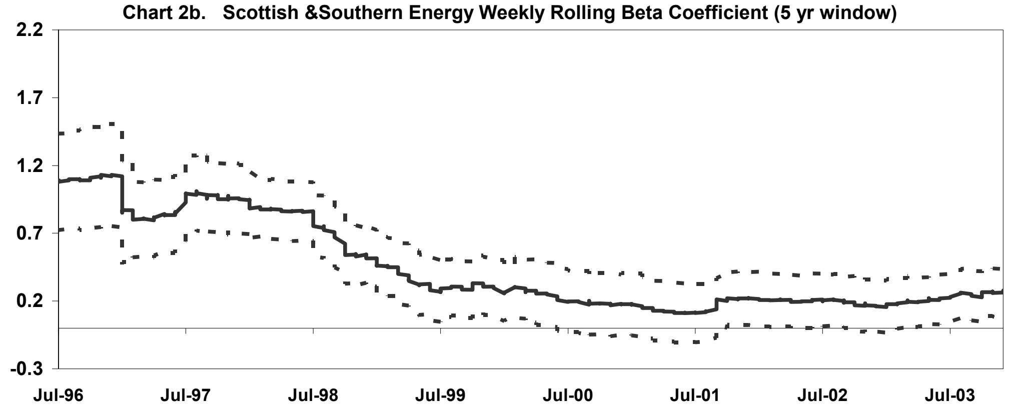


Chart 2c. Scottish & Southern Energy Daily Rolling Beta Coefficient (5 yr window)

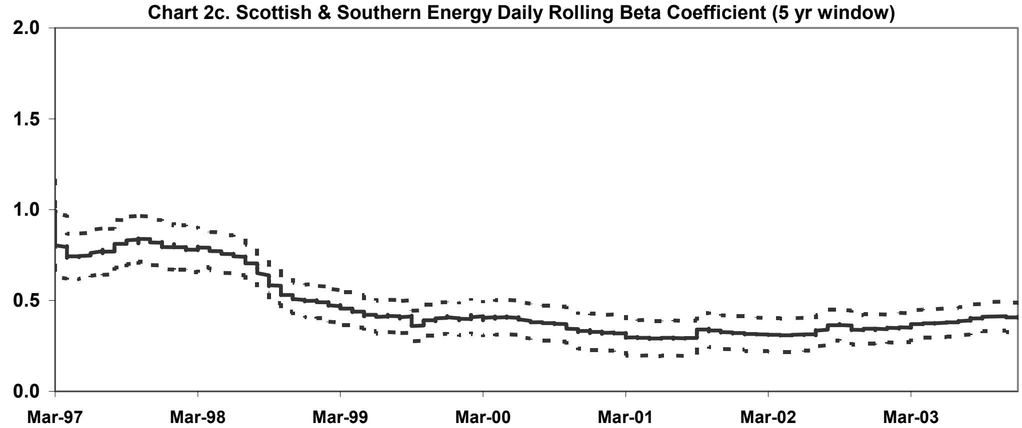
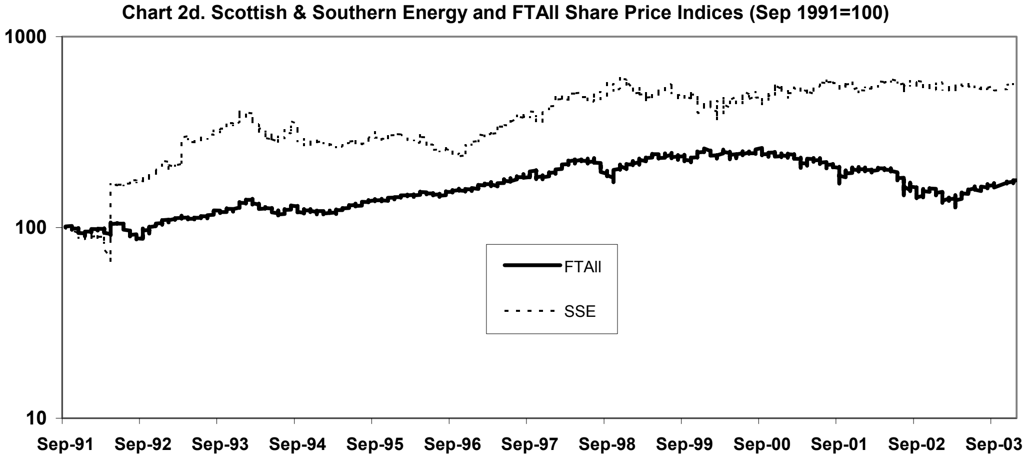


Chart 2d. Scottish & Southern Energy and FTAll Share Price Indices (Sep 1991=100)



3.3. Beta Estimates for Viridian

This company has the lowest whole sample beta estimate of all the companies examined: the point estimate is 0.18, with a 95% confidence interval of around 0.8 either side (hence, though very small, the beta estimate is still significantly different from zero).

It also again displays a somewhat similar pattern of a declining beta estimate; though even more markedly so, and, worryingly, with rather less evidence that beta has stabilised in more recent samples. The CUSUM statistic breaches the 95% bound rather later, and shows some signs of continuing to diverge (albeit less rapidly); this reflects the fact that beta estimates continue to decline in later samples (unlike the previous two companies).

Again, this pattern of the beta estimate reflects the share price's early sharp out-performance of the market index, followed by stabilisation.

In the last available sample of daily data, Viridian's beta had fallen below 0.1. This is however so low (indicating that Viridian should be priced more or less as a risk-free asset) that it would be wise to be cautious before employing such a low value, especially given the evidence of continuing drift. Here, the balance would seem to be tilted rather more strongly in favour of erring in an upward direction, given that future values of Viridian's beta must be treated as very uncertain.

Chart 3a. Viridian Group Monthly Rolling Beta Coefficient (5 yr window)

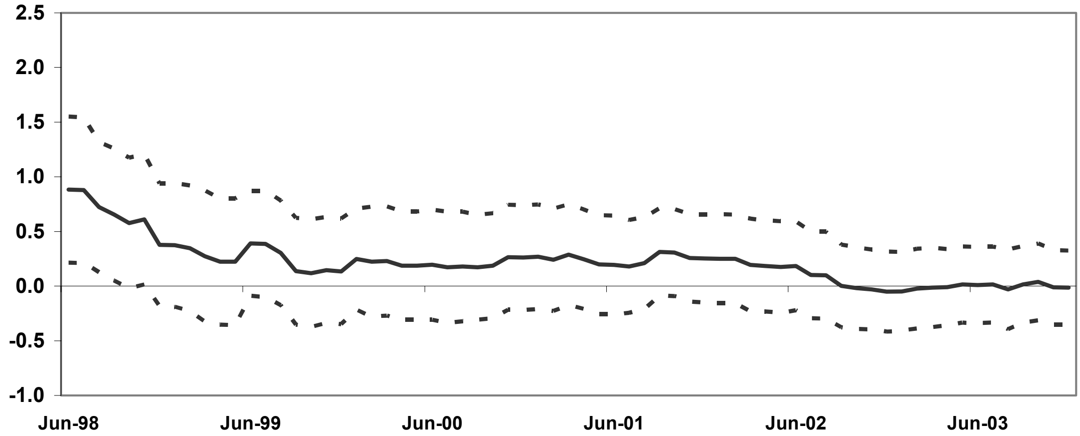


Chart 3b. Viridian Group Weekly Rolling Beta Coefficient (5 yr window)

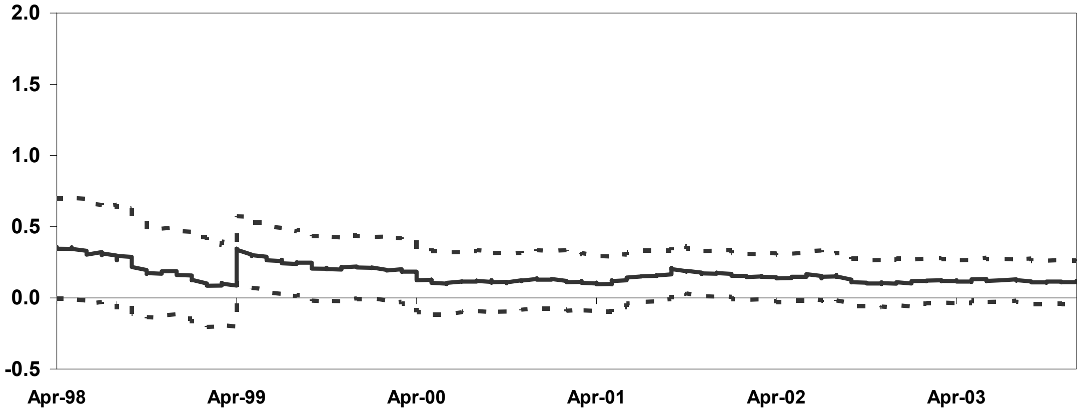


Chart 3c. Viridian Group Daily Rolling Beta Coefficient (5 yr window)

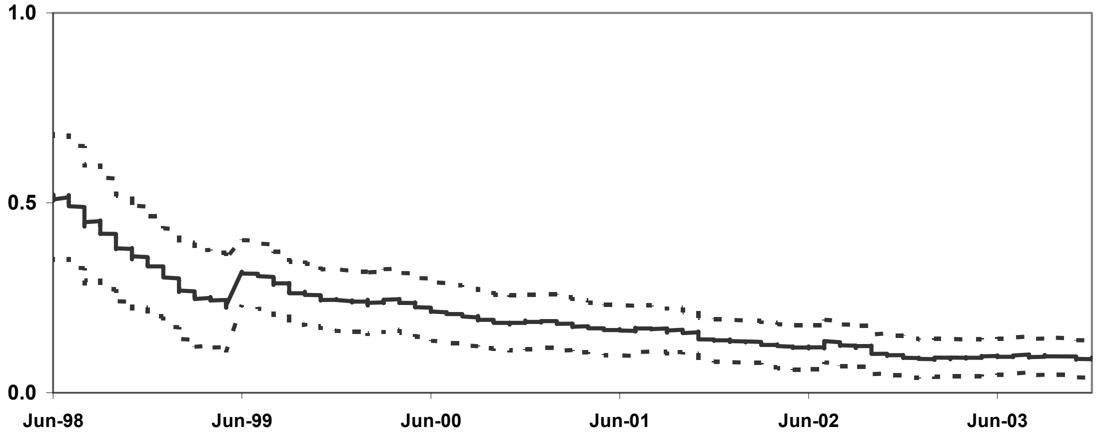
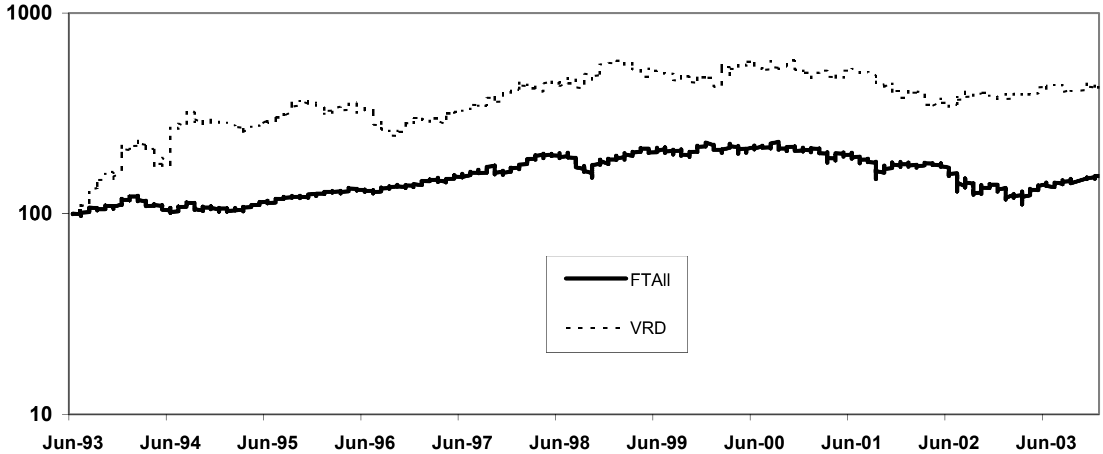


Chart 3d. Viridian Group and FTAll Share Price Indices (Jun 1993=100)



3.4. Beta Estimates for Centrica

This company has a point estimate of beta of just under 0.68, with a rather wider confidence interval (the widest of the companies examined) of around 0.24 either side of the central value, using Newey-West standard errors.

The statistical evidence of parameter instability is distinctly less strong than in the first three companies examined. The plots of the CUSUM and CUSUMSQ statistics in the Appendix are well within the 95% bounds for the former, and only briefly breach them in the latter. However, the path of the rolling beta estimates (here derived from rolling four year samples, given the somewhat shorter sample) shown in Chart 4 is quite distinct (and clearly visible in estimates at all three frequencies): namely a stable path until samples terminating on or after mid-2002, then a step up, then again stability. This step up is so distinct that it suggests the possibility that it may have been due to some structural shift either being included in the sample from the period after 2002, or being *ex*cluded from the sample from an earlier period. The most likely explanation would appear to be the exclusion of the very large jump-up in Centrica's share price in September 1998, which, being unrelated to general market movements, would tend to have lowered the beta estimate in samples containing this highly exceptional period.

Ofgem's superior knowledge of the company may make it possible to identify the cause of this shift: but the results do seem to point to two distinct periods: the first in which Centrica had a beta of around 0.5, the second, in which its beta was around 0.75. The whole-sample point estimate of around 0.68 can be viewed as essentially an average of these two values.

In contrast to the previous three companies examined, in the case of Centrica the pattern of parameter instability points fairly unambiguously to erring towards an upward adjustment to the whole-sample beta estimate, whatever the explanation of the instability. If Ofgem can identify a structural shift that can explain an upward movement in beta in more recent samples, this would point towards using the value of around 0.75 from more recent samples. But if no such explanation can be found, the evidence of unexplained parameter instability would *still* point in the same direction, since over longer forecast horizons, the statistical best guess of beta would in any case tend towards unity.

