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Report on the Cost of Capital

provided to Ofgem

by

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Report on Cost of Capital

1. Executive Summary

This report is made up of 11 sections. In this first section we provide a summary of the key findings of each section, followed by our recommendation on key input values.

Section 2. Beta Estimation Results

- As noted in our past reports beta estimates for the sample of nine regulated companies we examine have shown considerable instability over time. We compare estimates of beta based on rolling regressions, as in past reports, with alternative estimation techniques that explicitly allow for variation in beta, focussing in particular on the "Kalman Filter". When used on a comparable basis these alternative techniques results in central estimates that are quite similar, but with much wider confidence intervals.
- For most companies the statistical confidence interval for beta from the Kalman Filter is wide enough to include the figure of beta equal to one, as Ofgem assumes in setting the weighted average cost of capital. However it is notable that central estimates of beta using all techniques are, for all nine companies, well below one.
- We show that one possible economic explanation for the beta instability is that it may be largely, or possibly entirely due to a rise of the beta of the UK market itself in relation to the world market, which has risen significantly in recent years.
- One possible way to deal with this problem is to assume that, with increasingly integrated financial markets the appropriate measure of the market return is a measure of world, rather than UK market returns, and estimate company betas accordingly. For our sample of companies "world" betas are both more stable and distinctly lower than UK betas.

Section 3. Do betas matter for the cost of equity capital?

- In the light of the evidence presented in Section 2, Ofgem's continued policy of setting beta equal to one for all companies appears distinctly generous.
- We review the evidence to back up the central proposition of the CAPM model, that higher betas are associated with higher expected returns. The historic evidence appears very strong.
- The only qualification to this result arises from what appears to be the most empirically reliable "anomaly" with the CAPM: the "value" effect. This motivates our examination of the role of including additional factors in the asset pricing relation in Section 4.

Section 4. Fama French Estimates

- Ofgem have asked us to investigate the use of the Fama-French three factor model in assessing the cost of capital for the same nine companies examined in Section 2.
- We find that there is at best weak statistical evidence for a significant role for the additional two factors – the "size" effect and the "value vs growth" effect in determining returns on the nine companies examined in Section 2.
- This lack of statistical significance is compounded by the weak statistical significance of the risk premia associated with these two additional factors, and uncertainty as to their underlying economic rationale
- Of the two effects the "value'' effect appears both to be a more significant anomaly for the CAPM, and to be marginally more significant for the companies we examine. We estimate that as an upper bound the "value" effect might add 1 ¼ % to the cost of equity. Even this maximum effect, combined with a more realistic estimate of beta, would lead to a lower cost of equity than Ofgem's current approach which ignores the value effect but sets beta equal to one.

Section 5. Analysis of Grant Thornton Utilities Bond Yield Database

- We have carried out a provisional analysis of a new database of UK utility bond yields that has been constructed by Grant Thornton.
- Our overall conclusion based on this analysis is in line with that of our previous report: that corporate bonds appear to be essentially "commoditised". Once we know information about a company's credit rating and the other key characteristics of the bond, the most important of which is clearly maturity, there appears to be no evidence of any significant company-specific effect on yields that is not captured by these characteristics.

Section 6. Analysis of Benchmark Corporate Spreads

- Since yields on utilities' bonds are effectively commoditised, the only consideration in setting the cost of debt finance is to arrive at an estimate of the appropriate yield to assume for the chosen benchmark. We focus here exclusively on the A-rated benchmark, updating the analysis of our previous report.

- Since 2000 the average spread on an A-rated UK bond has been virtually identical to that on the much used Moody's Aaa benchmark for the United States, at just over 100 basis points. This in turn is only slightly above its long-term historic average (since 1925) of around 80 basis points, but is on the low side compared to its more recent history.

Section 7. Issues in the measurement of average expected returns

- In this section we discuss two technical issues relating to the use of historic average returns as a measure of expected returns: the impact of compound vs arithmetic averaging and biases in using bond yields as a proxy for expected bond returns.
- On the first point the key questions are whether we should look at long horizon returns, and whether returns are at all predictable at long horizons. If the answer to both these questions is yes then if we look at twenty year average returns the volatility adjustment to the arithmetic average stock return is lowered by anything up to a percentage point.
- Volatility effects are much less significant for bonds, and we conclude that while bond yields may at times be seriously biased measures of expected returns, on average the biases probably largely cancel out.

Section 8. The Common Components of the Cost of Capital
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- We have not altered our estimate of the real market return on equities (6.5% to 7.5%) or our estimate of the risk-free rate (2.5%).
- Yields on corporate debt can be broken down into the sum of the risk-free rate, a term premium and a default premium (discussed in Section 6).
- Recent yields on UK indexed bonds give a distorted impression of real yields. We recommend that risk-free government nominal bonds should be used to provide a benchmark estimate of the term premium.
- There is no obvious stability in term premia. In the twentieth century, the term premium was usually positive (but had no obvious stable mean); in the nineteenth century it was usually negative. Thus on a purely statistical basis there seems little reason for expecting the current term premium of essentially zero to revert to some historical average value. (A conservative approach might nonetheless be to assume a term premium equal to the average over the twentieth century of around ¾%.)
- The case for low term premia is supported by analysis of the determinants of term premia. Holding returns on long-term bonds in the twentieth century were both much more volatile over short horizons and, for a significant part of the century, distinctly risky at long horizons, due to inflation. The largest term premia occurred in periods after investors had made disastrous losses on long-term bonds.
- While short-term volatility of holding returns has remained quite high, the longer-term risks of holding nominal bonds have arguably been very significantly reduced in recent years by Bank of England independence. Even shorter term volatility may attract only a modest risk premium.
- If the term premium is indeed close to zero, the best current market-based estimate of the forward-looking real interest rate is the nominal yield on medium-dated bonds, less the Bank of England's inflation target of 2%: thus a figure of around 2 to 2 ½%, remarkably close to that in the benchmark "Taylor Rule".
- A very important caveat is that, while short-term rates and long-term yields are likely to move together in the future, their average level is quite uncertain. Both could in principle be pulled *upwards* towards the historically much more stable equity return. In the heyday of the stock market boom in the 1980s and 1990s real interest rates were significantly higher.

Section 9. Equity Issuance Costs

- This section summarises a range of research on the costs of equity issuance. These are of two types: direct and indirect.
- The direct costs of equity issues represent the costs of, eg, underwriting fees, professional fees, initial listing fees and marketing costs. Estimates of these costs, as a percentage of funds raised, range from 5% to 12% in the UK, and from 8% to 15% in the US. These costs may raise the required return on equity by between 30 to 80 basis points.
- The indirect costs represent "announcement" effects, whereby equity issues are deemed to represent a bad signal of underlying profitability, and thus stimulate price falls. Estimates of these price falls range from 1% to 3%, but, since these affect the entire equity issue they typically represent a much higher proportion – up to around one third, of the actual funds raised. This figure does however appear to be distinctly lower for regulated utilities.
- Although these figures are potentially a quite significant deterrent to equity issues, there are also important caveats. First there may be a relationship between direct and indirect costs; second, the indirect costs are assumed to arise from asymmetric information which are likely to be less relevant for regulated companies.

Section 10. Regulation, the cost of capital and capital structure

- There has been a clear trend, particularly noticeable among the water and electricity distribution companies, to increase gearing. We carry out some statistical analysis of the data to see if there is any evidence that movements in gearing appear to have had the predicted effect, in line with the Miller-Modigliani theorems, of raising the cost of equity capital. We find, if anything, the reverse to be the case. But the picture is clouded by what appears to be a strong negative relationship between asset betas and gearing.

- We also discuss whether regulation itself may affect gearing, and examine the issue of regulatory risk.

Section 11. A Comparison of Recent Regulatory Approaches to the Cost of Capital

- We compare the assumptions and the outcomes of five recent cost of capital estimations in 2002-5. The five studies are: Competition Commission report on BAA (November 2002), CC report on mobile network operators (February 2003), Ofgem's DPCR4 (March 2004), Ofwat's Periodic Review 04 (2004) and Ofreg's Transmission and Distribution Price Control (December 2005).

Tables 1.1 and 1.2 summarise our central estimates of key magnitudes. It should be emphasised that statistical confidence intervals around these figures are very large. Where ranges are given these reflect key uncertainties discussed in relevant sections; they do **not** represent confidence intervals.

Table 1.1
The Cost of Equity

	See Section of Report	Estimate
Real Market Return: Compound Average	8	5.5%
Adjustment to Arithmetic Average	7	1 to 2%
Real Market Return: Arithmetic Average	8	6.5% to 7.5%
Risk-Free Rate	8	2.5%
Implied Equity Premium	8	4% to 5%
Estimated "Value Effect"	4	0 to 1.25%
Implied Real Cost of Equity with beta=0.5	2, 3, 4	4.5% to 6.25%

Table 1.2
The Cost of Debt

	See Section of Report	Estimate
Real Risk-free Rate	8	2.5%
Term Premium	8	0 to 0.75%
Real Long-Term Risk-Free Yield	8	2.5% to 3.25%
Default Premium on A-Rated Debt	5,6	1% to 1.5%
Real Yield on Long-Term A-Rated Debt	5,6,7,8	3.5% to 4.75%

2. Beta Estimation Results

Summary

- As noted in our past reports beta estimates for the sample of nine regulated companies we examine have shown considerable instability over time, when we use the standard FT All Share Index as a measure of market returns. This is particularly marked in the early years after privatisation with a strong common tendency for betas across a range of companies to drift downwards. Movements in recent years have been in a narrower range but some drift is still evident.
- Under these circumstances the common methodology of estimating beta using only more recent data (by "rolling regressions") presents two problems: a) if beta continues to drift the rolling regression will only pick this up with some delay; b) the true range of uncertainty around beta may be much greater than that implied by confidence intervals calculated using conventional techniques, which assume beta is constant.
- We have investigated an alternative approach which uses the "Kalman Filter". This approach *assumes* beta varies over time. The resulting beta estimates are very similar to those using rolling regressions if compared on the same rolling basis, but also provide a "spot" estimate of beta at any point of time. These estimates are distinctly more volatile, and thus imply considerably wider statistical confidence intervals. We argue that these provide a reasonably conservative estimate of the degree of uncertainty surrounding beta.
- For a number of companies the statistical confidence interval for beta from the Kalman Filter is wide enough to include the figure of beta equal to one, as Ofgem assumes in setting the weighted average cost of capital.
- One possible economic explanation for the statistical property of beta instability is that it may be largely, or possibly entirely due to the nature of the "market" return. We show that if the UK stock market is viewed as a financial asset, its beta in relation to the world market (expressed in sterling) has risen significantly in recent years – probably reflecting the increasingly international composition of the firms that dominate the UK stock market. This upward movement has to a considerable extent mirrored the downward movement in the betas of regulated companies, suggesting that their relationship to the domestic component of the UK market may be distinctly more stable.
- One possible way to deal with this problem is to assume that, with increasingly integrated financial markets the appropriate measure of the market return is a measure of world, rather than UK market returns, and estimate company betas accordingly. For our sample of companies "world" betas are both more stable and distinctly lower than UK betas. While appealing in its simplicity, however, this approach may lead to an understatement of the cost of equity capital if there are significant currency risk factors in global markets and/or investors have "preferred habitats".

Detailed Analysis

Table 2.1
Alternative CAPM Beta Estimates Using Daily Data

	FTAS full sample	FTAS latest rolling sample	MSCI full sample	MSCI latest rolling sample	FTAS Kalman Filter	FTAS Rolling Kalman Filter, latest sample
Scottish Power	0.69	0.66	0.33	0.34	0.45	0.52
Scottish & Southern	0.48	0.46	0.21	0.22	0.86	0.42
Viridian	0.20	0.15	0.10	0.09	0.31	0.28
Centrica	0.66	0.90	0.34	0.51	0.71	0.70
IPR	0.74	0.76	0.43	0.32	0.89	0.84
National Grid	0.63	0.58	0.36	0.32	0.62	0.55
United Utilities	0.61	0.51	0.30	0.30	0.66	0.44
Kelda	0.32	0.32	0.15	0.18	0.90	0.35
Severn & Trent	0.46	0.44	0.24	0.29	0.67	0.39

Table 2.1 summarises the results of beta estimation using daily data for the range of different techniques we have employed. The appendix provides more detail for individual companies, with confidence intervals for both "UK" and "World" betas derived from rolling ordinary least squares regressions, and a comparison with results from using the Kalman Filter for the UK.