Chart 4a. Centrica Monthly Rolling Beta Coefficient (4 yr window)

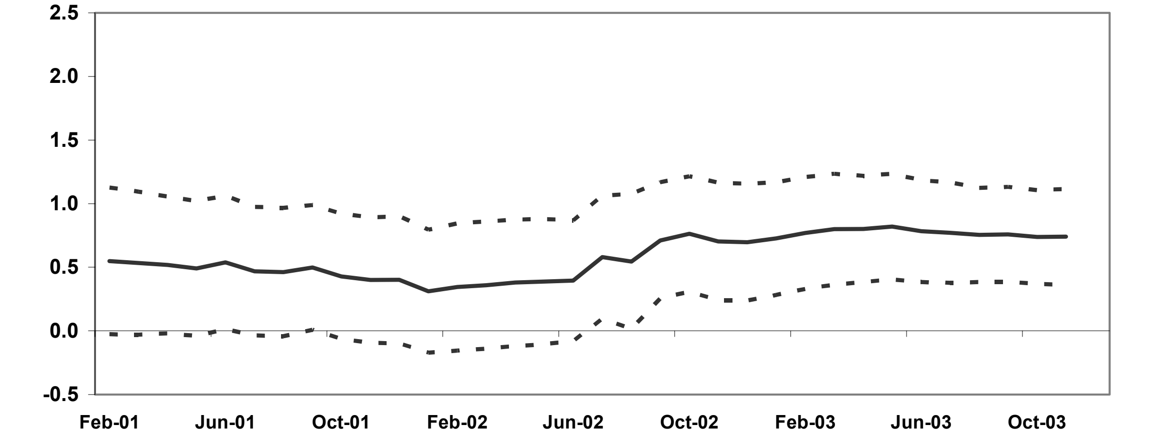


Chart 4b. Centrica Weekly Rolling Beta Coefficient (4 yr window)

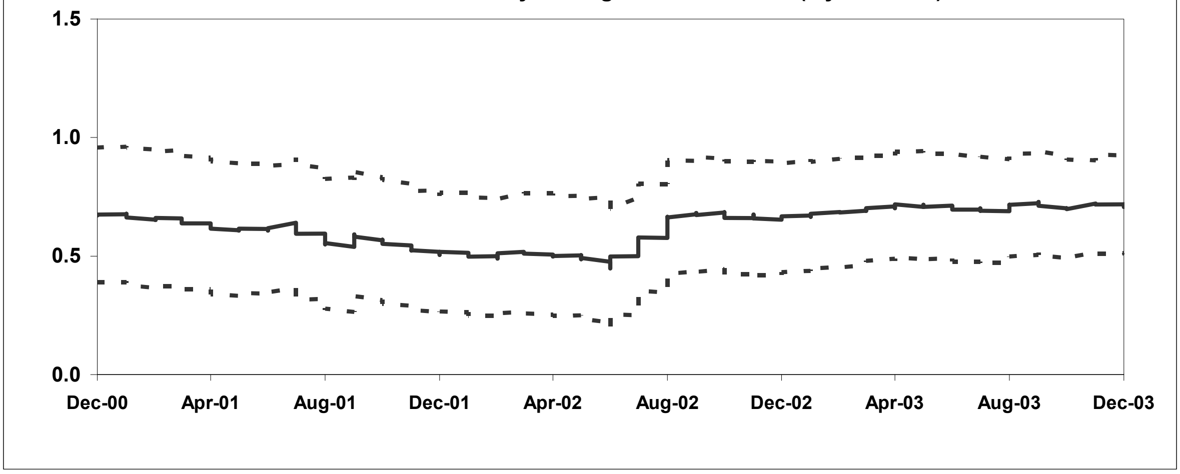


Chart 4c. Centrica Daily Rolling Beta Coefficient (4 yr window)

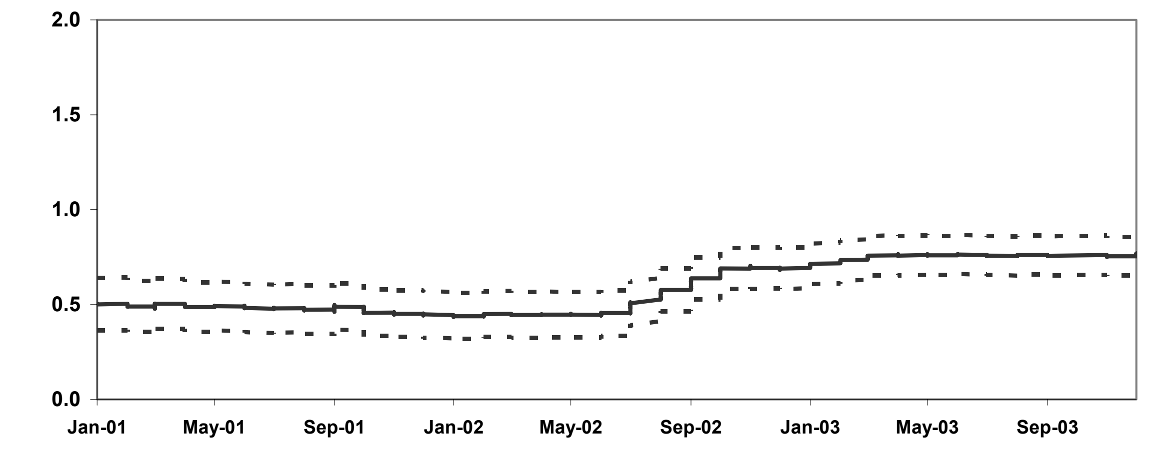
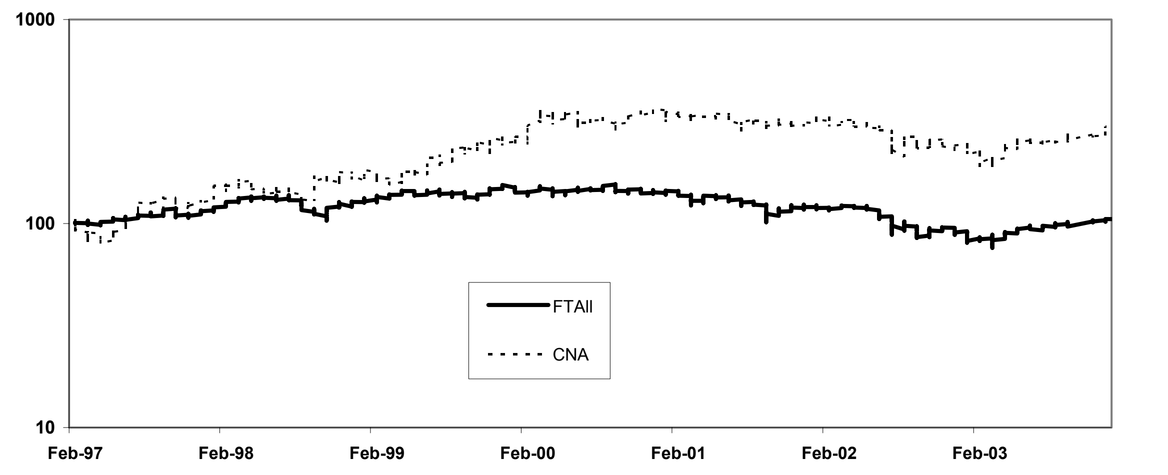


Chart 4d. Centrica and FTAll Share Price Indices (Feb 1997=100)



3.5. Beta Estimates for International Power

On the basis of estimation using daily data alone, the beta estimate for International Power appears to be fairly "well-behaved" in statistical terms. The point estimate from the (relatively short) whole sample is just over 0.7, with a 95% confidence interval of around 0.14 either side of this estimate. Neither the plots of rolling beta estimates (here based on 2 year rolling windows, given the very much shorter total sample length), nor the CUSUM and CUSUMSQ statistics in the Appendix appear to point to any sign of parameter instability.

It is worth noting that this is one of only two companies with a negative alpha coefficient on daily data (albeit, as in the other cases, not statistically significantly so), reflecting this company's general tendency to under-perform the market.

The only statistical fly in the ointment is the rather striking contrast between beta estimates from different frequencies. In the case of none of the other companies examined is this contrast so marked. On monthly data the estimated value of beta is no less than 2.2.[8] Were this the true value, it would be well out in the tail of the cross-sectional distribution of beta. However, this value appears to be a result of a particularly short sample (only just over three years' worth of data), in which the market index was predominantly falling, and International Power's share price fell even faster.

While the result using monthly data does seem to be something of a statistical freak, it should perhaps be a reminder that, even though daily data provide far more (819) observations, the sample used was nonetheless quite short in terms of calendar time, and was indeed predominantly a period of bear market. It would be easier to feel confident of the beta estimate for this company if it was based on a more "typical" historical sample. Nonetheless, there appears no obvious reason to deviate from the value of around 0.7 derived from all available data.

[8] A similar figure to that provided by Bloomberg's, also using monthly data.

Chart 5a. International Power Monthly Rolling Beta Coefficient (2 yr window)

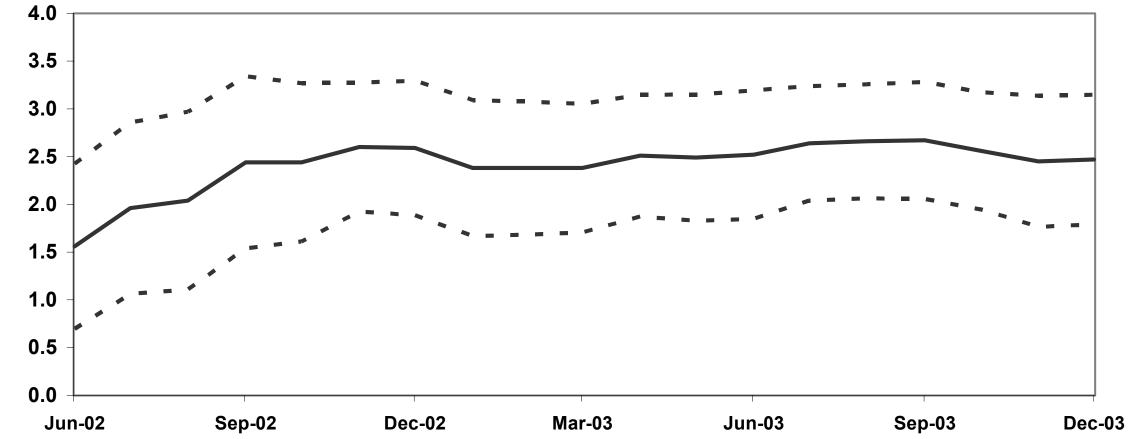


Chart 5b. International Power Weekly Rolling Beta Coefficient (2 yr window)

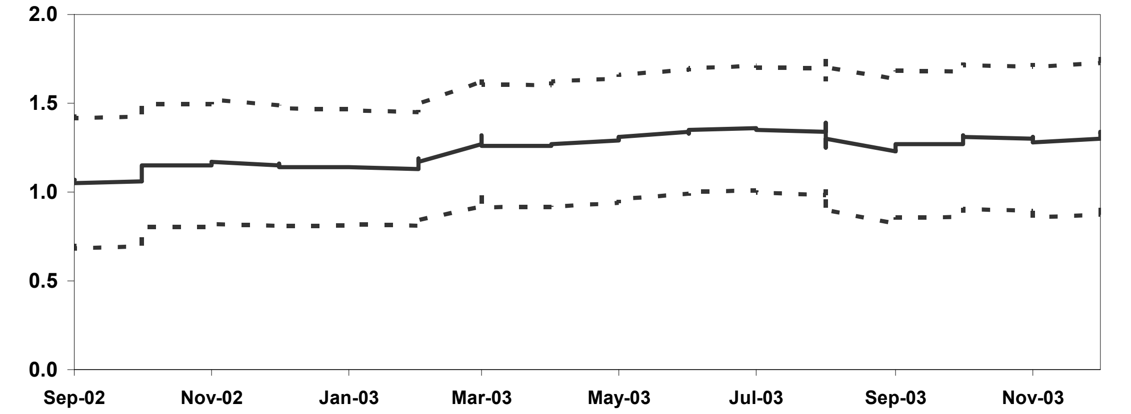


Chart 5c. International Power Daily Rolling Beta Coefficient (2 yr window)

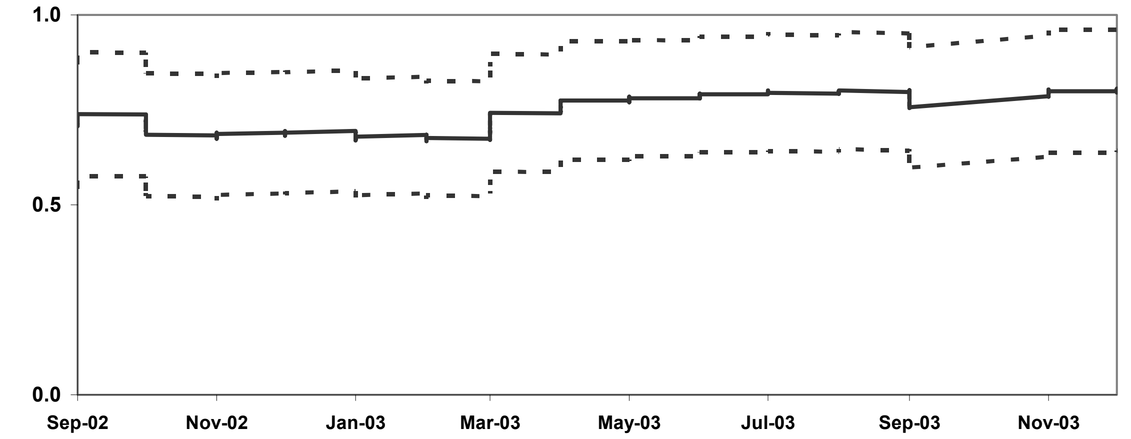
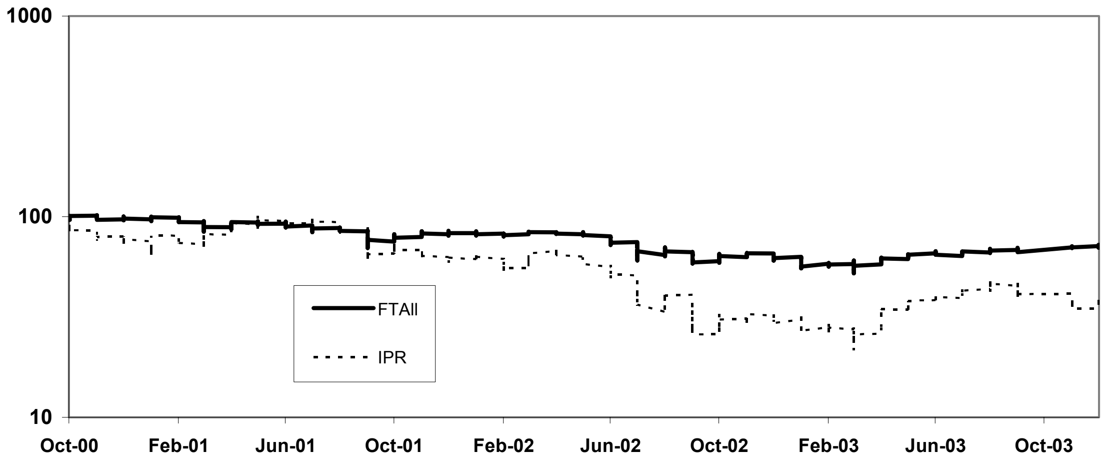


Chart 5d. International Power and FTAll Share Price Indices (Oct 2000=100)



3.6. Beta Estimates for National Grid Transco

As might be expected for a natural monopoly utility provider, this company appears to offer little in the way of surprises in terms of beta estimation. The point estimate of around 0.6 is well-determined (with a 95% confidence interval of less than 0.1 either side, using Newey-West standard errors), is fairly consistently estimated at different frequencies, and, crucially, shows no statistically significant evidence of parameter instability. There is a very modest downward drift in the rolling beta estimate using daily data (based on 4 year rolling windows), but the extent of this drift is so limited that it does not cause a breach of the 95% bounds on either CUSUM or CUSUMSQ test statistics.