The Kalman Filter is applied to a time-varying coefficient state space model where the CAPM beta is assumed to follow a random walk: ie, we assume

$$\beta_{it} = \beta_{it-1} + \varepsilon_{it}$$

where ε_{it}, the innovation to β_{it}, for firm *i*, is assumed to be uncorrelated with the specific risk of firm *i*, (ie, that part of firm *i*'s return that is uncorrelated with the market). The results shown are estimated by maximum likelihood and are "backward-smoothed": ie, the results from earlier in the sample make use of later data to provide a more precise picture of beta. Effectively this is a formal statistical exploitation of the benefit of hindsight.

In the appendix we also show for each company, for the purposes of comparison, the results of an alternative estimation procedure that assumes that beta follows a smooth trend over time, which we proxy with a high order polynomial. This typically produces very similar, albeit smoother results to the Kalman Filter. For most companies allowing beta to vary in this way improves the fit of the regression equation significantly, implying that there is statistically significant time variation in beta.

Chart 2.1

Rolling Beta Estimates on FT All Share

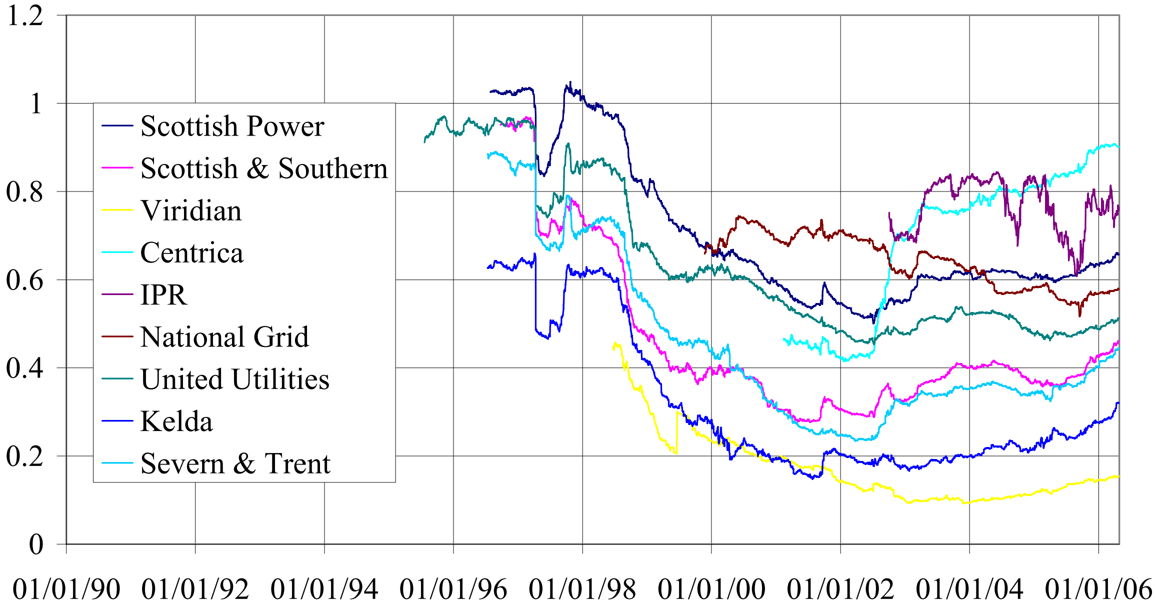


Chart 2.2

Rolling Kalman Filter Beta Estimates on FT All Share

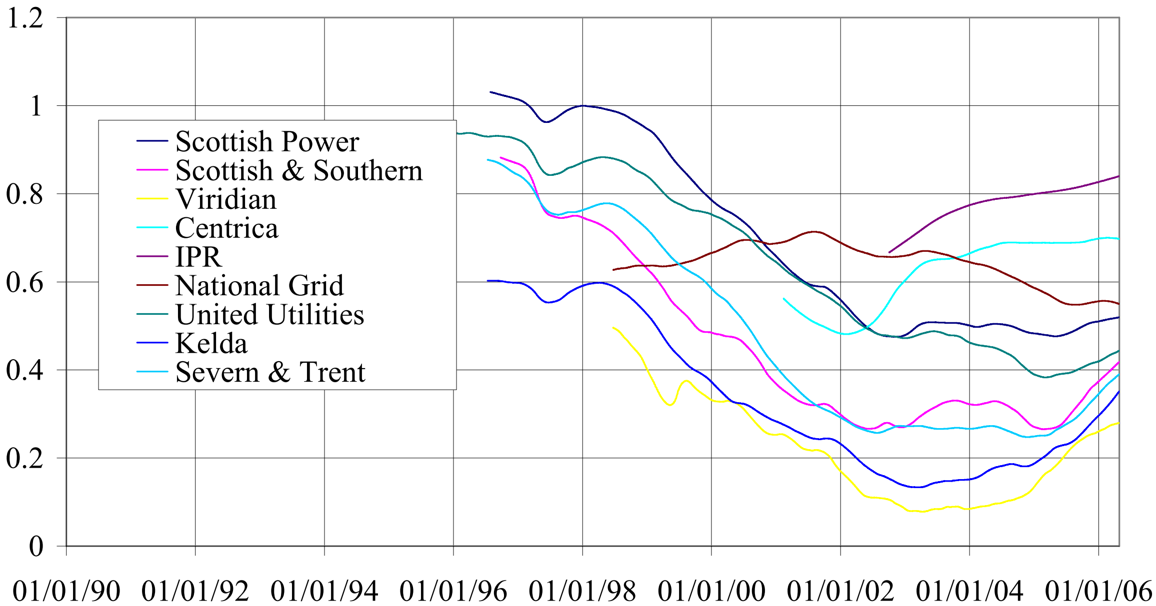
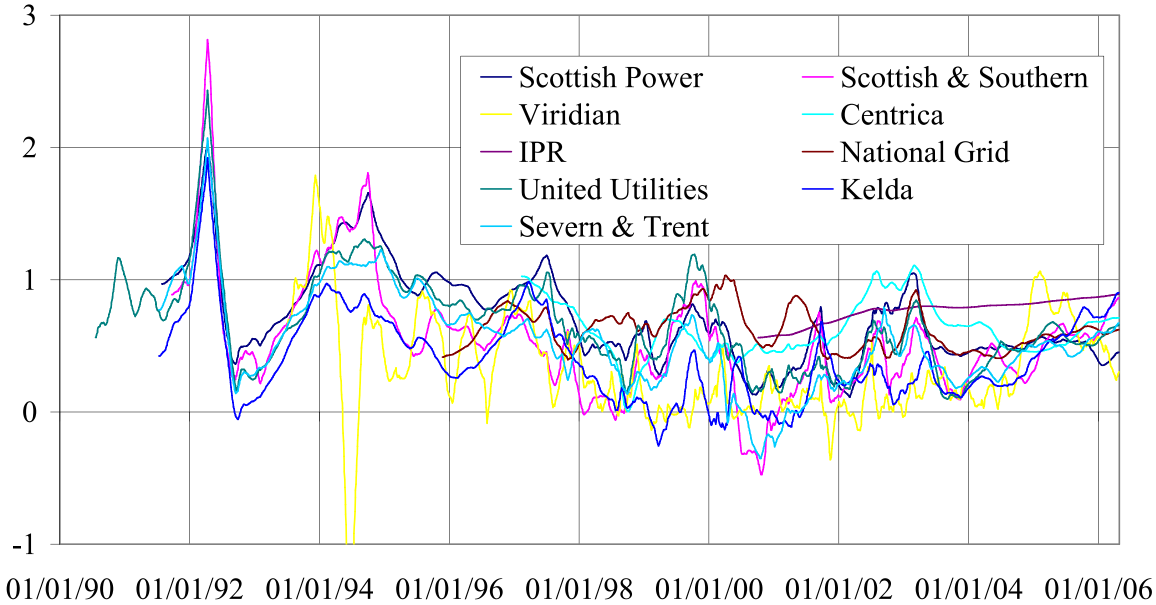


Chart 2.3

Kalman Filter "Spot" Beta Estimates on FT All Share



In comparing results from rolling regressions with those from the Kalman Filter and from polynomial trends it needs to be borne in mind that we are not entirely comparing like with like. If beta is truly varying over time, rolling regression estimates at any point in time will reflect the average value of beta in the rolling sample used for estimation (which varies from two to five years depending on the amount of data available for each firm). In contrast the Kalman Filter provides a snapshot of the best estimate of beta at a particular point in time. To make comparisons more meaningful, Chart 2.1 shows betas estimated by rolling regressions for all nine companies, while Chart 2.2 shows results from an equivalent "rolling" Kalman Filter: ie, a moving average of the "spot" Kalman Filter estimate over the same rolling data sample. Chart 2.3 shows the "spot" Kalman Filter estimates, which are, unsurprisingly, considerably more volatile. Charts for individual companies are provided in the appendix.

When measured on a comparable rolling basis, Charts 2.1 and 2.2 show that the results from the rolling regressions and rolling Kalman Filter are typically very similar. We have noted in past reports that a pattern is evident for a number of companies that rolling beta estimates appear to fall in the early years of the sample, and then are in a distinctly narrower range in those samples that terminate from roughly 2000 onwards (and thus are based on data running from roughly 1995 onwards). We noted previously that one explanation of this pattern might be that in these early years the properties of these companies were relatively unknown; whereas by the later sample periods, they had become more familiar to the markets, and therefore their betas began to settle down.

More recently there is some tendency for beta estimates to bottom out and rise somewhat, albeit within a distinctly narrower range. The "spot" Kalman Filter estimates shown in Chart 2.3 suggest that this tendency is likely to continue, with most betas rising over the past two years or so; the smoothing inherent in the rolling approach means that as yet this only shows up to a more limited extent in Charts 2.1 and 2.2. We should of course be reasonably cautious in interpreting short-term movements in the "spot" Kalman Filter estimates since these have in the past been quite volatile; but there does at least seem to be fairly clear evidence that the downward trend in betas has halted in recent years and may at least partially have gone into reverse.

Table 2.1 and Charts 2.1 to 2.3 show that, as far as central estimates of beta go, the rolling regression approach and the rolling Kalman Filter approach typically produce fairly similar (though by no means identical) answers. However, the two methods give a quite different picture of the degree of uncertainty surrounding these estimates.

In the appendix we show, for each company, confidence intervals for beta calculated both using rolling regressions[1] and the Kalman Filter. For all companies these are very different indeed. Taking Scottish Power as an example: while the rolling regression approach implies that we can be 95% certain that the "UK" beta lies between 0.5 and 0.8, the Kalman Filter suggests that with the same probability we cannot (quite) rule out beta being currently equal to either one, as Ofgem assumes in setting the WACC, or zero.

But given the very different assumptions underlying the two approaches this contrast should not be too surprising. We have argued in the past that the rolling regression approach is likely to understate the true degree of uncertainty in beta, since the confidence intervals are calculated on the assumption that beta is actually constant (an assumption, which, if true, would clearly invalidate the technique of using rolling regressions). In contrast, we would argue that the Kalman Filter method of allowing explicitly for parameter instability in beta by assuming it to be a random walk is likely to lead to estimated confidence intervals for beta that may well *over*state the degree of uncertainty.[2]

If betas were truly random walks then over the course of time they could in principle wander indefinitely far from the market-weighted average beta, which must be unity, and if all betas wandered in this way the cross-sectional standard deviation of firm betas would perpetually increase over time. We do not observe this to be the case, suggesting that, while it is plausible that betas may be subject to permanent shifts, the extent of these shifts is constrained in a way that our estimation procedure cannot allow for. Thus the true beta is likely to vary less than it would if it were actually a random walk, and hence confidence intervals from the Kalman Filter are likely to be overestimated.

Since the two approaches appear to be biased in different directions, we can therefore have some degree of confidence that the width of the confidence interval for beta lies somewhere between the two estimates. As such, it is notable that, while the confidence intervals from the Kalman Filter are distinctly wider than from the rolling regression approach, they still lie largely within the range of zero to one for most companies, for most of the time. Thus it seems safe to conclude that there is only a quite low probability that any of the companies examined (and especially those subject to regulation) have beta greater than or equal to one.