In the case of National Grid Transco, there thus would appear to be no reason to depart from the whole-sample beta estimate of around 0.6.

Chart 6a. National Grid Monthly Rolling Beta Coefficient (4 yr window)

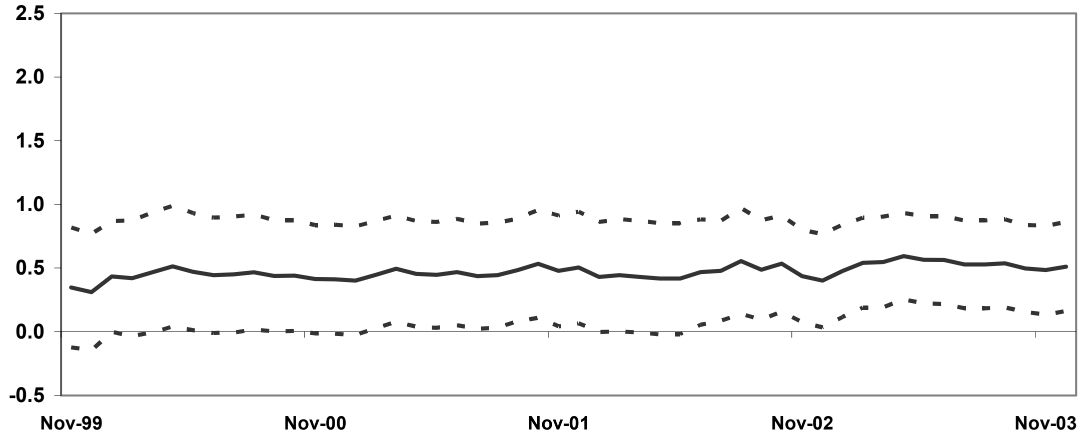


Chart 6b. National Grid Weekly Rolling Beta Coefficient (4 yr window)

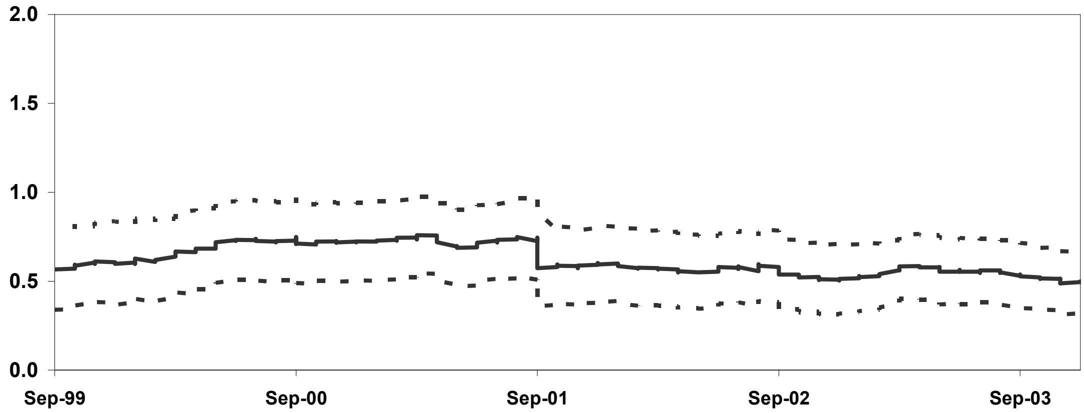


Chart 6c. National Grid Daily Rolling Beta Coefficient (4 yr window)

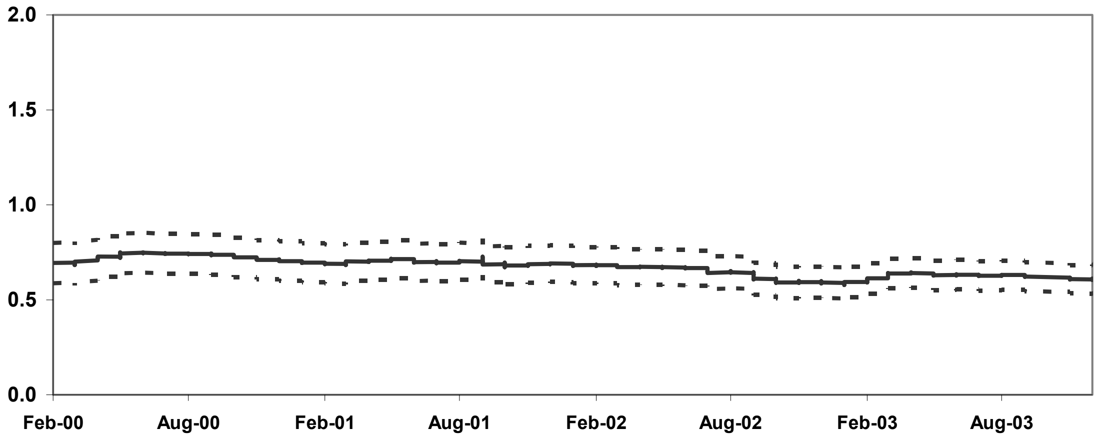
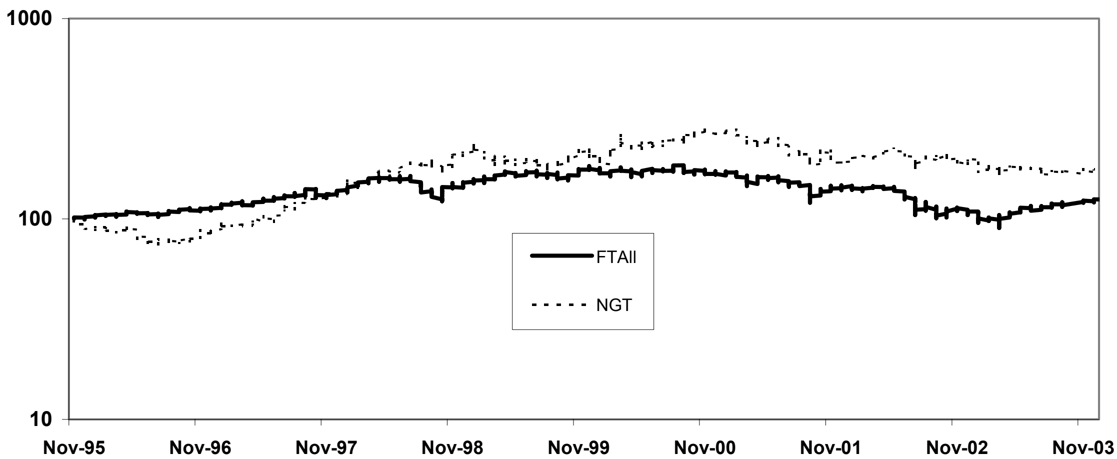


Chart 6d. National Grid and FTAll Share Price Indices (Nov 1995=100)



3.7. Beta Estimates for United Utilities

The whole-sample estimate of beta for this company is just under 0.6 based on daily data (and very similar based on other frequencies) with a 95% confidence interval of around 0.14 either side.

In terms of the pattern of beta estimates over time, this company again accords with the common pattern referred to in Section 2, of a declining tendency in beta in early samples followed by stabilisation in those samples terminating roughly from 2000 onwards. In the most recent samples United Utilities' beta appears to have stabilised at around 0.5.

However in this case the pattern, while visible in Chart 7, is not so strong as to be statistically significant (see relevant charts of statistics in Appendix). Hence, unless there are strong grounds, on the basis of prior information, to have expected a fall in beta, it would seem cautious to work on the basis of the full-sample estimate.

Chart 7a. United Utilities Monthly Rolling Beta Coefficient (5 yr window)

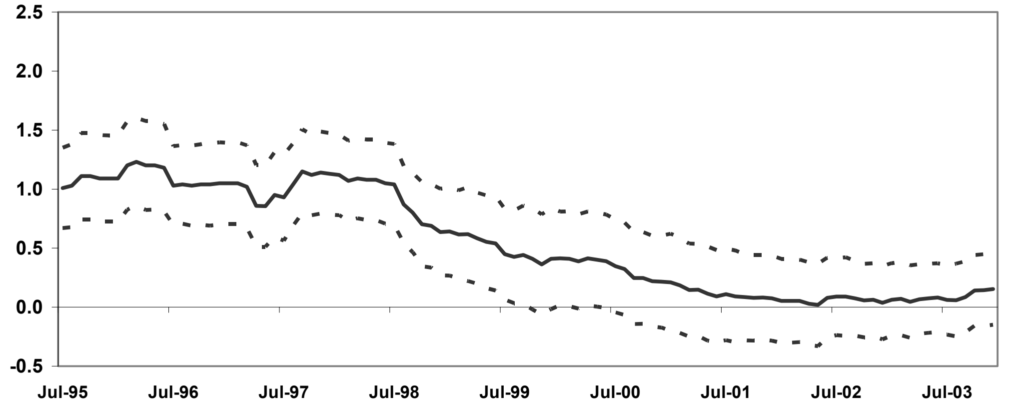


Chart 7b. United Utilities Weekly Rolling Beta Coefficient (5 yr window)

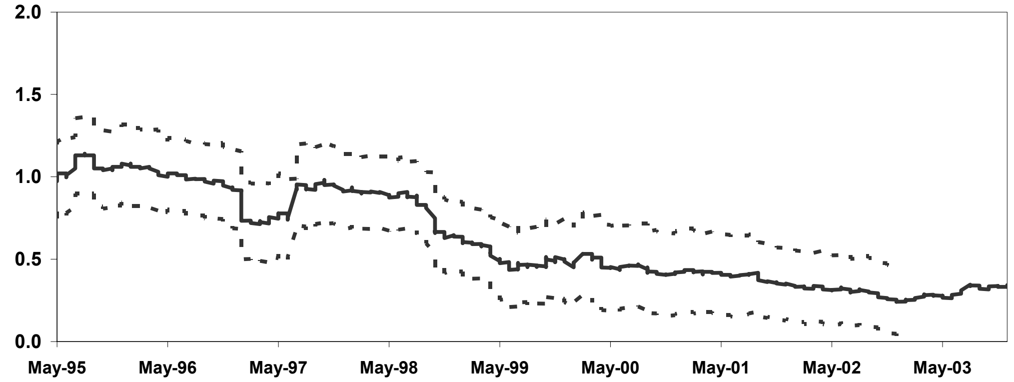


Chart 7c. United Utilities Daily Rolling Beta Coefficient (5 yr window)

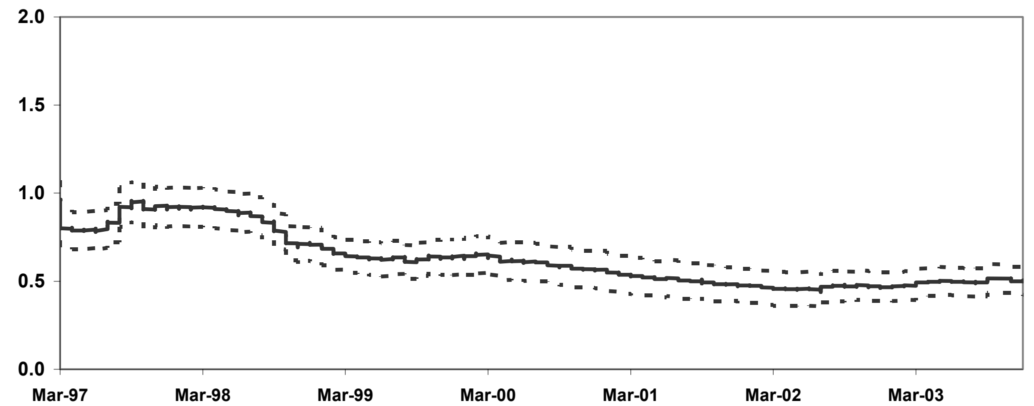
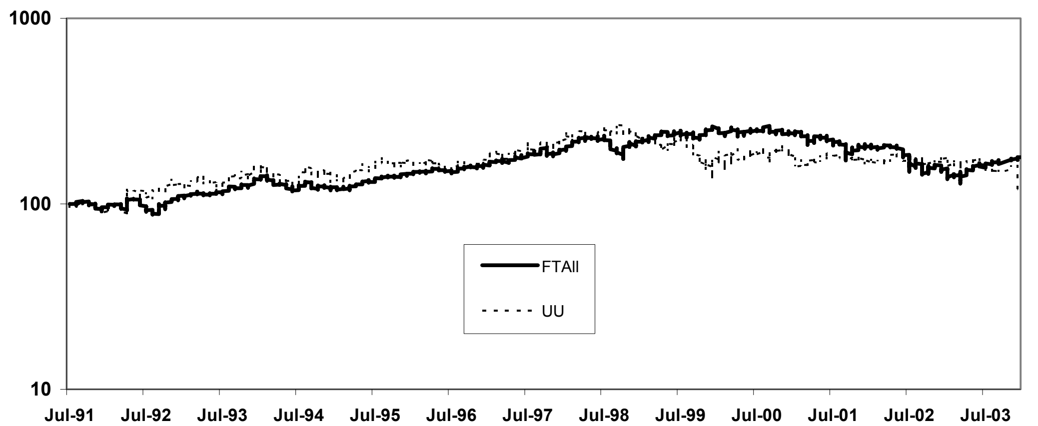


Chart 7d. United Utilities and FTAll Share Price Indices (July 1991=100)



3.8. Beta Estimates for Kelda Group

Apart from it having a lower whole-sample estimate of beta (of only 0.3, with a 95% confidence interval of around 0.13 either side), very similar arguments apply to this company to those applied to United Utilities. It, too, appears to share the common downward drifting tendency in its beta estimate, which fall to only around 0.2 in the most recent samples; but the CUSUM and CUSUMSQ test statistics in the Appendix do not suggest that the degree of implied parameter instability is statistically significant.

Thus in this case, again, there is a presumption in favour of the whole-sample estimate of around 0.3, rather than estimates derived from more recent samples.

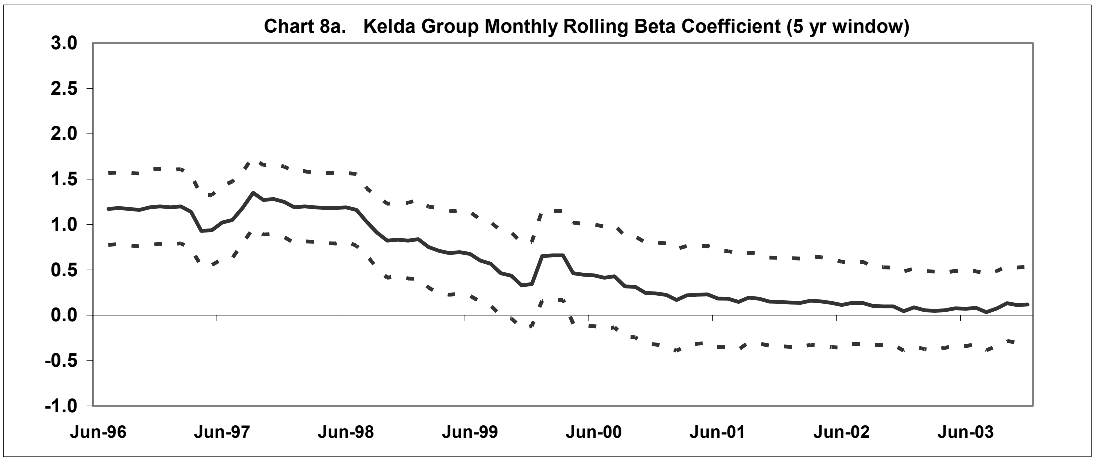


Chart 8a. Kelda Group Monthly Rolling Beta Coefficient (5 yr window)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
Jun-96
Jun-97
Jun-98
Jun-99
Jun-00
Jun-01
Jun-02
Jun-03

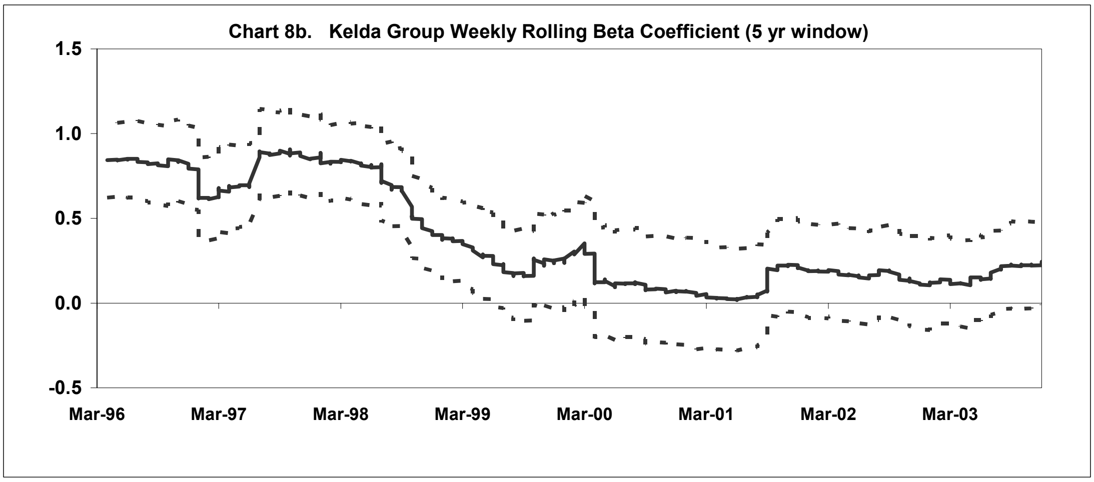


Chart 8b. Kelda Group Weekly Rolling Beta Coefficient (5 yr window)
1.5
1.0
0.5
0.0
-0.5
Mar-96
Mar-97
Mar-98
Mar-99
Mar-00
Mar-01
Mar-02
Mar-03

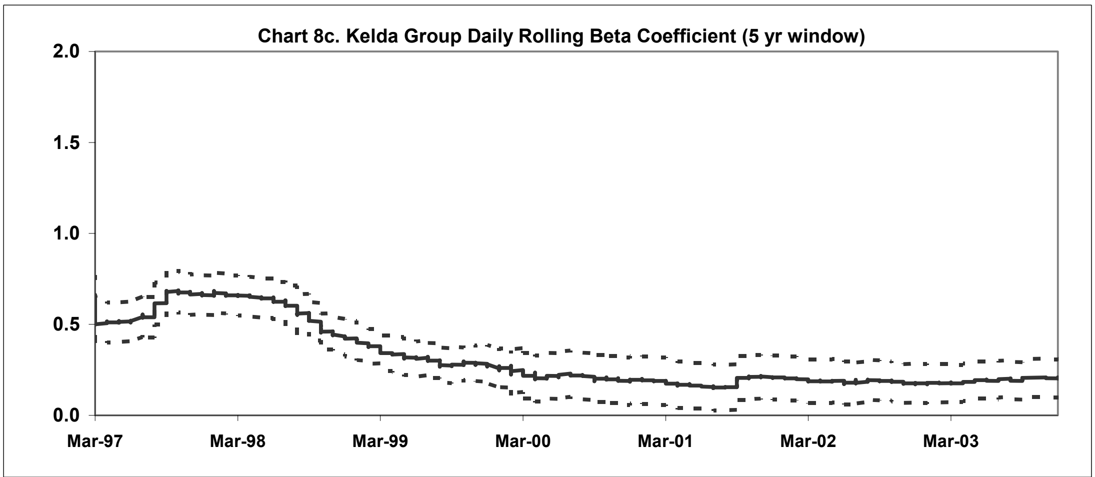


Chart 8c. Kelda Group Daily Rolling Beta Coefficient (5 yr window)
2.0
1.5
1.0
0.5
0.0
Mar-97
Mar-98
Mar-99
Mar-00
Mar-01
Mar-02
Mar-03

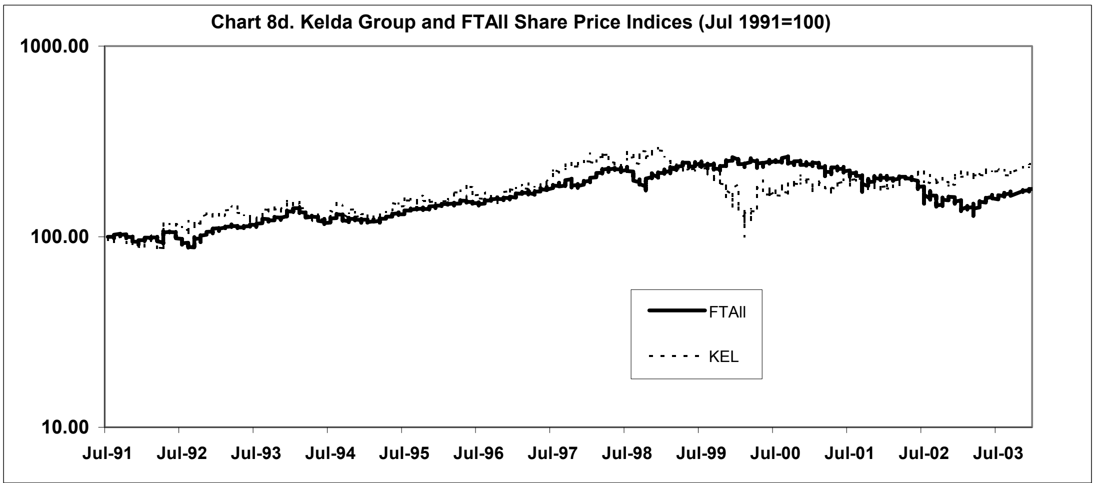


Chart 8d. Kelda Group and FTAll Share Price Indices (Jul 1991=100)
1000.00
100.00
10.00
FTAll
KEL
Jul-91
Jul-92
Jul-93
Jul-94
Jul-95
Jul-96
Jul-97
Jul-98
Jul-99
Jul-00
Jul-01
Jul-02
Jul-03

3.9. Beta Estimates for Severn Trent

In this final company examined, the diagnosis appears closer to that applied earlier to Scottish Power and Scottish & Southern Energy. The point estimate of beta from the full sample of daily data is 0.44, with a relatively wide 95% confidence interval (especially given the relatively long sample) of around 0.18 either side (based on Newey-West standard errors). But the common pattern of a downward drift in beta is again, in this case, strongly statistically significant. The relevant CUSUM statistic shown in the Appendix falls below the 95% lower bound in the early samples, but then stays pretty much parallel – indicating that in shorter, more recent samples the parameter instability would not be statistically significant.

In the case of monthly and weekly data the instability is so marked that in later samples the beta estimate sometimes turns negative, and is not statistically significantly different from zero. Using daily data beta does remain statistically significant, but values in recent samples, at around 0.3, are distinctly lower than the full sample estimate.

Similar arguments apply in this case to those used earlier in relation to the first two companies examined. If it seems plausible that Severn Trent's share price may have "settled down" in terms of its relationship to the market (there was again an early pattern of out-performance, shown in Panel d of Chart 9; but much less markedly so than in the case of the first two companies), then it might be argued that a beta estimate of around 0.3, consistent with the more recent samples, would be appropriate. But a more cautious approach would probably be to err, again, in an upward direction, and stick with the full sample estimate.

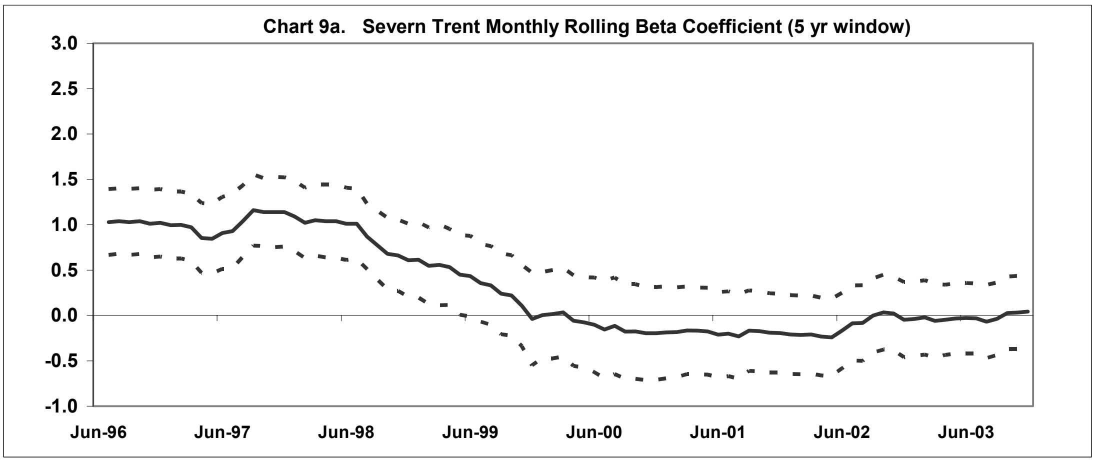


Chart 9a. Severn Trent Monthly Rolling Beta Coefficient (5 yr window)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
Jun-96
Jun-97
Jun-98
Jun-99
Jun-00
Jun-01
Jun-02
Jun-03

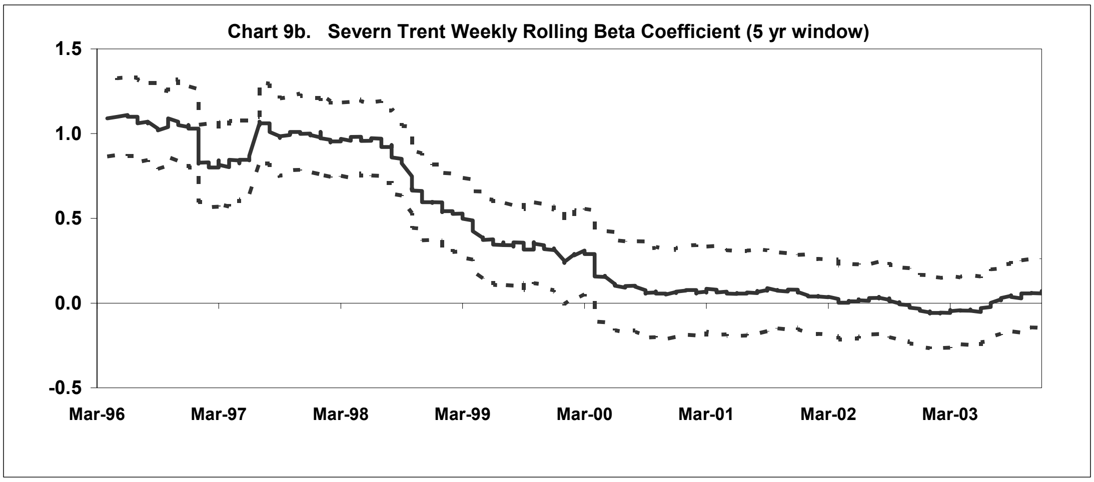


Chart 9b. Severn Trent Weekly Rolling Beta Coefficient (5 yr window)
1.5
1.0
0.5
0.0
-0.5
Mar-96
Mar-97
Mar-98
Mar-99
Mar-00
Mar-01
Mar-02
Mar-03

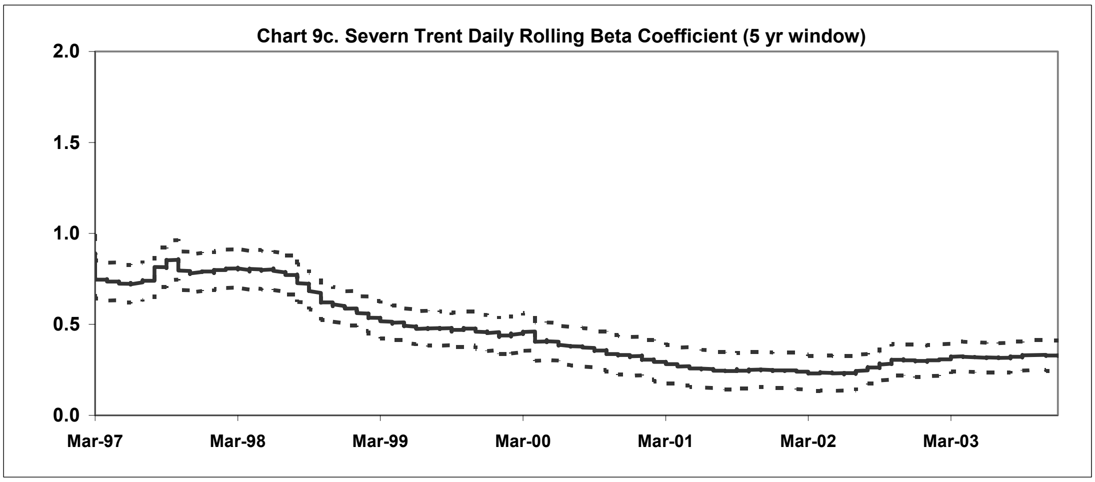


Chart 9c. Severn Trent Daily Rolling Beta Coefficient (5 yr window)
2.0
1.5
1.0
0.5
0.0
Mar-97
Mar-98
Mar-99
Mar-00
Mar-01
Mar-02
Mar-03