This conclusion is reinforced if we look at one possible explanation for the downward drift in beta in the earlier years of data shown in Charts 2.1 to 2.3: that it may be largely, or possibly entirely due to the nature of the "market" return. Chart 2.4 shows that if the UK stock market is viewed as a financial asset, its own beta in relation to the world market (expressed in sterling) has risen significantly in recent years – probably reflecting the increasingly international nature of the operations of the firms that dominate the UK stock market. This upward movement has to a considerable extent mirrored the

[1] As in past reports we apply the Newey-West correction to allow for possible heteroscedasticity and serial correlation in the estimated residuals.

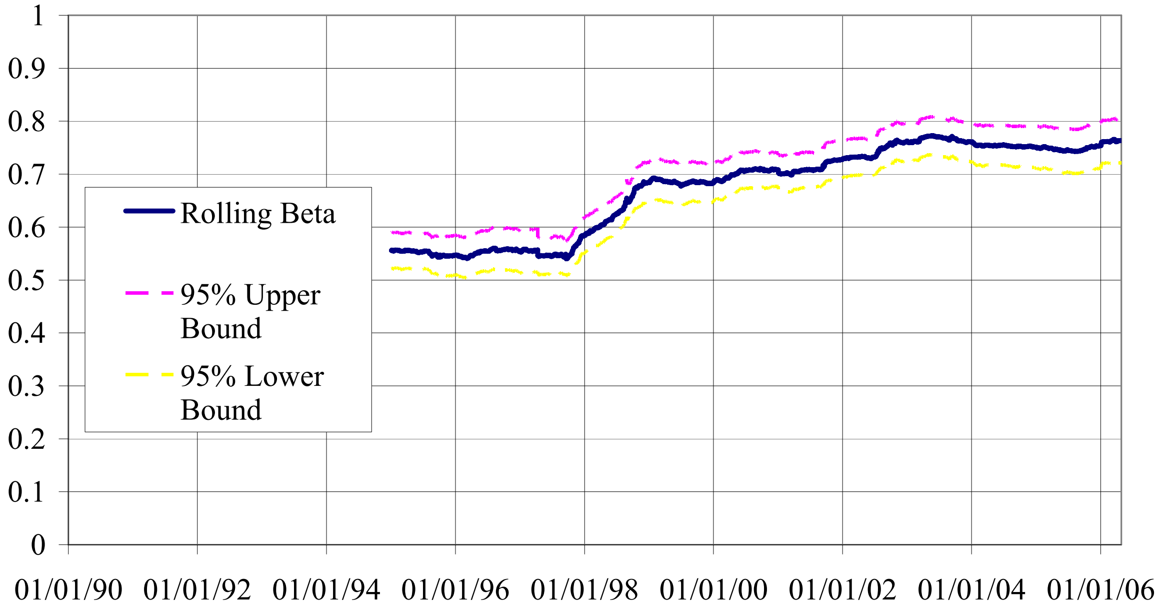
[2] We also experimented with estimating a form of time variation in which beta varies only temporarily, but tends to revert towards a stable mean. This approach did not lead however to any useful results: beta was either estimated to be constant, or to vary so much that it effectively became the residual in the CAPM regression.

downward movement in the betas of regulated companies, suggesting that their relationship to the domestic component of the UK market may be distinctly more stable.

One possible way to deal with this problem is to assume that, with increasingly integrated financial markets the appropriate measure of the market return is a measure of world, rather than UK market returns, and estimate company betas accordingly. Chart 2.5 shows the results from rolling regressions with the sterling return on the MSCI world index as the measure of the market return. [3] For comparability with Chart 2.1 it uses the same vertical scale.

Chart 2.4

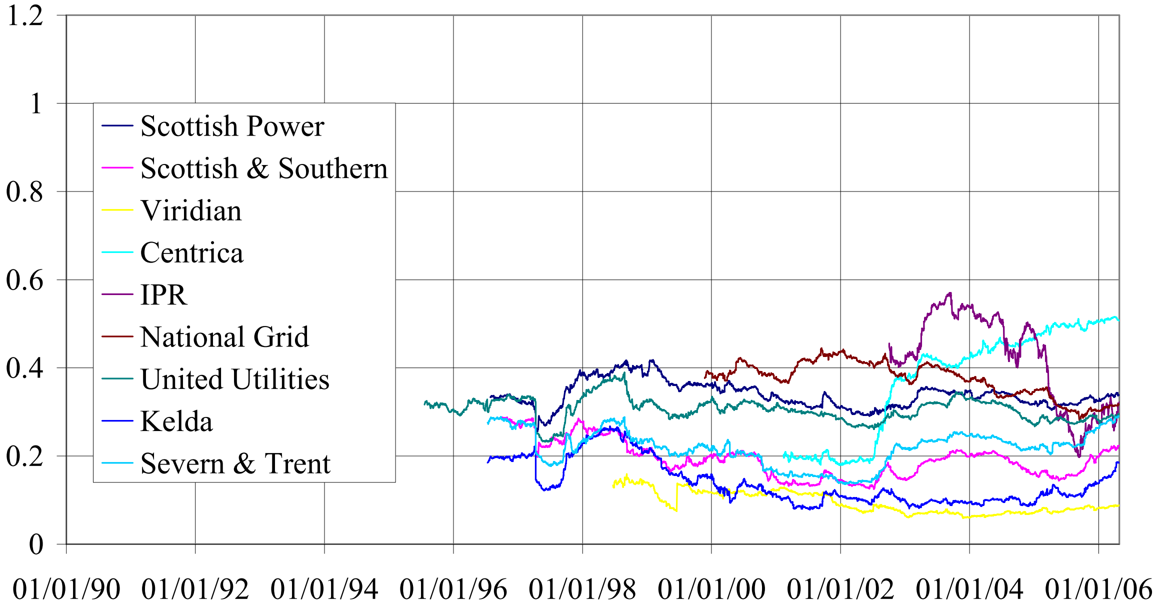
FT All Share Beta on World Return (MSCI)



[3] We have also investigated applying the Kalman Filter to "world" betas but our early results suggest so little evidence of parameter instability that for most companies the resulting beta estimates were simply constant.

Chart 2.5

Rolling Beta Estimates on MSCI World Index



For our sample of companies "world" betas are more stable and distinctly lower than UK betas. While the explanatory power of the associated regressions is lower (which, given the lower beta estimates, is almost inevitable, since this implies that company and world returns are not so highly correlated as company and UK market returns), the charts in the Appendix show that confidence intervals around the resulting beta estimates are no wider than for "UK" betas, and for some companies are actually narrower.

The results shown in Chart 2.5 suggest the alternative approach of simply using "world" betas instead of "UK" betas. This approach is certainly appealing in its simplicity. However, there is a risk that it may lead to an understatement of the true cost of equity capital if there are significant currency risk factors in global markets[4] and/or investors have "preferred habitats" (two possible explanations of the well-known "home bias" puzzle in finance). If this is the case, UK regulated companies may end up selling the greater part of their equities to UK investors, in which case "UK" betas, despite being less well-measured, and possibly unstable, may nonetheless imply more realistic estimates of the true cost of equity capital.

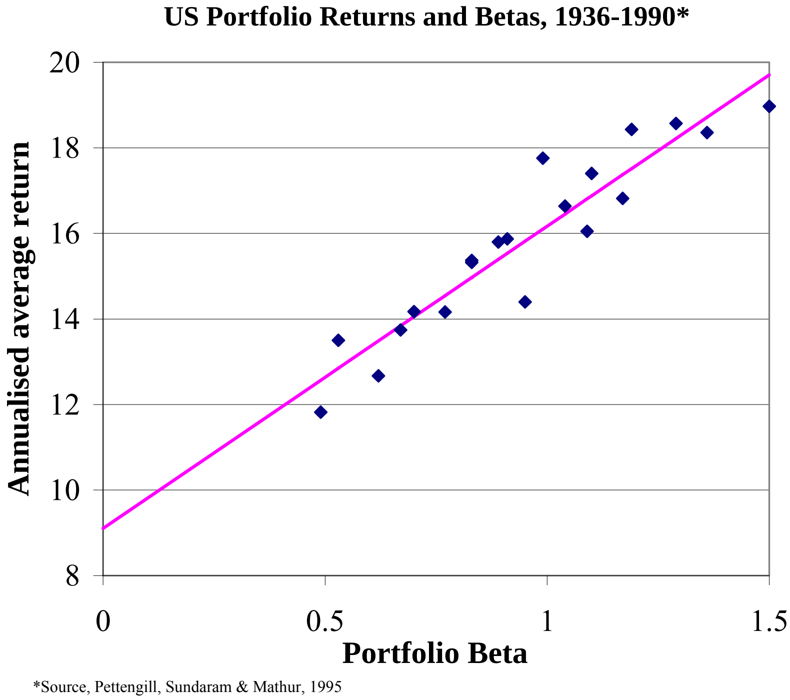
[4] See for example, Solnik (1974, 1982) Diermeir & Solnik (2001),

3 Do betas matter for the cost of equity capital?

In the light of the evidence of the previous section Ofgem's continued policy of setting beta equal to one for all companies does look distinctly generous, if the CAPM's predictions about the relationship between expected returns (in this context, the cost of equity capital) and beta can be treated as reliable. So an obvious question is: how reliable is the CAPM in this respect?

Chart 3.1 provides a simple illustration, using data taken from Pettengill, Sundaram & Mathur (1995). It shows the relationship between beta and realised returns for 20 portfolios of US stocks. Note that here, as in most other contexts, the implicit assumption is that average realised returns are a good measure of average *expected* returns: or, put another way, that expectational errors average out to zero. Given the length of the sample employed this is arguably not too strong an assumption (it becomes much more problematic in shorter samples). There is a clear positive relationship (the solid line shows the line-of-best-fit).

Chart 3.1



After the initial evidence in favour of the CAPM of authors such as Fama & Macbeth (1973), Black, Jensen and Scholes (1972) a number of "anomalies" were identified in subsequent research: factors that appeared to influence expected returns that were unrelated to beta. The most notable of these were the "size" and "value" effects that in due course were captured in the Fama-French multifactor framework that we analyse in the next section. To what extent do these anomalies undermine the key prediction of the CAPM that high betas are associated with high expected returns?

Chart 3.2
The CAPM and the Small Firm Effect

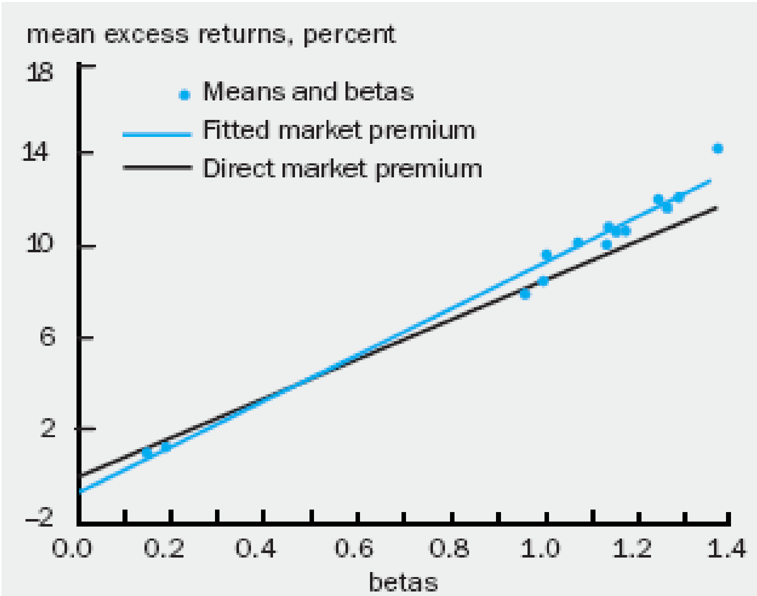


Chart 3.2, taken from Cochrane (1999), provides some visual evidence that one of the famous anomalies, the small firm effect, was actually only a fairly modest qualification to the CAPM. Using data from the sample 1947-1996, the "direct market premium" is the "security market line" predicted by theory, which should link betas and average excess returns over the safe rate. This line simply joins up the safe rate (with an excess return and beta both equal to zero) and the realised market return (proxied by the NYSE value-weighted portfolio) with a beta of one. The remaining points on the chart show betas and excess returns for ten stock portfolios (sorted by size) and two bond portfolios (at the bottom left of the diagram), and the dashed line shows the line of best fit between these points.