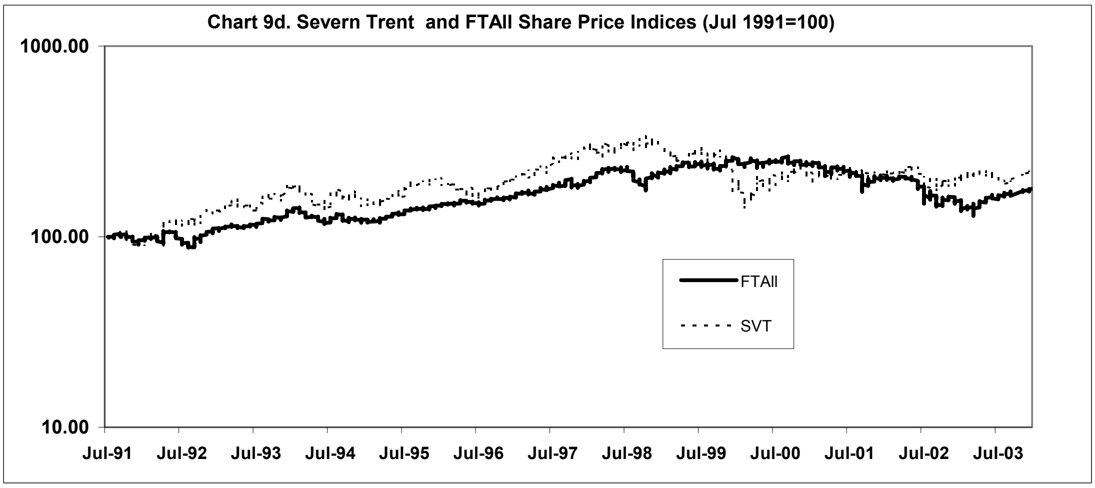


Chart 9d. Severn Trent and FTAll Share Price Indices (Jul 1991=100)
1000.00
100.00
10.00
FTAll
SVT
Jul-91
Jul-92
Jul-93
Jul-94
Jul-95
Jul-96
Jul-97
Jul-98
Jul-99
Jul-00
Jul-01
Jul-02
Jul-03

Appendix

A. Data Transformations

Excess Returns for all companies, and for the market are given by

$\ln (P_t / P_{t-1}) - r$

where P is the relevant price, and

$r = \ln ((1+R_t)^{1/k})$

where R_t is the safe rate , and k is the annualisation factor, set equal to 251 for daily data, 52 for weekly data, and 12 for monthly data

All price data are ex-dividend, and were downloaded from Bloomberg's Data Service

B. Detailed Estimation Results on Daily Data

```
                       Ordinary Least Squares Estimation
*******************************************************************************
 Dependent variable is SCOTTISH POWER
 2967 observations used for estimation from    2 to 2968
*******************************************************************************
 Regressor              Coefficient       Standard Error         T-Ratio[Prob]
 CONS                     .3127E-3           .3541E-3              .88299[.377]
 FTAS                        .69778            .035774             19.5051[.000]
*******************************************************************************
 R-Squared                     .11372   R-Bar-Squared                     .11342
 S.E. of Regression           .019287   F-stat.    F(  1,2965)  380.4479[.000]
 Mean of Dependent Variable  .3068E-3   S.D. of Dependent Variable      .020484
 Residual Sum of Squares       1.1029   Equation Log-likelihood          7505.7
 Akaike Info. Criterion        7503.7   Schwarz Bayesian Criterion       7497.7
 DW-statistic                  1.8951
*******************************************************************************


                               Diagnostic Tests
*******************************************************************************
*    Test Statistics  *        LM Version        *         F Version
*******************************************************************************
*                     *                          *
* A:Serial Correlation*CHSQ(   1)=   8.1693[.004]*F(   1,2964)=   8.1836[.004]
*                     *                          *
* B:Functional Form   *CHSQ(   1)=   .76790[.381]*F(   1,2964)=   .76732[.381]
*                     *                          *
* C:Normality         *CHSQ(   2)=  3538386[.000]*       Not applicable
*                     *                          *
* D:Heteroscedasticity*CHSQ(   1)=   .38612[.534]*F(   1,2965)=   .38591[.535]
*******************************************************************************
   A:Lagrange multiplier test of residual serial correlation
   B:Ramsey's RESET test using the square of the fitted values
   C:Based on a test of skewness and kurtosis of residuals
   D:Based on the regression of squared residuals on squared fitted values

                       Ordinary Least Squares Estimation
              Based on White's Heteroscedasticity adjusted S.E.'s
*******************************************************************************
 Dependent variable is SCOTTISH POWER
 2967 observations used for estimation from    2 to 2968
*******************************************************************************
 Regressor              Coefficient       Standard Error         T-Ratio[Prob]
 CONS                     .3127E-3           .3541E-3              .88289[.377]
 FTAS                        .69778            .041237             16.9212[.000]
*******************************************************************************

                       Ordinary Least Squares Estimation
    Based on Newey-West adjusted S.E.'s Parzen weights, truncation lag= 500
*******************************************************************************
 Dependent variable is SCOTTISH POWER
 2967 observations used for estimation from    2 to 2968
*******************************************************************************
 Regressor              Coefficient       Standard Error         T-Ratio[Prob]
 CONS                     .3127E-3           .3957E-3              .79014[.430]
 FTAS                        .69778            .078153              8.9284[.000]
*******************************************************************************
```

```
                        Ordinary Least Squares Estimation
*******************************************************************************
 Dependent variable is SCOTTISH AND SOUTHERN
 2967 observations used for estimation from    2 to 2968
*******************************************************************************
 Regressor              Coefficient       Standard Error         T-Ratio[Prob]
 CONS                     .4897E-3           .3406E-3            1.4379[.151]
 XRM                        .48715            .034412           14.1566[.000]
*******************************************************************************
 R-Squared                     .063312   R-Bar-Squared                  .062996
 S.E. of Regression            .018552   F-stat.    F(  1,2965)  200.4091[.000]
 Mean of Dependent Variable  .4856E-3   S.D. of Dependent Variable     .019166
 Residual Sum of Squares        1.0205   Equation Log-likelihood         7620.9
 Akaike Info. Criterion         7618.9   Schwarz Bayesian Criterion      7612.9
 DW-statistic                   1.9117
*******************************************************************************


                                Diagnostic Tests
*******************************************************************************
*    Test Statistics  *        LM Version        *         F Version
*******************************************************************************
*                     *                          *
* A:Serial Correlation*CHSQ(   1)=   5.7776[.016]*F(   1,2964)=   5.7831[.016]
*                     *                          *
* B:Functional Form   *CHSQ(   1)=   2.2986[.129]*F(   1,2964)=   2.2980[.130]
*                     *                          *
* C:Normality         *CHSQ(   2)=  3900648[.000]*       Not applicable
*                     *                          *
* D:Heteroscedasticity*CHSQ(   1)=   3.1691[.075]*F(   1,2965)=   3.1703[.075]
*******************************************************************************
   A:Lagrange multiplier test of residual serial correlation
   B:Ramsey's RESET test using the square of the fitted values
   C:Based on a test of skewness and kurtosis of residuals
   D:Based on the regression of squared residuals on squared fitted values

                        Ordinary Least Squares Estimation
               Based on White's Heteroscedasticity adjusted S.E.'s
*******************************************************************************
 Dependent variable is SCOTTISH AND SOUTHERN
 2967 observations used for estimation from    2 to 2968
*******************************************************************************
 Regressor              Coefficient       Standard Error         T-Ratio[Prob]
 CONS                     .4897E-3           .3407E-3            1.4374[.151]
 XRM                        .48715            .047847           10.1815[.000]
*******************************************************************************
```

```
                    Ordinary Least Squares Estimation
*******************************************************************************
 Dependent variable is VIRIDIAN
 2660 observations used for estimation from  309 to 2968
*******************************************************************************
 Regressor              Coefficient       Standard Error         T-Ratio[Prob]
 CONS                     .3389E-3           .3015E-3             1.1240[.261]
 FTAS                       .18421             .030044             6.1311[.000]
*******************************************************************************
 R-Squared                     .013945   R-Bar-Squared                  .013574
 S.E. of Regression            .015548   F-stat.    F(  1,2658)   37.5910[.000]
 Mean of Dependent Variable  .3287E-3   S.D. of Dependent Variable     .015655
 Residual Sum of Squares        .64259   Equation Log-likelihood         7302.3
 Akaike Info. Criterion         7300.3   Schwarz Bayesian Criterion      7294.4
 DW-statistic                   1.7077
*******************************************************************************


                            Diagnostic Tests
*******************************************************************************
*    Test Statistics  *        LM Version        *         F Version
*******************************************************************************
*                     *                          *
* A:Serial Correlation*CHSQ(   1)=  56.8809[.000]*F(   1,2657)=  58.0582[.000]
*                     *                          *
* B:Functional Form   *CHSQ(   1)=   .16287[.687]*F(   1,2657)=   .16270[.687]
*                     *                          *
* C:Normality         *CHSQ(   2)=  7017305[.000]*       Not applicable
*                     *                          *
* D:Heteroscedasticity*CHSQ(   1)=   .15555[.693]*F(   1,2658)=   .15544[.693]
*******************************************************************************
   A:Lagrange multiplier test of residual serial correlation
   B:Ramsey's RESET test using the square of the fitted values
   C:Based on a test of skewness and kurtosis of residuals
   D:Based on the regression of squared residuals on squared fitted values

                    Ordinary Least Squares Estimation
              Based on White's Heteroscedasticity adjusted S.E.'s
*******************************************************************************
 Dependent variable is VIRIDIAN
 2660 observations used for estimation from  309 to 2968
*******************************************************************************
 Regressor              Coefficient       Standard Error         T-Ratio[Prob]
 CONS                     .3389E-3           .3007E-3             1.1268[.260]
 FTAS                       .18421             .035931             5.1267[.000]
*******************************************************************************

                    Ordinary Least Squares Estimation
    Based on Newey-West adjusted S.E.'s Parzen weights, truncation lag= 500
*******************************************************************************
 Dependent variable is VIRIDIAN
 2660 observations used for estimation from  309 to 2968
*******************************************************************************
 Regressor              Coefficient       Standard Error         T-Ratio[Prob]
 CONS                     .3389E-3           .3565E-3             .95059[.342]
 FTAS                       .18421             .051552             3.5732[.000]
*******************************************************************************
```

```
                   Ordinary Least Squares Estimation
*******************************************************************************
 Dependent variable is CENTRICA
 1738 observations used for estimation from 1231 to 2968
*******************************************************************************
 Regressor              Coefficient       Standard Error         T-Ratio[Prob]
 CONS                     .5412E-3           .5011E-3              1.0800[.280]
 FTAS                       .67940            .042964              15.8133[.000]
*******************************************************************************
 R-Squared                      .12591   R-Bar-Squared                    .12540
 S.E. of Regression            .020889   F-stat.    F(  1,1736)  250.0611[.000]
 Mean of Dependent Variable  .4186E-3   S.D. of Dependent Variable     .022336
 Residual Sum of Squares        .75749   Equation Log-likelihood          4258.4
 Akaike Info. Criterion         4256.4   Schwarz Bayesian Criterion       4251.0
 DW-statistic                   2.0944
*******************************************************************************


                           Diagnostic Tests
*******************************************************************************
*    Test Statistics  *        LM Version        *         F Version
*******************************************************************************
*                     *                          *
* A:Serial Correlation*CHSQ(   1)=   4.3922[.036]*F(   1,1735)=   4.3958[.036]
*                     *                          *
* B:Functional Form   *CHSQ(   1)=  .080821[.776]*F(   1,1735)=  .080686[.776]
*                     *                          *
* C:Normality         *CHSQ(   2)=   1294.4[.000]*       Not applicable
*                     *                          *
* D:Heteroscedasticity*CHSQ(   1)=   9.5110[.002]*F(   1,1736)=   9.5523[.002]
*******************************************************************************
   A:Lagrange multiplier test of residual serial correlation
   B:Ramsey's RESET test using the square of the fitted values
   C:Based on a test of skewness and kurtosis of residuals
   D:Based on the regression of squared residuals on squared fitted values

                   Ordinary Least Squares Estimation
              Based on White's Heteroscedasticity adjusted S.E.'s
*******************************************************************************
 Dependent variable is CENTRICA
 1738 observations used for estimation from 1231 to 2968
*******************************************************************************
 Regressor              Coefficient       Standard Error         T-Ratio[Prob]
 CONS                     .5412E-3           .5012E-3              1.0799[.280]
 FTAS                       .67940            .050058              13.5723[.000]
*******************************************************************************

                   Ordinary Least Squares Estimation
    Based on Newey-West adjusted S.E.'s Parzen weights, truncation lag= 500
*******************************************************************************
 Dependent variable is CENTRICA
 1738 observations used for estimation from 1231 to 2968
*******************************************************************************
 Regressor              Coefficient       Standard Error         T-Ratio[Prob]
 CONS                     .5412E-3           .2638E-3              2.0517[.040]
 FTAS                       .67940             .12249               5.5466[.000]
*******************************************************************************
```

```
                     Ordinary Least Squares Estimation
*******************************************************************************
 Dependent variable is INTERNATIONAL POWER
 819 observations used for estimation from 2150 to 2968
*******************************************************************************
 Regressor              Coefficient       Standard Error         T-Ratio[Prob]
 CONS                    -.9481E-3          .8713E-3             -1.0882[.277]
 FTAS                        .70988           .066359             10.6976[.000]
*******************************************************************************
 R-Squared                     .12286   R-Bar-Squared                    .12179
 S.E. of Regression           .024912   F-stat.    F(  1, 817)  114.4384[.000]
 Mean of Dependent Variable -.0013501   S.D. of Dependent Variable     .026583
 Residual Sum of Squares       .50704   Equation Log-likelihood         1863.0
 Akaike Info. Criterion        1861.0   Schwarz Bayesian Criterion      1856.3
 DW-statistic                  2.1217
*******************************************************************************


                             Diagnostic Tests
*******************************************************************************
*    Test Statistics  *        LM Version        *         F Version
*******************************************************************************
*                     *                          *
* A:Serial Correlation*CHSQ(   1)=   3.0471[.081]*F(   1, 816)=   3.0473[.081]
*                     *                          *
* B:Functional Form   *CHSQ(   1)=   3.2097[.073]*F(   1, 816)=   3.2105[.074]
*                     *                          *
* C:Normality         *CHSQ(   2)= 899.8307[.000]*       Not applicable
*                     *                          *
* D:Heteroscedasticity*CHSQ(   1)=   5.9402[.015]*F(   1, 817)=   5.9690[.015]
*******************************************************************************
   A:Lagrange multiplier test of residual serial correlation
   B:Ramsey's RESET test using the square of the fitted values
   C:Based on a test of skewness and kurtosis of residuals
   D:Based on the regression of squared residuals on squared fitted values

                     Ordinary Least Squares Estimation
              Based on White's Heteroscedasticity adjusted S.E.'s
*******************************************************************************
 Dependent variable is INTERNATIONAL POWER
 819 observations used for estimation from 2150 to 2968
*******************************************************************************
 Regressor              Coefficient       Standard Error         T-Ratio[Prob]
 CONS                    -.9481E-3          .8686E-3             -1.0915[.275]
 FTAS                        .70988           .079312              8.9505[.000]
*******************************************************************************

                     Ordinary Least Squares Estimation
    Based on Newey-West adjusted S.E.'s Parzen weights, truncation lag= 500
*******************************************************************************
 Dependent variable is INTERNATIONAL POWER
 819 observations used for estimation from 2150 to 2968
*******************************************************************************
 Regressor              Coefficient       Standard Error         T-Ratio[Prob]
 CONS                    -.9481E-3          .5291E-3             -1.7918[.074]
 FTAS                        .70988           .073090              9.7123[.000]
*******************************************************************************
```

```
                      Ordinary Least Squares Estimation
*******************************************************************************
 Dependent variable is NATIONAL GRID
 2045 observations used for estimation from  924 to 2968
*******************************************************************************
 Regressor              Coefficient       Standard Error         T-Ratio[Prob]
 CONS                     .1314E-3           .3354E-3               .39183[.695]
 FTAS                        .63044            .030680             20.5488[.000]
*******************************************************************************
 R-Squared                     .17128   R-Bar-Squared                    .17088
 S.E. of Regression           .015166   F-stat.    F(  1,2043)  422.2540[.000]
 Mean of Dependent Variable  .6616E-4   S.D. of Dependent Variable     .016656
 Residual Sum of Squares       .46991   Equation Log-likelihood         5665.1
 Akaike Info. Criterion        5663.1   Schwarz Bayesian Criterion      5657.5
 DW-statistic                  2.0335
*******************************************************************************


                              Diagnostic Tests
*******************************************************************************
*    Test Statistics  *        LM Version        *         F Version
*******************************************************************************
*                     *                          *
* A:Serial Correlation*CHSQ(   1)=   .68212[.409]*F(   1,2042)=   .68135[.409]
*                     *                          *
* B:Functional Form   *CHSQ(   1)=   6.2344[.013]*F(   1,2042)=   6.2443[.013]
*                     *                          *
* C:Normality         *CHSQ(   2)= 563.1199[.000]*       Not applicable
*                     *                          *
* D:Heteroscedasticity*CHSQ(   1)=  13.6735[.000]*F(   1,2043)=  13.7520[.000]
*******************************************************************************
   A:Lagrange multiplier test of residual serial correlation
   B:Ramsey's RESET test using the square of the fitted values
   C:Based on a test of skewness and kurtosis of residuals
   D:Based on the regression of squared residuals on squared fitted values
```

```
                      Ordinary Least Squares Estimation
             Based on White's Heteroscedasticity adjusted S.E.'s
*******************************************************************************
 Dependent variable is NATIONAL GRID
 2045 observations used for estimation from  924 to 2968
*******************************************************************************
 Regressor              Coefficient       Standard Error         T-Ratio[Prob]
 CONS                     .1314E-3           .3357E-3               .39145[.696]
 FTAS                        .63044            .035780             17.6201[.000]
*******************************************************************************
```

```
                      Ordinary Least Squares Estimation
    Based on Newey-West adjusted S.E.'s Parzen weights, truncation lag= 500
*******************************************************************************
 Dependent variable is NATIONAL GRID
 2045 observations used for estimation from  924 to 2968
*******************************************************************************
 Regressor              Coefficient       Standard Error         T-Ratio[Prob]
 CONS                     .1314E-3           .2939E-3               .44719[.655]
 FTAS                        .63044            .048598             12.9727[.000]
*******************************************************************************
```

```
                      Ordinary Least Squares Estimation
*******************************************************************************
 Dependent variable is UNITED UTILITIES
 2967 observations used for estimation from    2 to 2968
*******************************************************************************
 Regressor              Coefficient       Standard Error         T-Ratio[Prob]
 CONS                    -.2395E-4           .2876E-3           -.083250[.934]
 FTAS                        .59069            .029061            20.3256[.000]
*******************************************************************************
 R-Squared                     .12230   R-Bar-Squared                    .12200
 S.E. of Regression           .015668   F-stat.    F(  1,2965)  413.1311[.000]
 Mean of Dependent Variable -.2890E-4   S.D. of Dependent Variable     .016721
 Residual Sum of Squares       .72784   Equation Log-likelihood         8122.3
 Akaike Info. Criterion        8120.3   Schwarz Bayesian Criterion      8114.3
 DW-statistic                  1.9383
*******************************************************************************


                               Diagnostic Tests
*******************************************************************************
*    Test Statistics  *        LM Version        *         F Version
*******************************************************************************
*                     *                          *
* A:Serial Correlation*CHSQ(   1)=   2.8104[.094]*F(   1,2964)=   2.8102[.094]
*                     *                          *
* B:Functional Form   *CHSQ(   1)=   2.2301[.135]*F(   1,2964)=   2.2296[.135]
*                     *                          *
* C:Normality         *CHSQ(   2)=   8157.1[.000]*       Not applicable
*                     *                          *
* D:Heteroscedasticity*CHSQ(   1)= 127.5203[.000]*F(   1,2965)= 133.1574[.000]
*******************************************************************************
   A:Lagrange multiplier test of residual serial correlation
   B:Ramsey's RESET test using the square of the fitted values
   C:Based on a test of skewness and kurtosis of residuals
   D:Based on the regression of squared residuals on squared fitted values

                     Ordinary Least Squares Estimation
             Based on White's Heteroscedasticity adjusted S.E.'s
*******************************************************************************
 Dependent variable is UNITED UTILITIES
 2967 observations used for estimation from    2 to 2968
*******************************************************************************
 Regressor              Coefficient       Standard Error         T-Ratio[Prob]
 CONS                    -.2395E-4           .2877E-3           -.083226[.934]
 FTAS                        .59069            .046064            12.8233[.000]
*******************************************************************************

                      Ordinary Least Squares Estimation
   Based on Newey-West adjusted S.E.'s Parzen weights, truncation lag= 500
*******************************************************************************
 Dependent variable is UNITED UTILITIES
 2967 observations used for estimation from    2 to 2968
*******************************************************************************
 Regressor              Coefficient       Standard Error         T-Ratio[Prob]
 CONS                    -.2395E-4           .1710E-3            -.14002[.889]
 FTAS                        .59069            .071773             8.2299[.000]
*******************************************************************************
```

```
                      Ordinary Least Squares Estimation
*******************************************************************************
 Dependent variable is KELDA
 2967 observations used for estimation from    2 to 2968
*******************************************************************************
 Regressor              Coefficient       Standard Error         T-Ratio[Prob]
 CONS                     .1176E-3           .3370E-3              .34887[.727]
 FTAS                       .30202            .034049              8.8702[.000]
*******************************************************************************
 R-Squared                    .025850  R-Bar-Squared                   .025522
 S.E. of Regression           .018357  F-stat.    F(  1,2965)   78.6801[.000]
 Mean of Dependent Variable  .1150E-3  S.D. of Dependent Variable     .018596
 Residual Sum of Squares       .99911  Equation Log-likelihood         7652.4
 Akaike Info. Criterion        7650.4  Schwarz Bayesian Criterion      7644.4
 DW-statistic                  1.9815
*******************************************************************************


                              Diagnostic Tests
*******************************************************************************
*    Test Statistics  *        LM Version        *         F Version
*******************************************************************************
*                     *                          *
* A:Serial Correlation*CHSQ(   1)=   .25234[.615]*F(   1,2964)=   .25210[.616]
*                     *                          *
* B:Functional Form   *CHSQ(   1)=   3.6405[.056]*F(   1,2964)=   3.6413[.056]
*                     *                          *
* C:Normality         *CHSQ(   2)=  15698.5[.000]*       Not applicable
*                     *                          *
* D:Heteroscedasticity*CHSQ(   1)=  73.2416[.000]*F(   1,2965)=  75.0447[.000]
*******************************************************************************
   A:Lagrange multiplier test of residual serial correlation
   B:Ramsey's RESET test using the square of the fitted values
   C:Based on a test of skewness and kurtosis of residuals
   D:Based on the regression of squared residuals on squared fitted values

                      Ordinary Least Squares Estimation
              Based on White's Heteroscedasticity adjusted S.E.'s
*******************************************************************************
 Dependent variable is KELDA
 2967 observations used for estimation from    2 to 2968
*******************************************************************************
 Regressor              Coefficient       Standard Error         T-Ratio[Prob]
 CONS                     .1176E-3           .3371E-3              .34881[.727]
 FTAS                       .30202            .051538              5.8601[.000]
*******************************************************************************
```


```
                      Ordinary Least Squares Estimation
              Based on White's Heteroscedasticity adjusted S.E.'s
*******************************************************************************
 Dependent variable is KELDA
 2967 observations used for estimation from    2 to 2968
*******************************************************************************
 Regressor              Coefficient       Standard Error         T-Ratio[Prob]
 CONS                     .1176E-3           .3371E-3              .34881[.727]
 FTAS                       .30202            .051538              5.8601[.000]
*******************************************************************************
```

```
                    Ordinary Least Squares Estimation
******************************************************************************
 Dependent variable is SEVERN & TRENT
 2967 observations used for estimation from    2 to 2968
******************************************************************************
 Regressor              Coefficient       Standard Error         T-Ratio[Prob]
 CONS                     .7161E-4          .2892E-3               .24762[.804]
 FTAS                        .44190            .029218             15.1245[.000]
******************************************************************************
 R-Squared                     .071624   R-Bar-Squared                   .071311
 S.E. of Regression            .015752   F-stat.    F(  1,2965)  228.7497[.000]
 Mean of Dependent Variable  .6790E-4   S.D. of Dependent Variable     .016346
 Residual Sum of Squares        .73571   Equation Log-likelihood         8106.4
 Akaike Info. Criterion         8104.4   Schwarz Bayesian Criterion      8098.4
 DW-statistic                   1.8821
******************************************************************************


                            Diagnostic Tests
******************************************************************************
*    Test Statistics  *        LM Version         *         F Version
******************************************************************************
*                     *                           *
* A:Serial Correlation*CHSQ(   1)=  10.0109[.002]*F(   1,2964)=  10.0346[.002]
*                     *                           *
* B:Functional Form   *CHSQ(   1)=   4.8055[.028]*F(   1,2964)=   4.8084[.028]
*                     *                           *
* C:Normality         *CHSQ(   2)=   5246.2[.000]*       Not applicable
*                     *                           *
* D:Heteroscedasticity*CHSQ(   1)= 112.1644[.000]*F(   1,2965)= 116.4927[.000]
******************************************************************************
   A:Lagrange multiplier test of residual serial correlation
   B:Ramsey's RESET test using the square of the fitted values
   C:Based on a test of skewness and kurtosis of residuals
   D:Based on the regression of squared residuals on squared fitted values

                    Ordinary Least Squares Estimation
           Based on White's Heteroscedasticity adjusted S.E.'s
******************************************************************************
 Dependent variable is SEVERN & TRENT
 2967 observations used for estimation from    2 to 2968
******************************************************************************
 Regressor              Coefficient       Standard Error         T-Ratio[Prob]
 CONS                     .7161E-4          .2893E-3               .24756[.804]
 FTAS                        .44190            .044218              9.9937[.000]
******************************************************************************

                    Ordinary Least Squares Estimation
    Based on Newey-West adjusted S.E.'s Parzen weights, truncation lag= 500
******************************************************************************
 Dependent variable is SEVERN & TRENT
 2967 observations used for estimation from    2 to 2968
******************************************************************************
 Regressor              Coefficient       Standard Error         T-Ratio[Prob]
 CONS                     .7161E-4          .2177E-3               .32889[.742]
 FTAS                        .44190            .087493              5.0507[.000]
******************************************************************************
```

C. Stability Tests

CUSUM Test

The CUSUM test (Brown, Durbin, and Evans, 1975) is based on the cumulative sum of the recursive residuals.[9] The test finds parameter instability if the cumulative sum goes outside the area between the two critical lines. If there is no parameter instability the test statistic would be expected to stay around zero. Movement outside the critical lines is suggestive of coefficient instability.

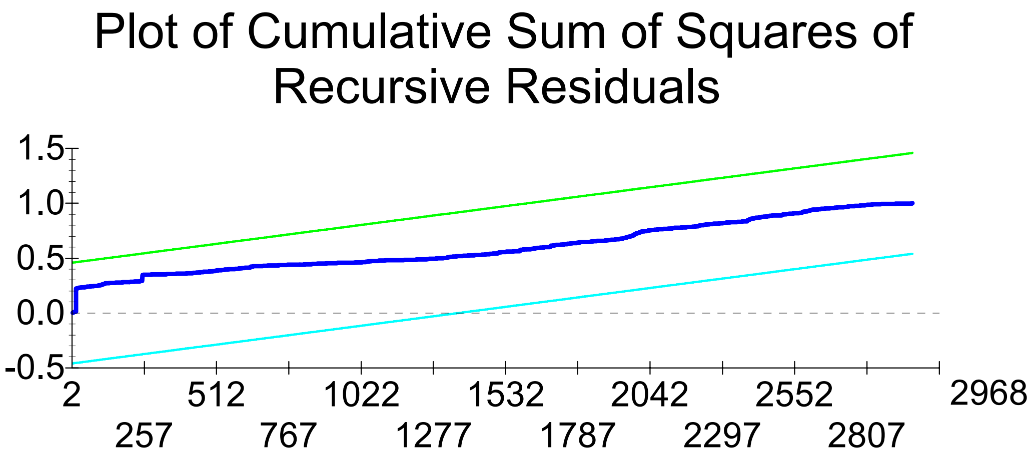
CUSUM of Squares Test

The CUSUM of squares test (Brown, Durbin, and Evans, 1975) is based on the cumulative sum of squared residuals.[10] If there is no parameter instability this statistic should rise steadily from zero to unity at the end of the sample. The significance of the departure of from its expected value is assessed by reference to a pair of parallel straight lines around the expected value.