The chart shows that while the CAPM does not fit the data perfectly it did a pretty good job over the post-war period, consistent with the evidence of the previous chart. The line of best fit between the observations is somewhat steeper than the relationship predicted by theory, due to the "size" effect: points moving north east are portfolios of firms of increasingly smaller size. While these had higher betas in this sample period returns on these portfolios were higher than the CAPM would have predicted (in commonly used parlance, these portfolios had "positive alpha"). The deviation from the CAPM prediction was however both quite modest (to quote Cochrane: "Would that all failed economic theories worked so well!") and subsequently appears to have disappeared (see next section for evidence on this score from this UK).

A more significant caveat, and potentially a more important one for Ofgem, relates to the other (and, thus far, seemingly more statistically robust) anomaly, the "value" effect. Portfolios of stocks in companies with relatively high book-to-market ratios ("value" firms) have in the post-war era typically earned higher returns than portfolios with low book-to-market ratios ("growth" firms), for a given value of beta. Since regulated companies typically fall into the former category, the extent of this value effect is clearly potentially of some interest.

Chart 3.3
The CAPM and the Value Effect

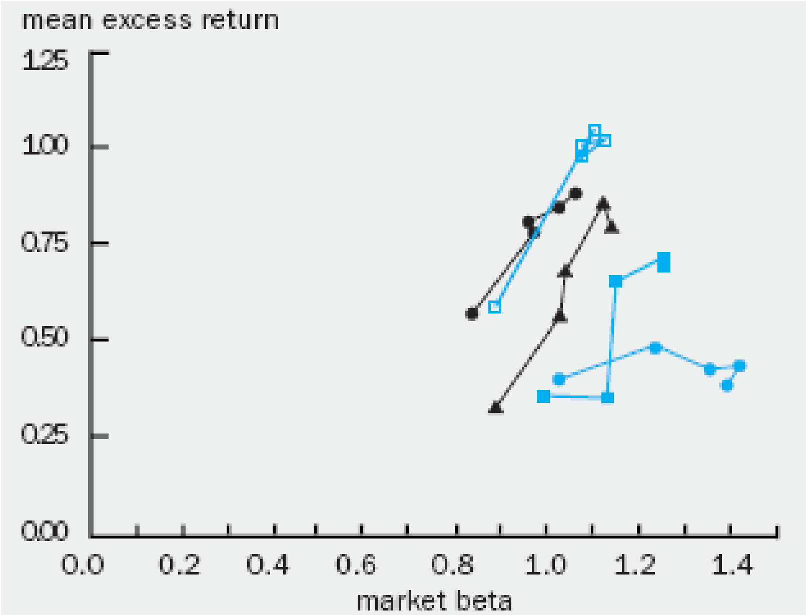


Chart 3.3, also taken from Cochrane (1999), using Fama & French's (1995) dataset, illustrates the extent of the value anomaly.[5] Instead of sorting stocks into portfolios on the basis of size alone, they are also sorted on the basis of book-to-market ratios. Each set of points joined up by a given line are in the same book-to-market category, but of different sizes. Within the same book-to-market category the same positive relationship between beta and expected return is clearly visible (as in the first diagram, firms are in a smaller size category moving north-eastwards), but lower book-to-market ratios (ie, an increase in "value") shift the line upwards: ie, value firms have "positive alpha". This additional element in realised returns for value firms is quite significant. Subsequent research (eg, Dimson et al, 2001) has provided evidence that the "value" effect appears significant in other markets and in other samples.

Thus we can state two fairly clear conclusions:

- Betas *do* appear to have mattered for historic returns, thus, other things being equal, to the extent that Ofgem chooses to ignore the evidence that betas of companies it regulates are typically well below one, it may be overstating the cost of capital quite significantly.
- On the other hand, to the extent that the firms it regulates can be viewed as "value" stocks, there may be an offsetting element in the cost of capital for these companies that is not related to beta.

In the next section we turn to the evidence on the latter point.

[5] Note that in this chart excess returns are measured monthly, hence the difference in scale.

4. Fama French Estimates

Summary

Ofgem have asked us to investigate the use of the Fama-French three factor model in assessing the cost of capital for the same nine companies examined in Section 2. This alternative asset pricing model has attracted increasing attention in recent regulatory discussions (see Section 11).

We find that, using monthly UK data from Exeter Enterprises, there is at best weak statistical evidence for a significant role for the additional two factors – the "size" effect and the "value vs growth" effect in determining returns on the nine companies examined in Section 2. This lack of statistical significance is compounded by uncertainty as to the statistical significance of any risk premia associated with these two additional factors, and considerable uncertainty as to the underlying economic rationale for a value effect.

If we lean over backwards to extract as much evidence in favour of the value effect as we can, a "pooled" estimate using data for all regulated companies in our sample suggests it might add at most around 1 ¼% to the cost of equity. Ofgem might wish to consider investigating the significance of the value effect on daily data.

Detailed Analysis

The Fama French (or more generally, the multifactor) approach has two key elements, *both* of which are crucial if it is to have implications for the cost of capital.

- There may be other sources of mutual correlation between assets besides that arising from assets being correlated with the "market", as assumed in the CAPM. To the extent that these sources of mutual correlation cannot be diversified away in large portfolios, they represent non-diversifiable, or "systematic" risk.
- Such additional sources of risk must have associated risk premia.

The first element is quite easy to substantiate; the second distinctly less so.

Table 4.1 shows that even after allowing for the mutual correlation across the nine companies we examined in Section 2 due to their correlation with the market, there remain reasonably significant correlations between the notionally "idiosyncratic" risk elements in individual company returns. This pattern is confirmed by formal statistical tests.[6]

[6] Common factor and principal component analysis provides quite strong evidence of at least one common factor driving returns, even after allowing for the impact of the market return.

Table 4.1
Correlation between residuals from daily beta regressions

	SPW	SSE	VRD	CEN	IPR	NGT	UU	KEL	SVT
SPW	1.00								
SSE	0.60	1.00							
VRD	0.16	0.19	1.00						
CEN	0.17	0.16	0.02	1.00					
IPR	0.24	0.21	0.10	0.16	1.00				
NGT	0.28	0.26	0.11	0.22	0.17	1.00			
UU	0.25	0.29	0.12	0.20	0.16	0.23	1.00		
KEL	0.18	0.22	0.14	0.06	0.14	0.08	0.40	1.00	
SVT	0.25	0.30	0.11	0.18	0.14	0.17	0.51	0.42	1.00

Oftem have provided us with monthly data from the Exeter Enterprises Risk-Style database on the three Fama-French factors for the UK market which we have analysed to see whether these are a significant source of mutual correlation across the nine companies we examine. Chart 4.1 shows the cumulative returns on the three portfolios. The first, the market portfolio, is the excess return on the FT All Share, and hence identical to the UK market measure we use in Section 1. The second portfolio captures the well-known "size effect" which was one of the first anomalies identified in empirical investigations of the CAPM. The third proxies for the"value vs growth" effect. In both cases the portfolios are long-short portfolios: eg, the return on the "small-vs-big" portfolio is the return on a sample of the smallest firms *less* the return on a sample of the largest; that on the value-vs-growth is the return on companies with high book-to-market ratios, *less* the return on companies with low book-to-market ratios.

Chart 4.1

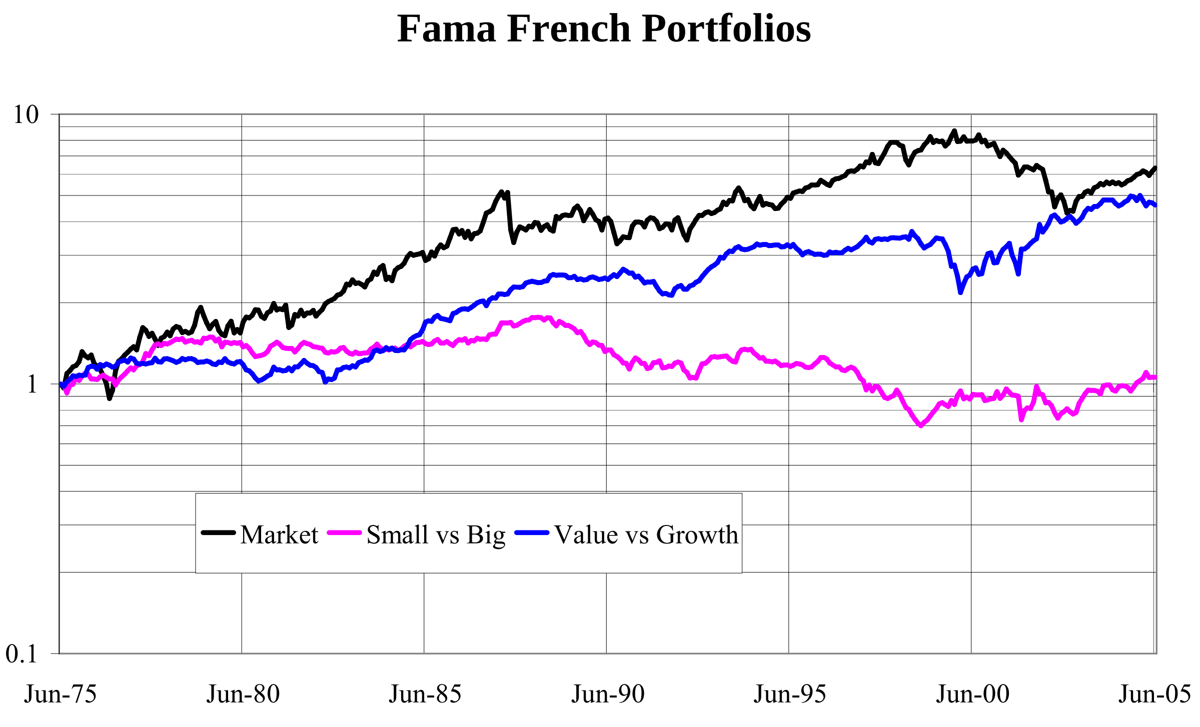


Table 4.2 shows the estimated multifactor betas for the nine companies we examine. The results are not very promising. Estimated betas on the first factor, the market return, are all highly significant, and, as Table 4.3 shows, very close to CAPM betas when these are estimated in isolation. However, while betas on the two additional factors are typically of the expected sign, for only a few of the companies are they statistically significant.

Table 4.2
Fama French Factor Betas*

	Market	Value vs Growth	Small vs Big
SPW	0.75 (0.00)	0.39 (0.02)	-0.08 (0.63)
SSE	0.65 (0.00)	0.43 (0.01)	0.04 (0.84)
VRD	0.41 (0.01)	-0.11 (0.49)	-0.25 (0.15)
CEN	0.80 (0.00)	-0.12 (0.43)	-0.22 (0.19)
IPR	2.13 (0.00)	0.24 (0.25)	0.05 (0.85)
NGT	0.57 (0.00)	0.04 (0.73)	-0.43 (0.00)
UU	0.56 (0.00)	0.22 (0.05)	-0.10 (0.38)
KEL	0.55 (0.00)	0.31 (0.02)	-0.09 (0.55)
SVT	0.44 (0.00)	0.29 (0.02)	-0.04 (0.75)

* Seemingly unrelated regression estimates. Figures in brackets show "p-values": ie, the probability that the relevant coefficient is zero.

These results are rather discouraging. They are however not entirely surprising, for two reasons. First, the factors are only available on a monthly basis. We have noted in past reports that when CAPM betas are estimated using monthly data the results do not appear as reliable as those using daily data. There are for example some distinctly strange beta estimates using monthly data – for example the extremely high beta for International Power – that are almost identical whether estimated in isolation or in conjunction with the other Fama French coefficients. These are, however, as Table 4.3 shows, very different indeed from those using daily data.

Table 4.3
Fama French vs CAPM Market Beta Estimates

	Fama French*	CAPM*	CAPM daily	CAPM (World) daily
SPW	0.75	0.78	0.69	0.33
SSE	0.65	0.68	0.48	0.21
VRD	0.41	0.42	0.20	0.10
CEN	0.80	0.80	0.66	0.34
IPR	2.13	2.15	0.74	0.43
NGT	0.57	0.57	0.63	0.36
UU	0.56	0.57	0.61	0.30
KEL	0.55	0.57	0.32	0.15
SVT	0.44	0.45	0.46	0.24

* Seemingly unrelated regression estimates
** OLS estimates

A second reason why weak results are unsurprising is that typically (as in Fama & French's original research) the strongest evidence for multifactor models comes from regression results using portfolios of many stocks, so that results are not affected by truly idiosyncratic elements in company returns.[7]

Quite apart from the weakness of the results shown in Tables 4.2 and 4.3, it is also important to bear in mind the crucial second element which is required if multifactor models are to have implications for the cost of capital: that additional factors should have statistically significant associated risk premia. Chart 4.1 makes it clear that for one of the additional factors, the "size" effect, there has been effectively no associated risk premium over the past thirty years or so. For the "value-vs-growth" effect there is stronger evidence of a sustained risk premium in returns, but even here caveats are in order. First, the average excess return is only barely significantly different from zero (with a *t*-statistic of 1.9); and second, and probably more crucially, it is an "anomaly" with a distinctly shorter track record. It should be borne in mind that, had we been writing this report in the early 1980s, we would be able to point to what was then very strong statistical evidence of the "size" effect, which has however been seriously undermined by more recent data.

Bearing all the caveats about weak statistical significance in mind, Table 4.4 calculates estimates of the impact of incorporating a role for Fama French factors for the nine companies. Since the market beta estimates are barely affected by the inclusion of the two new factors, the table shows the estimated *marginal* impact on the cost of capital of allowing for the additional factors. This shows that, despite being mostly statistically barely significant, for some companies the resulting adjustments to the cost of capital are quite large.

However, even apparently statistically significant results for some companies are seriously undermined by the very fact of the overall results being so patchy: it is not easy to see, for example, why Centrica should be regarded as a "growth stock". Our overall conclusion is that it would be unwise to place much, if any, weight on these results for individual companies as they currently stand.

[7] We have investigated whether the results shown in Table 3.2 are strengthened if we form portfolios of similar stocks: eg, electricity generation companies. The results are no stronger; but again this should not be too surprising, since the associated portfolios have only very small numbers of companies.

Table 4.4
Naive Estimates of Fama French Impacts on Cost of Equity Capital

	Value vs Growth	Small vs Big	Value vs Growth	Small vs Big	Total
			Historic Risk Premia		
	Betas		6.01%	0.58%	n/a
			Implied Impact on Cost of Equity		
SPW	**0.39***	-0.08	**2.34%***	-0.05%	2.30%
SSE	**0.43***	0.04	**2.58%***	0.02%	2.61%
VRD	-0.11	-0.25	-0.66%	-0.15%	-0.81%
CEN	-0.12	-0.22	-0.72%	-0.13%	-0.85%
IPR	0.24	0.05	1.44%	0.03%	1.47%
NGT	0.04	**-0.43***	0.24%	**-0.25%***	-0.01%
UU	0.22	-0.1	1.32%	-0.06%	1.26%
KEL	**0.31***	-0.09	**1.86%***	-0.05%	1.81%
SVT	**0.29***	-0.04	**1.74%***	-0.02%	1.72%

* Factor beta is significant at 5% level.

Could a "value effect" for regulated companies offset low CAPM betas?

In section 3 we noted that, taken in isolation, Ofgem's choice of a value of beta equal to one appears distinctly generous. The only caveat to this conclusion, we noted, was if the impact of a low beta on expected returns might be offset by a positive value effect. Our Fama French estimation results, while not very impressive for individual firms, *do* give an overall impression that there may be a value effect associated with regulated companies. It is noteworthy that, ignoring the significance of the estimates for individual companies, all but one of the regulated companies in our sample (ie, excluding Centrica and IPR, which are effectively unregulated) has a positive coefficient on the value vs growth portfolio. But is this collective value effect sufficient to outweigh the impact of Ofgem's beta assumption?

To answer this question we engage in an exercise in fairly shameless data-mining: ie, we do our utmost to extract notionally statistical significant result from the data, on the assumption that there is indeed a collective value effect. In general such forms of data mining are frowned upon by academic economists, except when used in an attempt to provide an upper bound for parameter estiamates. To get the most that we can out of the data, we impose two restrictions on the equations described above. First, since the size effect appears largely insignificant, we eliminate it entirely from all equations (this joint restriction is fairly easily accepted on standard criteria, with a probability value of 11% on a Wald Test). Second, in order to capture some collective value effect, we impose the restriction that all regulated companies have the common coefficients both on the market, and on the value-vs-growth portfolio (this restriction is again quite easily accepted, with a probability value of 21%). Table 4.5 shows resulting coefficients from this exercise, and the implied impact on the cost of equity, taking the observed sample excess returns on the market and the value-vs-growth portfolio as given.

Table 4.5
Pooled Estimates of "Value Effects": Impact on the Equity Premium

	Market Beta	"Value Beta"	
Pooled coefficient (1)	0.529	0.206	
Standard Error	0.074	0.075	
P-value	0.000	0.006	Total Impact on Equity Premium
Sample Excess Return on Factor (2)	6.68%	6.01%	
Impact on Equity Premium (1)*(2)	3.53%	1.24%	4.77%

The table shows that the resulting pooled estimates of the market and value betas are both quite precisely estimated, and statistically strongly significant (with the clear caveat that, since they result from an exercise in data mining this significance is fairly notional). The final line of the table calculates the impact on the cost of capital of using the resulting coefficient estimates.

As a basis for comparison, if we applied the current Ofgem approach to this dataset, and set beta equal to one, the risk premium element in the cost of equity would simply equal the sample excess return on the market of 6.68%. If instead we use the pooled estimates of the two betas, the risk premium element is nearly two percentage points lower: that is, while the value effect is significant and positive, if we apply it consistently along with the market beta estimate it certainly not does offset the impact of a low beta.

We would argue that the sample excess return in this dataset almost certainly overstates the true equity premium, which, in line with our previous analysis in Mason, Miles and Wright, we would put at only around 4 to 5 percentage points (see discussion in Section 8). But even with a figure as low as 4 percentage points the joint impact on the equity premium element in returns of a low market beta and the value effect would be 3.24%[8] - ie, below the estimate of 4% if a beta of one were used and the value effect were ignored.

We thus conclude that, while there may be a modest value effect for regulated companies, the evidence for this is at best fragile, and, crucially, the overall impact on the cost of capital of allowing for any such value effect along with a lower market beta estimate would be to lower the implied estimate of the cost of equity capital. We would however suggest that Ofgem might wish to consider further investigations of the value effect: in particular it might be worth pursuing this line of approach using daily data.

A further caveat: What is the Value Effect anyway?

Quite apart from the weak evidence for a value effect for regulated companies, and its limited impact on the cost of capital, there is a further caveat: what *is* the value effect? This is still subject to considerable debate in academic circles, and thus far there are no clear-cut agreed answers.[9]

Cochrane (2005) summarises arguments that both the value and small firm effect may reflect forms of systematic risk that affect the typical investor differentially from the market return. The small firm

[8] Calculated as beta times equity premium plus value effect= 0.5*4%+1.24%

[9] In this respect the Fama French model is in marked contrast to the CAPM. The Fama French factors arose out of the data, from CAPM anomalies: the rationale for these additional factors arose afterwards. In contrast CAPM arose from an equilibrium model of expected asset returns derived from first principles: this theoretical model was used to generate testable hypotheses. As such it is much less prone to a data mining critique.

effect (if it exists!) may reflect the fact that the typical investor is (or works for) a small firm (Heaton & Lucas, 2000) while the value effect may reflect risk factors related to financial distress (a point originally made by Fama & French themselves).

To the extent that this argument holds water it is perhaps worth noting that it is arguably *not* relevant to regulated companies, since they are typically not in a state of permanent financial distress. It therefore casts doubt on their having a permanent value effect. It should be stressed that the "value vs growth" portfolios used in estimation do not contain a fixed population of companies: on the contrary, different firms move in and out. Cochrane points out that a typical firm in the value portfolio has seen its share price fall in the recent past. To some extent the value effect may therefore reflect the historic "return reversal" tendency in stock returns in general.

Petkova (2006) takes this link further, and thus provides a quite different perspective. She examines the Fama-French model in the light of Campbell (1996), who noted the necessary link between the cross section of returns and factors that predict returns. Petkova's results suggest that the Fama French factors may be proxying for "news" about other factors that predict returns in general, such as interest rates, term spreads and dividend yields. When such terms are included in Fama French regressions their effects dominate the original small firm and value vs growth factors.

Given the difficulties involved in untangling ultimate causes in economic relationships, this perspective on the Fama French model might not of itself be too much cause for concern – it would simply provide a new "story" to back up their original results. Unfortunately the basis for this story, the predictability of aggregate stock market returns, is in itself the subject of considerable academic controversy (an issue we discuss briefly in Section 7 below), with a number of authors taking the revisionist line that stock returns are, after all essentially unpredictable, with any evidence of predictability arising from "data mining". If this revisionist view of return predictability is correct, Petkova's results mean that the Fama French factors are effectively tarred with the same brush, and are an artefact of a particular period of history, rather than a permanent phenomenon.

One thing that is fairly predictable is that the academic debate on both return predictability and Fama French will not be concluded any time soon. For as long as the debate continues, this lack of consensus casts further doubt on the importance of the value effect.

5. Analysis of Grant Thornton Utilities Bond Yield Database

Summary

We have carried out some statistical analysis of a new database of utility bond yields that has been constructed by Grant Thornton. This database provides yields for UK, US and Euro bonds; we have however focussed exclusively on the UK data.

Our overall conclusion based on this analysis is in line with that of our previous report: that corporate bonds appear to be essentially "commoditised". Once we know information about a company's credit rating (which may possibly include not only its current rating, but also any warnings given by credit rating agencies that it may be re-rated) and the other key characteristics of the bond, the most important of which is clearly maturity, there appears to be no evidence of any significant company-specific effect on yields that is not captured by these characteristics.

Detailed Analysis

Table 5.1 summarises the key features of the database. The population of bonds covered rises over time, to reach 76 bonds in the most recent data. Of these in 2005 20 were rated AA or AAA. For most of the bonds in this category however this rating is illusory since they were issued and guaranteed by a third party, which thereby assumed any default risk. The rating therefore relates to the third party issuer, not the companies themselves.

Of the remaining bonds a significant majority (45 in 2005) are A-Rated, with the remainder rated BBB. While the database subdivides A-rated bonds further, we have not been able to find any evidence that this further subdivision has any informational content.

Chart 5.1 provides a summary of the full database. All yields in Chart 5.1 and succeeding charts are shown on the left scale, while the right scale shows the number of bonds. As a benchmark for comparison Chart 5.1 also shows the 10 year UK gilt yield. The chart reveals three key characteristics: first the recent narrowing of the spread between the average utilities yield and the risk-free yield; second there has been a considerable degree of cross-sectional variation in yields; and third, the degree of cross-sectional variation has itself varied over time, with a particularly narrow degree of variation in the recent past.

To a great extent this pattern of cross-sectional variation is however explicable in terms of key characteristics of the bonds. Charts 5.2 and 5.3 progressively narrow down the sample of bonds in terms of the two key characteristics: credit rating and maturity. Chart 5.2 restricts the sample to the dominant group of A-rated bonds; Chart 5.3 in turn shows only the dominant sub-group of A-rated bonds: those with maturity greater than 10 years. In each chart, this progressive narrowing down produces a significant reduction in cross-sectional variation in yields – to the extent that in recent data cross-sectional variation is largely eliminated.