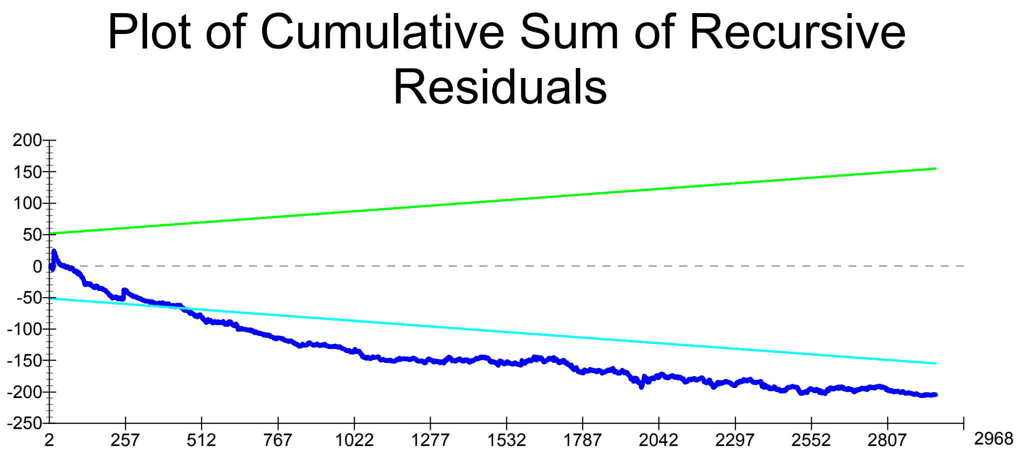
[9] Strictly = sum of recursive residuals/sample standard error of equation

[10] Strictly = sum of squared recursive residuals to point *t*, divided by total sum of squared residuals over entire sample

1. Scottish Power

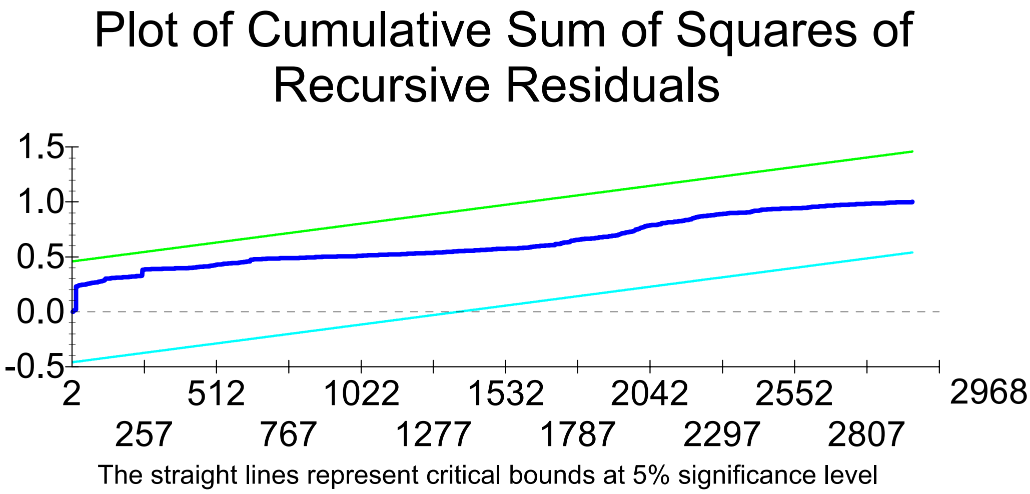


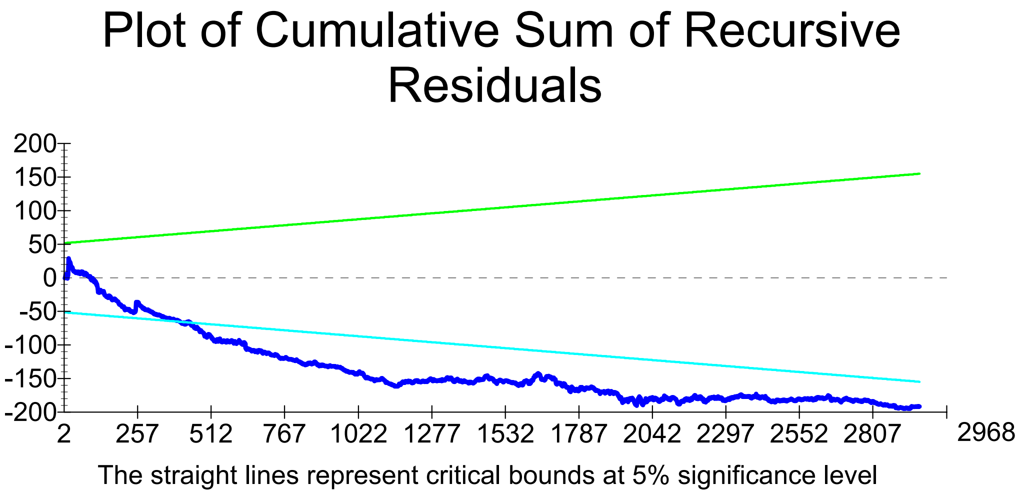
The straight lines represent critical bounds at 5% significance level



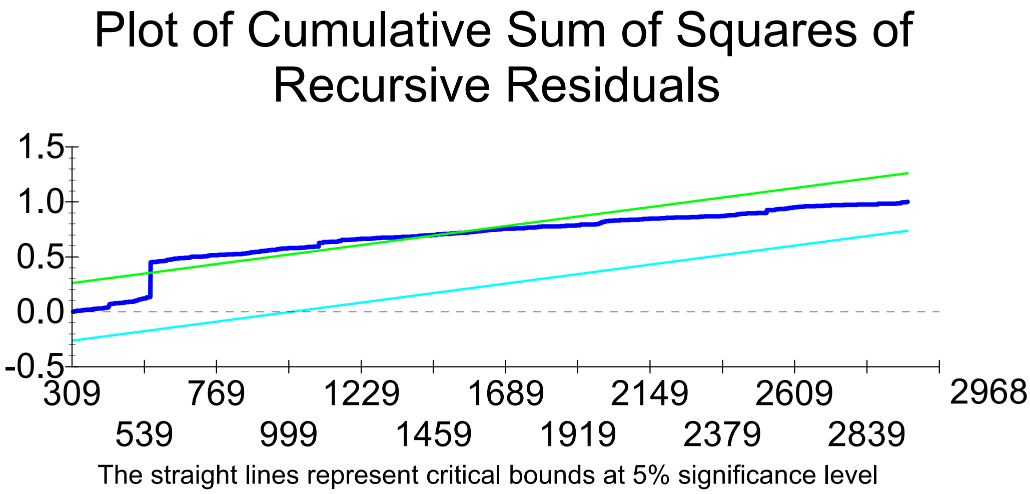
The straight lines represent critical bounds at 5% significance level

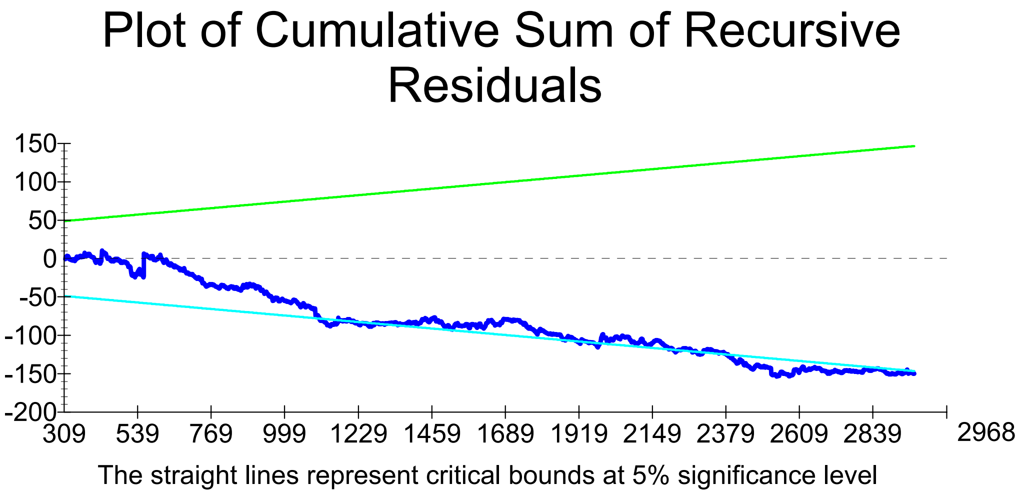
2. Scottish and Southern Energy



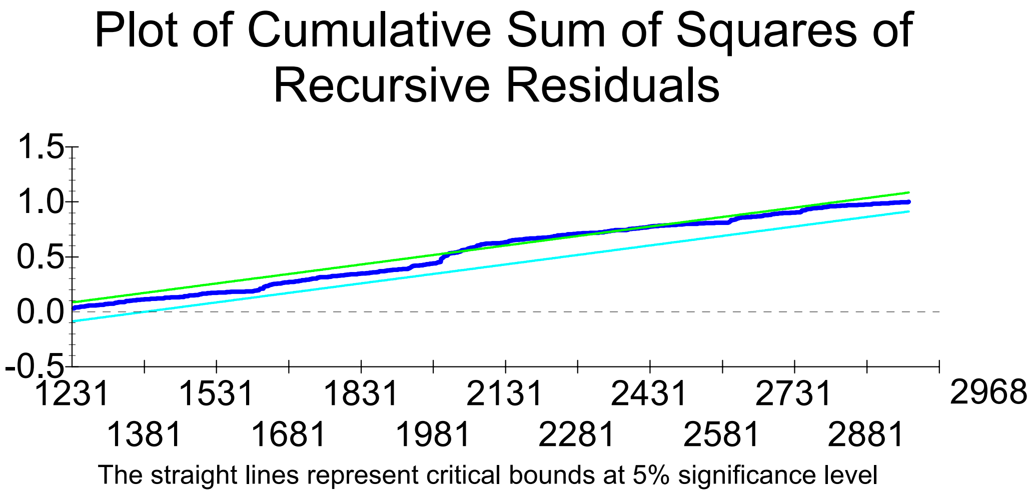


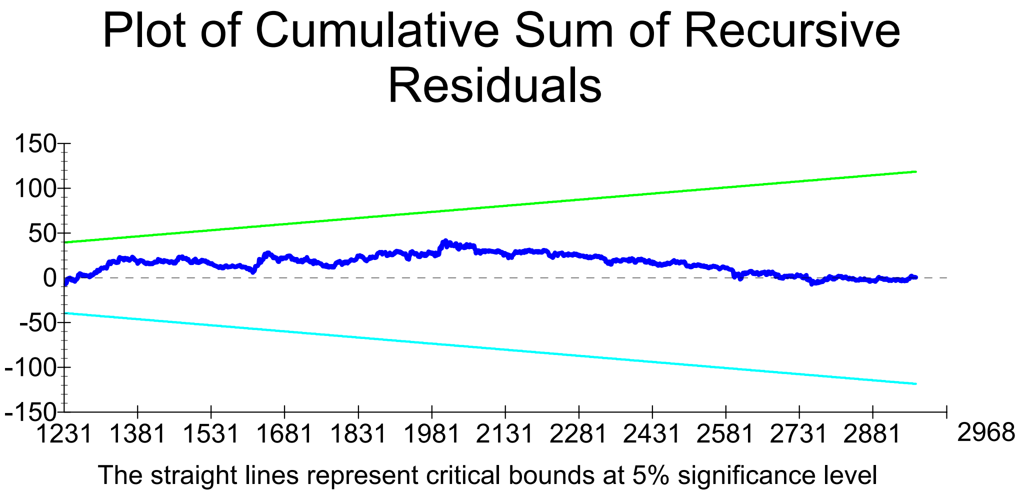
3. **Viridian Group**



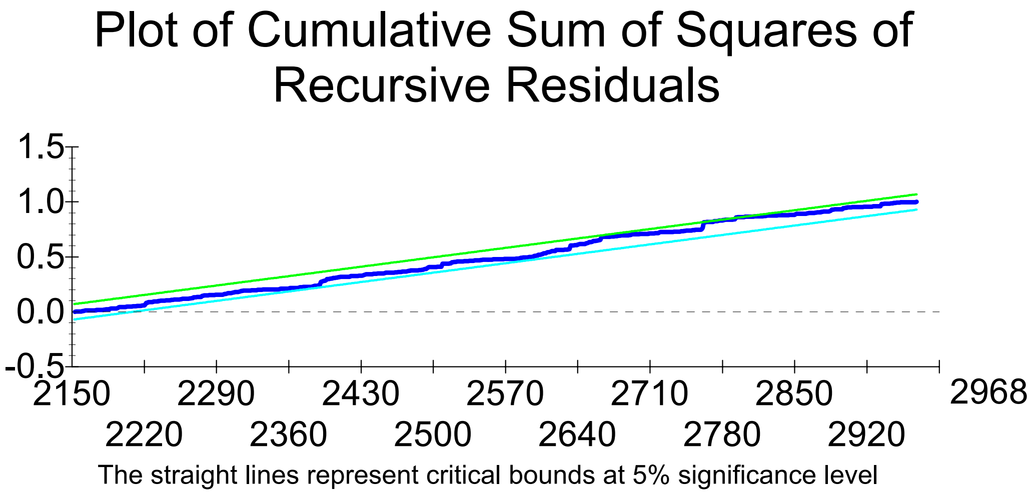


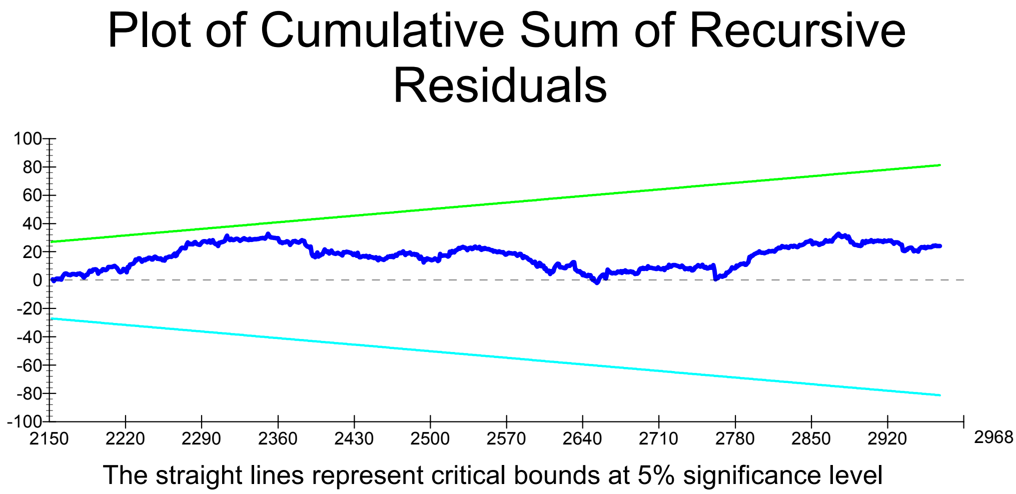
4. **Centrica**


Plot of Cumulative Sum of Squares of Recursive Residuals
1.5
1.0
0.5
0.0
-0.5
1231
1531
1831
2131
2431
2731
2968
1381
1681
1981
2281
2581
2881
The straight lines represent critical bounds at 5% significance level