Table 5.1
The Grant Thornton UK Utilities Bond Database

Population		Year	End of year population									
Rating	**Sector**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
1) AAA rated	electric-distribution			1	1	1	1	1	1	1	1	2
	electric-integrated											1
	gas-distribution											10
	water							1	3	4	4	6
1) AAA rated Total				***1***	***1***	***1***	***1***	***2***	***4***	***5***	***5***	***19***
2) AA rated	electric-distribution		1					2	2	2	2	1
	electric-integrated	1	1	1				2	2	2	2	
	electric-transmission		2	2	1	2						
	gas-transportation	3	3									
	water		1	1	2	2		2				
2) AA rated Total		***4***	***8***	***4***	***3***	***4***		***6***	***4***	***4***	***4***	***1***
3) A rated	electric-distribution	2	2	3	2	3	2	3	5	5	5	6
	electric-integrated		1	3	4	7	5	4	7	6	5	7
	electric-transmission						2	3	3	4	4	4
	gas-integrated							1	1	1	1	1
	gas-transportation			3	2	4	5	6	7	7	7	7
	water		1	1	4	5	11	11	17	17	18	20
3) A rated Total		***2***	***4***	***10***	***12***	***19***	***25***	***28***	***40***	***40***	***40***	***45***
4) BBB rated	electric-distribution			1	4	3	4	3	2	4	4	4
	electric-integrated				1	1	3	3		1	1	1
	water				2	2			2	4	4	6
4) BBB rated Total				***1***	***7***	***6***	***7***	***6***	***4***	***9***	***9***	***11***
5) BB rated	water						2			1	1	
5) BB rated Total							***2***			***1***	***1***	
Grand Total		**6**	**12**	**16**	**23**	**30**	**35**	**42**	**52**	**59**	**59**	**76**

Chart 5.1
Grant Thornton UK Utilities Bond Yields: All

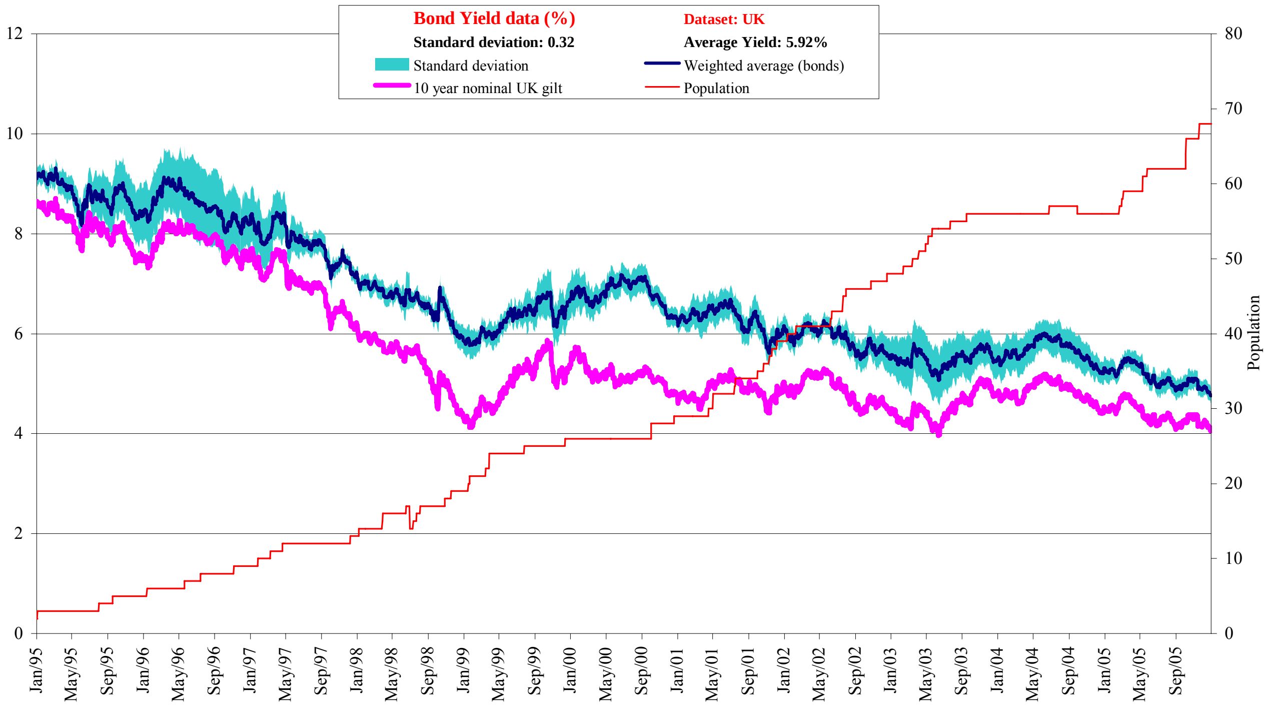


Chart 5.2
Grant Thornton UK Utilities Bond Yields: A-Rated

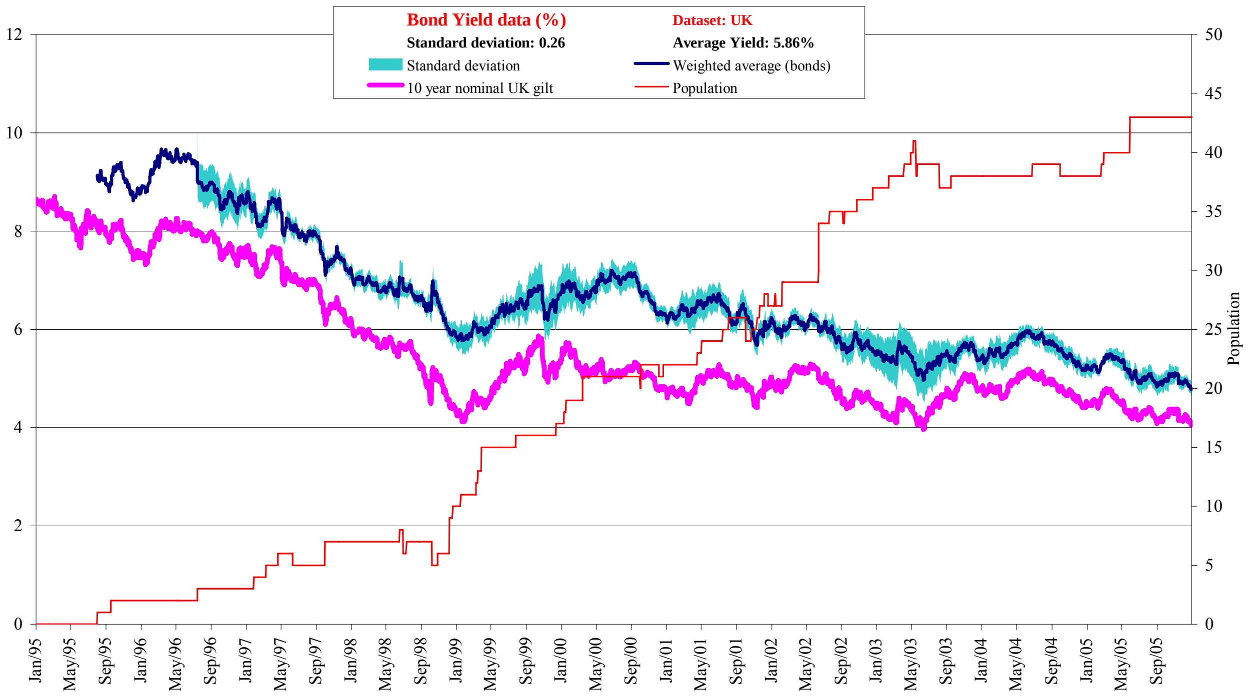
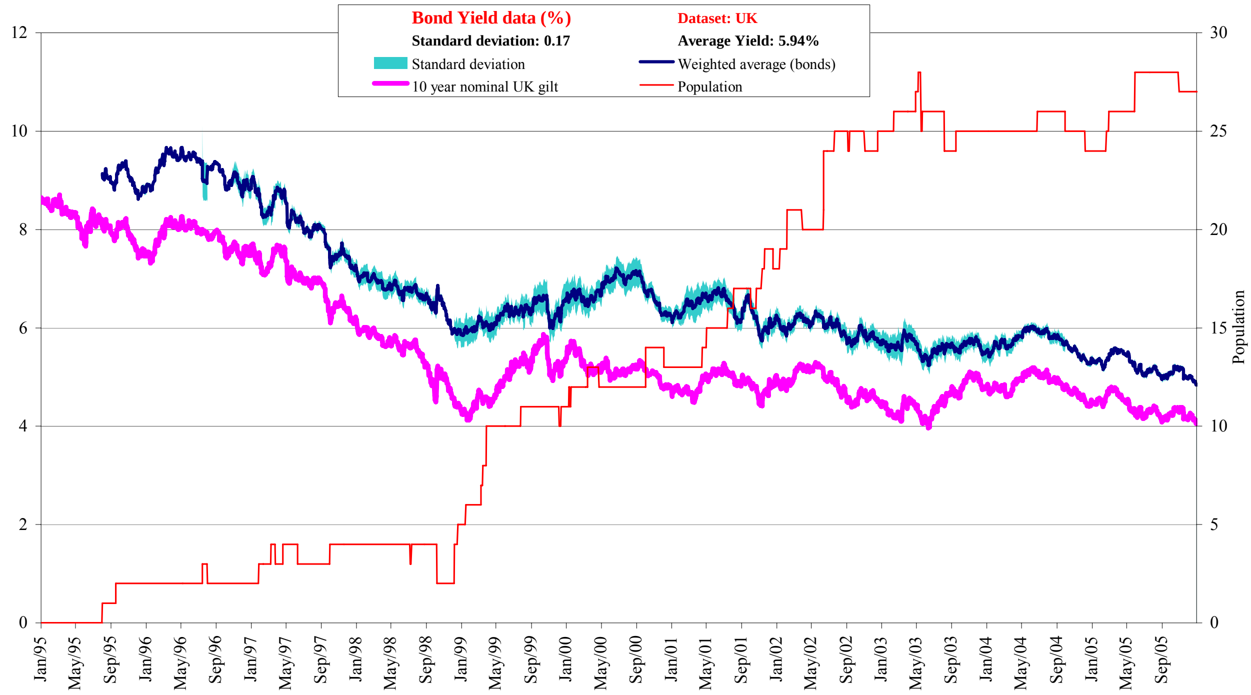


Chart 5.3
Grant Thornton UK Utilities Bond Yields: A-Rated, 10 year+



We suggested in our last report that the appropriate benchmark for comparison for utilities yields is not a gilts yield, but the yield on a benchmark corporate bond of a comparable credit rating and maturity. Such benchmarks are readily available.

Chart 5.4 shows (over a shorter sample) yields from Bloomberg's A-rated "Fair Value Curve", for a range of maturities. These yields are not yields on actual quoted bonds, or averages thereof, but are yields on notional bonds trading at par, fitted to a curve. One salutary feature of the yields in Chart 5.4 is that these too have the property that the degree of cross-sectional variation between yields itself varies considerably over time, and has also largely disappeared in recent data. But this feature is of course entirely explicable in terms of a single market characteristic, namely maturity. In the period shown the maturity-yield curve moved from being fairly strongly upward-sloping to being almost entirely flat.

Charts 5.5 and 5.6 provide a comparison between the Grant Thornton database and the Bloomberg 10 year benchmark yield. Since, as noted above, the majority of the Grant Thornton bonds have maturity greater than 10 years, the comparison with all such bonds in Chart 5.5 is not a particularly good one. If the sample is reduced to bonds in the 8 to 15 year maturity range the match with the Bloomberg benchmark is extremely strong, suggesting that it is very important to get a precise maturity match. Unfortunately the number of bonds within this range is quite small.[10]

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[10] Unfortunately the Bloomberg yields do not run beyond a maturity of 15 years. Additionally we have currently not succeeded in matching the longer-dated Bloomberg yield data to the Grant Thornton database due to non-matching daily samples.

Chart 5.4

Bloomberg Fair Value A-Rated Yields

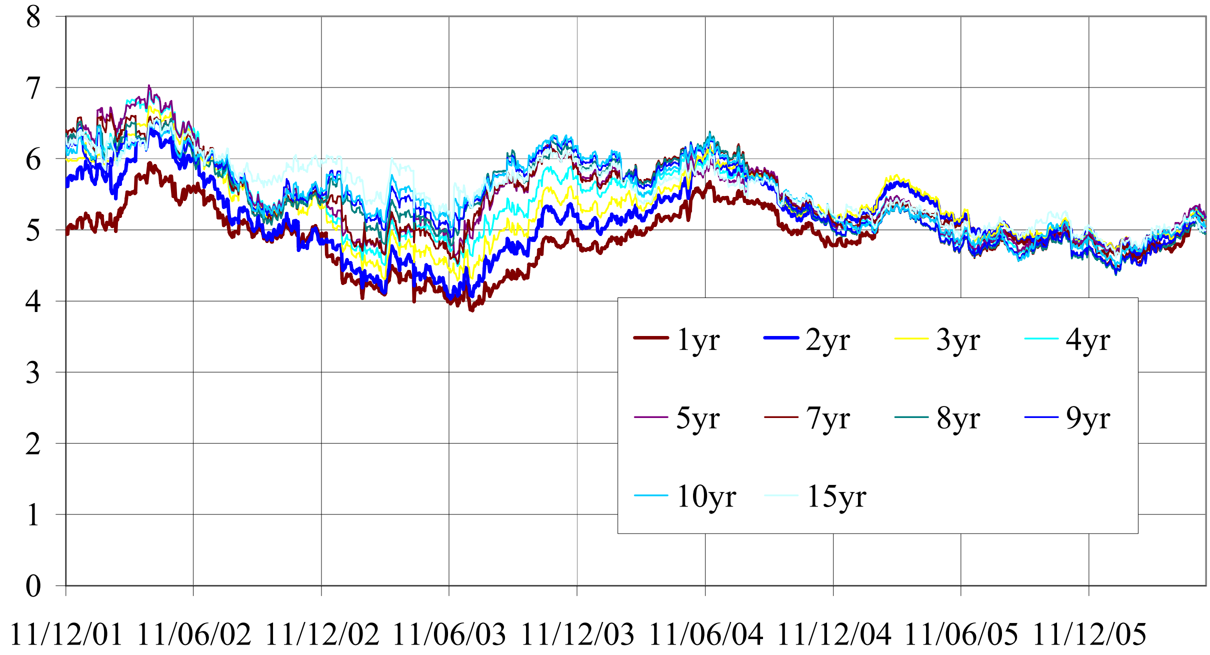


Chart 5.5
Grant Thornton vs Bloomberg 10 Year Benchmark: A-Rated, 10 yr+

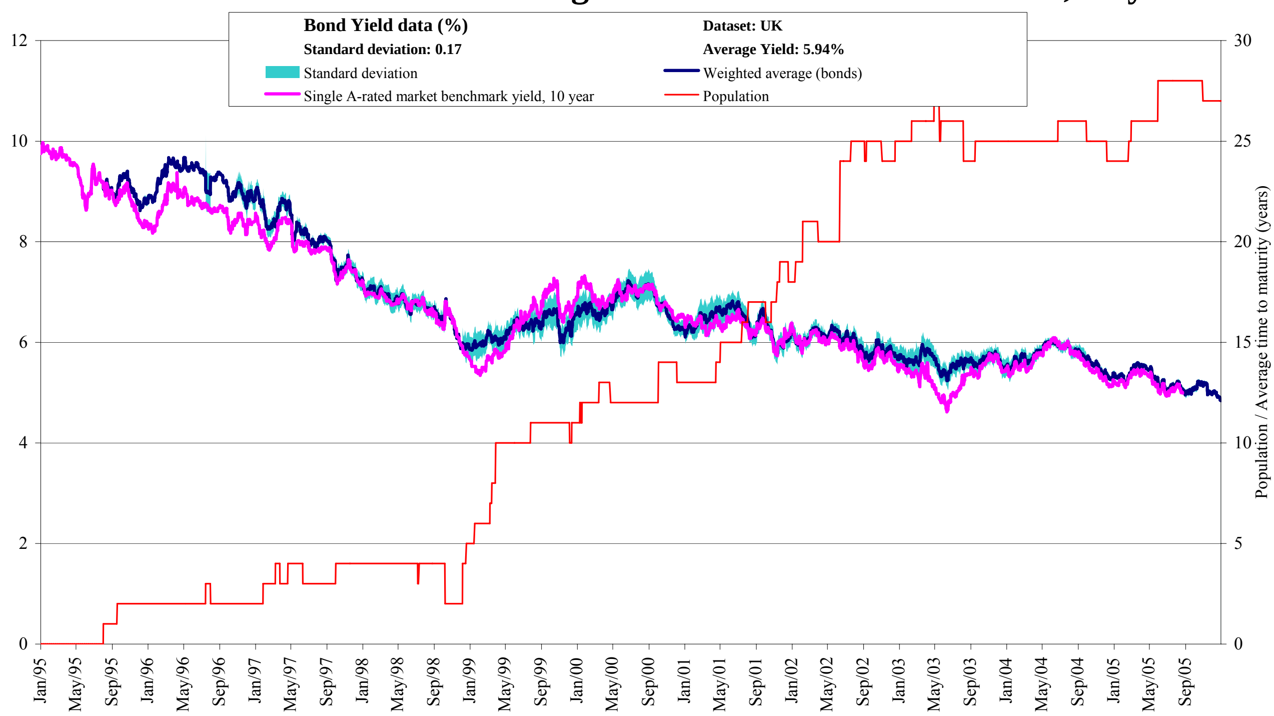
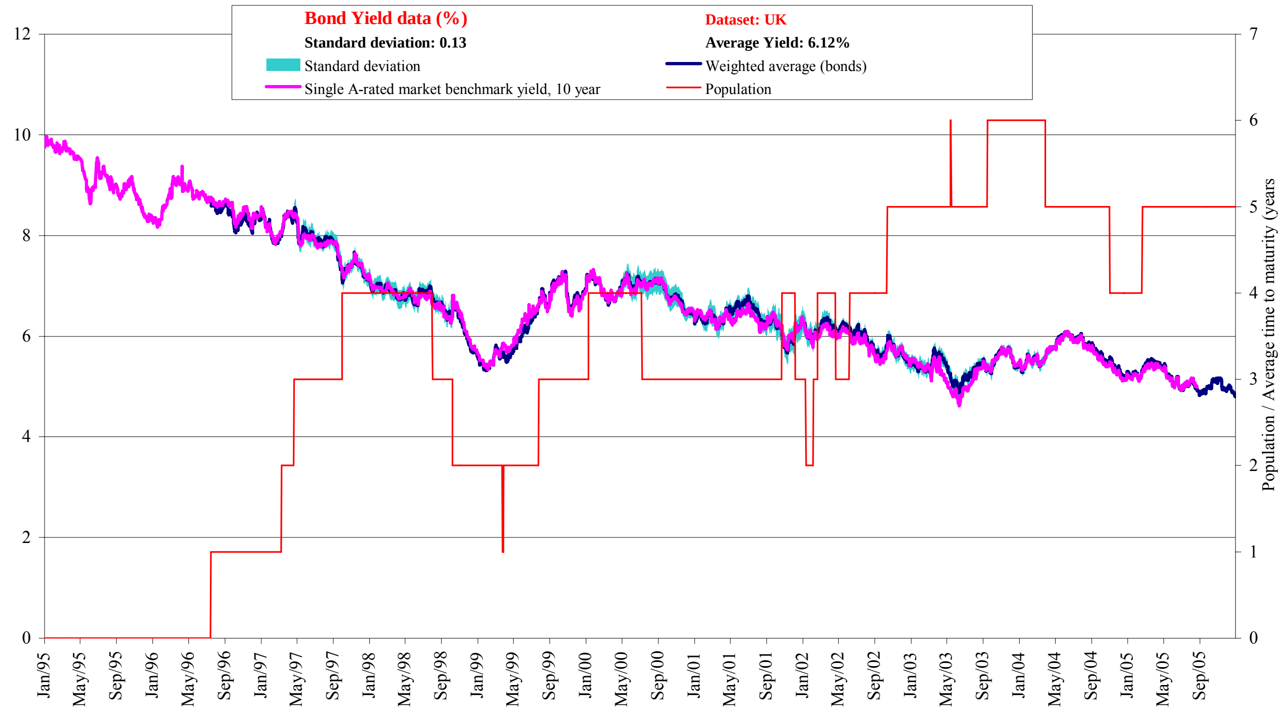


Chart 5.6
Grant Thornton vs Bloomberg 10 Year Benchmark: A-Rated, 8-15 yr



The visual evidence from Charts 5.1 to 5.6 is supported by statistical analysis which shows that a significant amount of cross-sectional variation in yields can be explained by identifiable market characteristics of the bonds. In Appendix F we report the results of panel regressions using both yields and spreads (relative to risk-free bonds that are notionally of the same maturity[11]) The characteristics allowed for are: coupon (to allow for possible tax distortions); duration and convexity; issue size (to proxy for possible liquidity effects); and a dummy variable capturing credit rating. All characteristics are strongly significant, with the expected sign. On average these characteristics explain around one third of the cross-sectional variation in yields. This figure would almost certainly be considerably higher with a more flexible formulation of the underlying relationships. [12]

[11] These spreads are directly provided by Datastream so we do not have details of the benchmark gilts that are being used, nor of how precisely maturities are matched). The fact that the two maturity-related indicators are strongly significant in the spread regression than in the yield regression suggests that the maturity match with risk-free bonds used to calculate the spread may not be a good one.

[12] For example we also include a dummy variable for each calendar year which gives a rather crude adjustment for time variation in yields. A larger number of time dummies would no doubt improve fit considerably but with loss of degrees of freedom. Similarly the impact of credit rating is assumed to follow a linear pattern which may lead to understatement of the impact of individual ratings.

6. Analysis of Benchmark Corporate Spreads

Summary

Since the conclusion of the previous section was that yields on utilities' bonds are effectively commoditised, the only consideration in setting the cost of debt finance is to arrive at an estimate of the appropriate yield to assume for the chosen benchmark. We focus here exclusively on the A-rated benchmark, and our analysis in this section is largely an update of that in our previous report.

In recent years credit spreads of corporate bonds in the UK and the US, compared to risk-free bonds of the same maturity, appear to have been increasingly strongly linked, to the extent that since 2000 the average spread on an A-rated UK bond has been virtually identical to that on the much used Moody's Aaa benchmark for the United States, at just over 100 basis points. The advantage of the latter series is that we have a very long run of historical data, running from 1925. This suggests that the current spread only is slightly above its long-term historic average of around 80 basis points, but is rather low compared to more recent history.

Detailed Analysis

As noted in our last report, in comparison with the long swings in asset prices that have been observed over the past couple of centuries, corporate spread data have a relatively short history, if we restrict ourselves to data from the UK. However, data from the US are available for a much longer period.

Chart 6.1 compares spread data for the Bloomberg's benchmark A-rated 10 year bond for the UK with the spread on Moody's Aaa. This latter series has the advantage of a long run of data published by the Federal Reserve. The chart brings out the common features in spreads in both economies in recent years. Strikingly, also, the correlations appear to have increased in more recent years as markets have become more integrated.

Over the full sample shown in Chart 6.1 the average spread for the UK A-rated bond has been 105 basis points, while that for the US Aaa bond has been 85 basis points. Notably, however, this difference in spreads has more or less disappeared in more recent years: since the start of 2000 the average spreads have been 105 and 101 basis points respectively. Thus the much longer history of Moody's Aaa rated bond appears to provide a relevant historic benchmark.