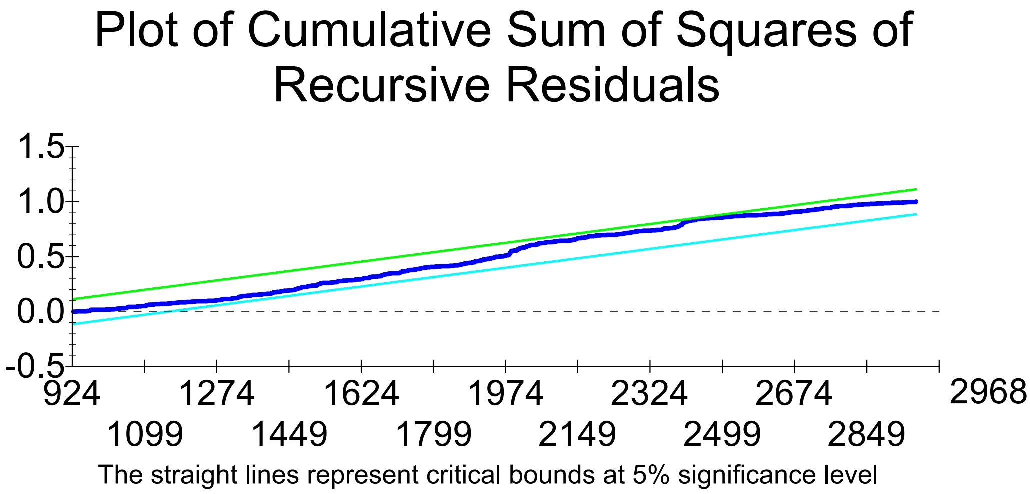

Plot of Cumulative Sum of Recursive Residuals
150
100
50
0
-50
-100
-150
1231
1381
1531
1681
1831
1981
2131
2281
2431
2581
2731
2881
2968
The straight lines represent critical bounds at 5% significance level

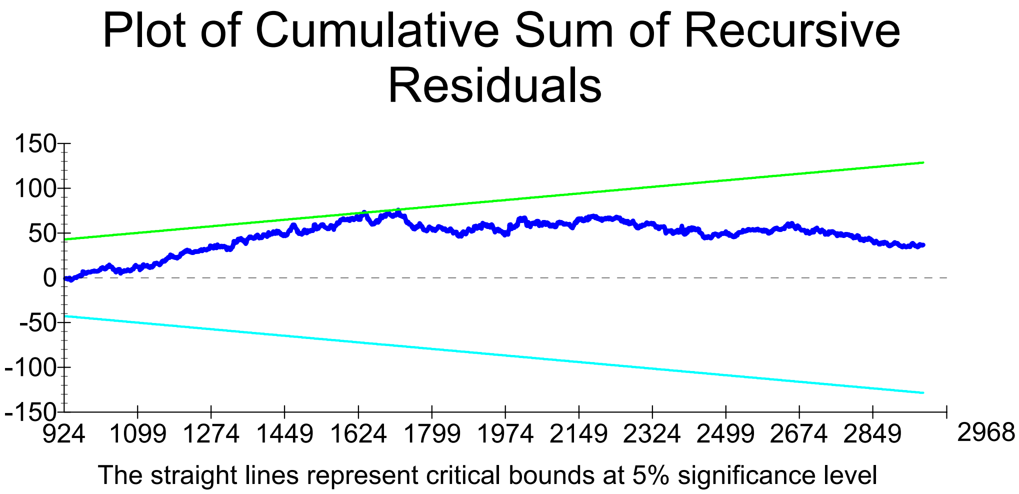
5. International Power



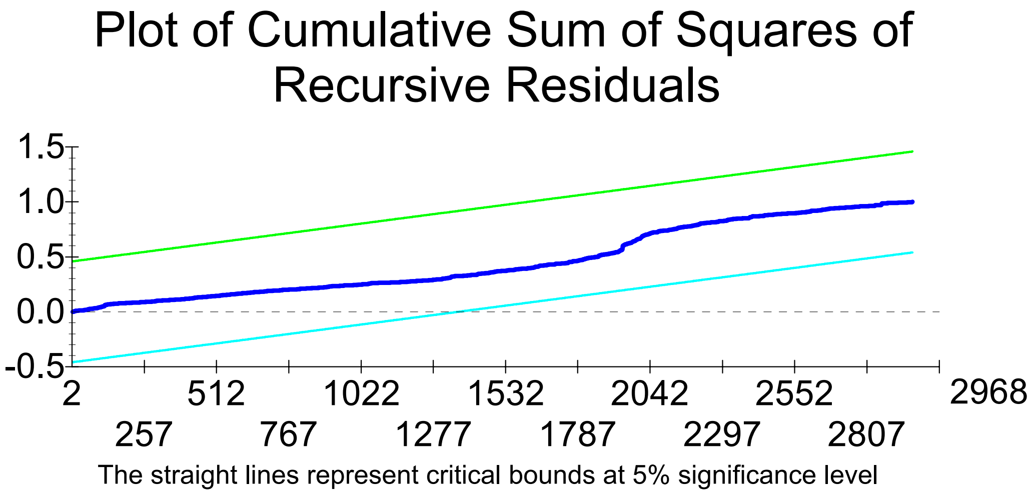


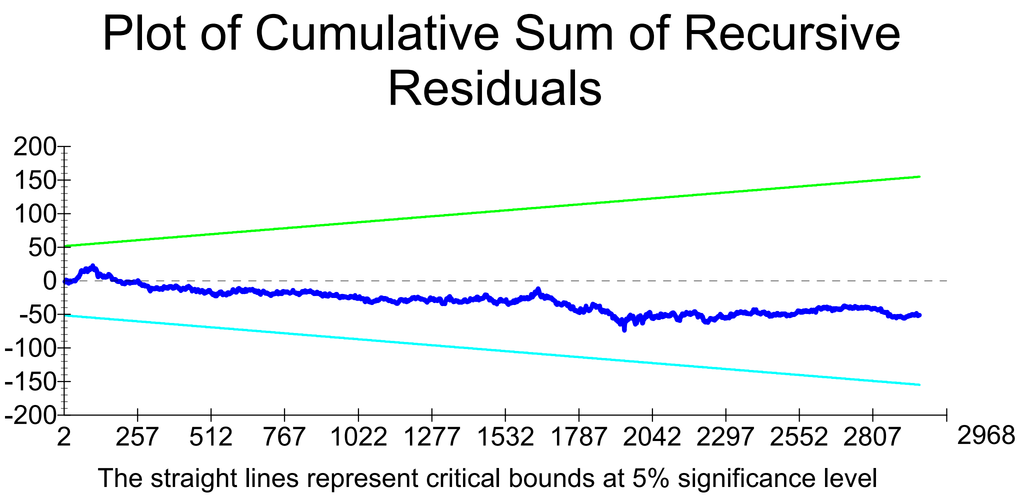
6. **National Grid Transco**



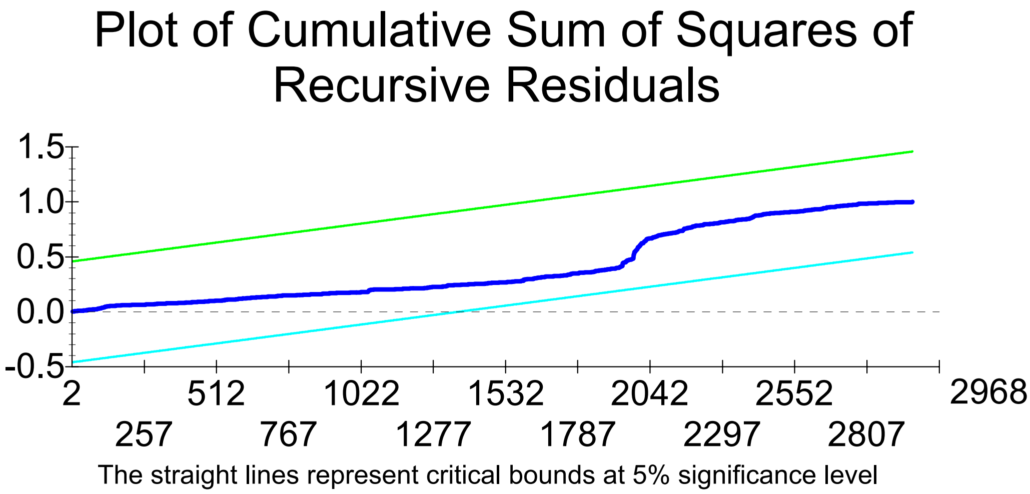


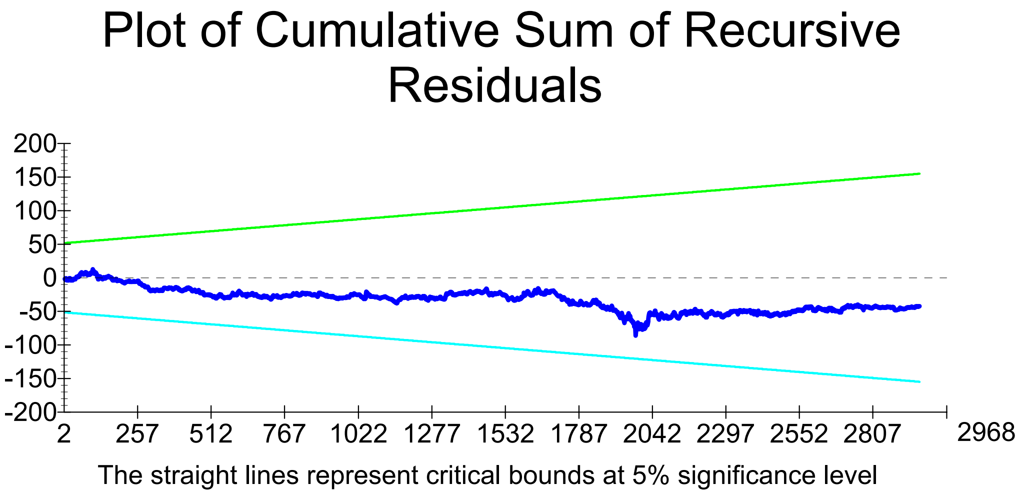
7. United Utilities



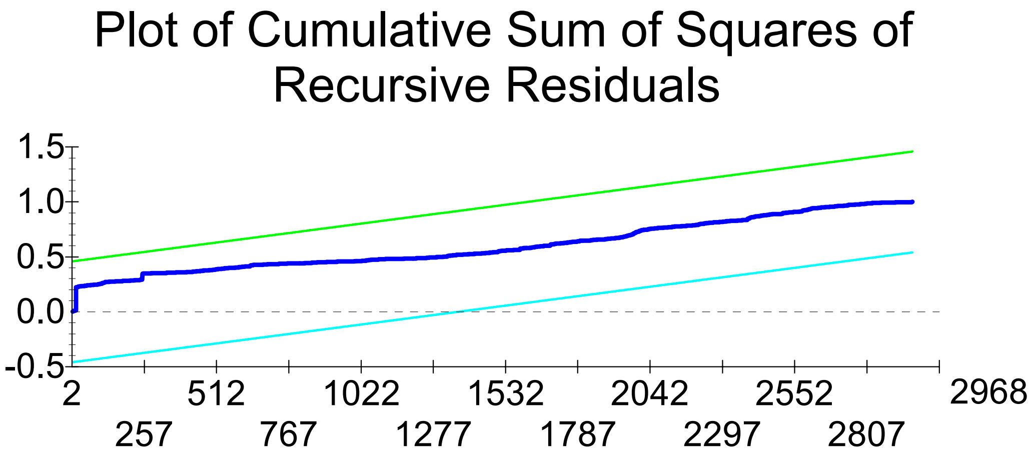


8. Kelda Group

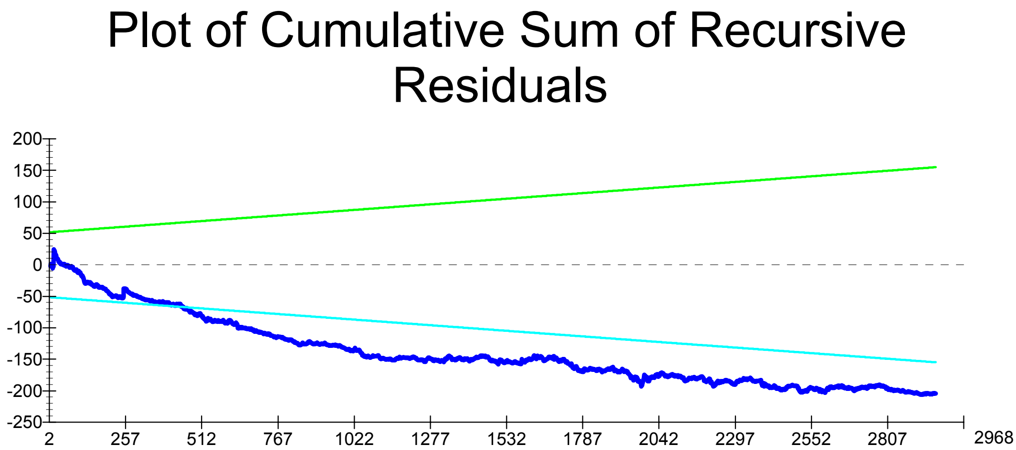




9. Severn Trent



The straight lines represent critical bounds at 5% significance level



The straight lines represent critical bounds at 5% significance level