Chart 6.1

UK vs US Corporate Bond Spreads

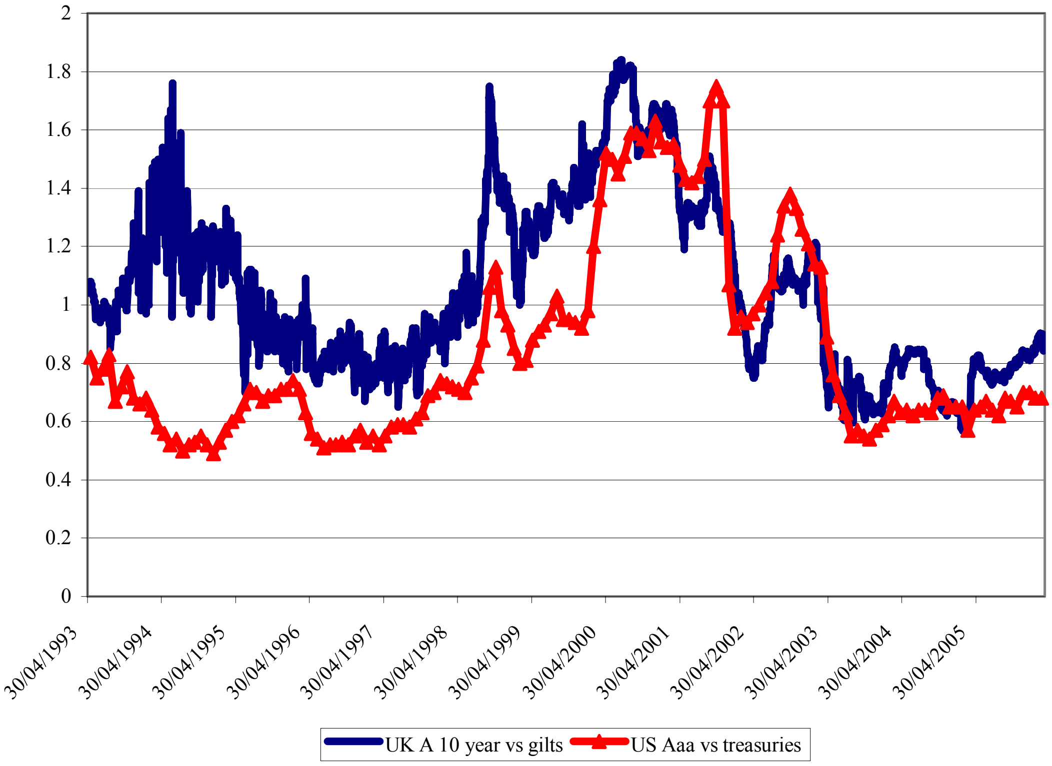
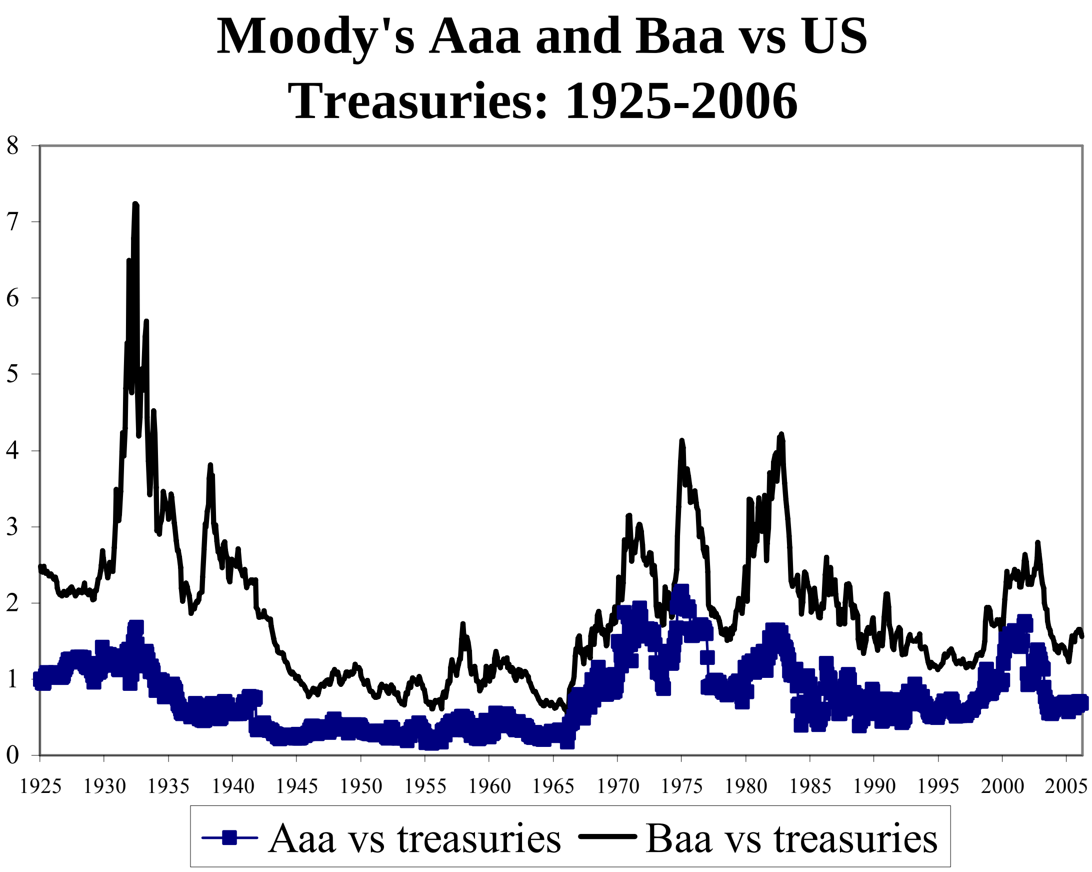


Chart 6.2 provides a much longer historical comparison using US data on both Moody's Aaa and Baa from 1925 to early 2006. In our previous report we noted a number of key features visible in this chart.

- The degree of historical variation in spreads has been quite wide. Current credit spreads in the USA are at fairly low levels historically, but certainly not at all-time lows. They are comparable to values in the 1980s and 1990s, but still above the lows seen in the early postwar period.
- The chart suggests a greater stability in the higher rated Aaa spread.
- This is reflected in average spreads over all available data: the average for the Aaa spread has been 77 basis points, compared to 190 basis points for the Baa spread. The similarity between the long historical average for the Aaa spread and its average of 85 basis points in the much shorter sample since 1993 shown in Chart 6.1 is quite striking.
- An obvious statistical caveat is that historical movements in both spreads have been highly persistent. Thus it would be overly simplistic to assume that current rather low spreads must inevitably revert towards the historic average over the sort of time horizons relevant to regulators.

Chart 6.2



Moody's Aaa and Baa vs US Treasuries: 1925-2006
8
7
6
5
4
3
2
1
0
1925 1930 1935 1940 1945 1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005
Aaa vs treasuries
Baa vs treasuries

7. Issues in the measurement of average expected returns

Geometric vs arithmetic averaging and horizon effects

This issue was covered in some detail in our earlier report (Mason, Miles & Wright, 2003), so we will only summarise the key issues here. (We provide the key algebraic relationships in Appendix C.) The key distinction is between compound and arithmetic average returns. The latter measure is the appropriate measure to apply in the CAPM and most other asset pricing models, and is systematically higher than the compound average return.[13]

The difference can be expressed in terms of the volatility of returns: to a reasonable approximation the arithmetic average return exceeds the compound average by half the squared volatility of returns. Thus, as an illustration, suppose that the volatility of annual log returns is 20%, which Mason, Miles and Wright cite as a rough ballpark figure for a range of equity markets. The implied difference between the arithmetic mean annual return will approximately equal $0.2^2/2 = 0.02$, or two percentage points. The difference between the two measures of mean returns is therefore quite significant for equity returns. For bonds, with lower volatility of returns, the adjustment is not so significant (and frequently for this reason is ignored), but the adjustment does provide one reason (discussed further in the next sub-section) why bond yields are at best an imperfect measure of the true cost of debt.

Mason, Miles and Wright note that a possible complication with the adjustment is that it may be horizon-dependent, if there is an element of predictability of returns. This can be expressed most simply in terms of the "variance ratio" of long-horizon returns, first analysed by Cochrane (1988), which compares the variance (squared volatility) of, eg, a 10 period return with 10 times the variance of the one period return. If the variance ratio is one at all horizons returns are completely unpredictable in terms of their own past, and we show in the appendix that the investment horizon over which returns are measured is immaterial. But if it declines with the investment horizon the variance adjustment to expected returns falls proportionately to the variance ratio.

How important this effect is depends on just how long a horizon is deemed appropriate for measuring returns. Chart 7.1 shows the variance ratio for real US stock returns over the past two hundred years[14]. At medium-term horizons the decline is not very significant, but at long horizons of 15 to 20 years (arguably those of most importance to the typical equity investor) the historic variance ratio has been around a half, so that if this is taken as a reliable estimate of the true variance ratio at this horizon the implied difference between the compound average and arithmetic average returns is also half that for annual returns: ie only around 1 percentage point as opposed to two, so the effect is non-trivial.

However, as is often the case in such matters, there is an important caveat. In recent years the return predictability literature originating in the work of authors such as Fama & French, Campbell & Shiller and Cochrane (1999) has come under significant fire, and is currently an area of considerable academic controversy.[15] Of particular relevance to the issue discussed above, Kim et al (1991) noted that the evidence of a declining variance ratio appears to disappear in post-war data. If the evidence of a

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[13] The simplest example of this is an asset that rises by 50% and then the next year falls by one third, so that if its initial value was £100 it ends up worth £100 again after two years. The compound average return over two years is thus zero but the average return is (50-33)/2=8.5%.

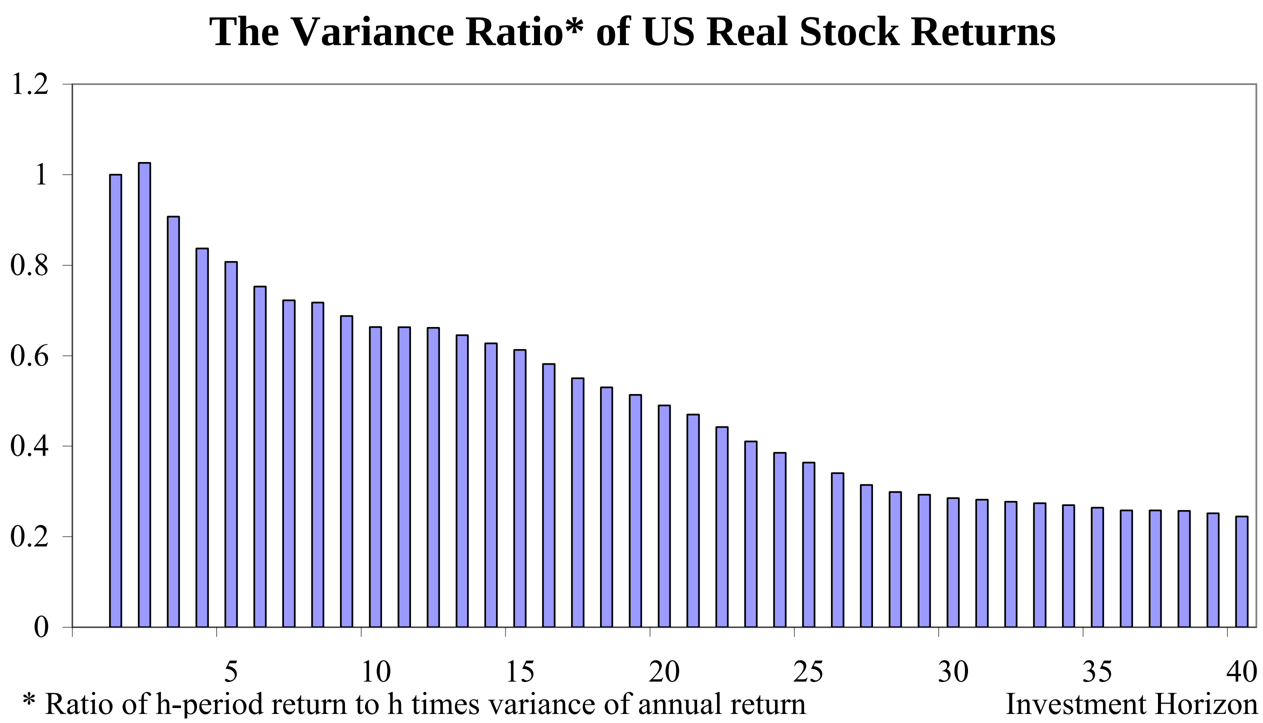
[14] Data construction is described in Robertson & Wright (2006).

[15] For two strong contributions to the debate see, on the revisionist side, Goyal & Welch (2003), and on the pro-predictability side, Cochrane (1999).

declining variance ratio is indeed now effectively redundant, then the horizon effect for arithmetic vs compound average equity returns disappears.

For as long as the academic jury is out on the predictability debate, a conservative approach is therefore probably to use the arithmetic return adjustment based on annual returns, of around 2 percentage points.

Chart 7.1



Bond yields as proxies for the cost of debt

Bond yields are commonly used as direct measures of the cost of debt. It should be borne in mind that they are, at best, imperfect *proxies* for the true cost of debt, which is the expected investment return to the holder of the bond. There are three sources of potential bias:

<u>a) Capital appreciation</u>

The yield does not capture expected changes in the *price* of the bond. At any point in time future yields may be expected to rise or fall, implying in turn that bond prices are expected to fall or rise. This point is potentially an important limitation of the use of current bond yields as a measure of expected returns: to do this thoroughly requires that account also be taken of current market forecasts (explicit or implicit) of future yields, which in turn will affect the expected return on long-dated bonds. The most obvious example of this phenomenon is the "inverted" yield curve (ie when long yields are less than short-term interest rates) Typically this does not imply that the true expected return on bonds is less than that on short-term rates, but rather that all rates are expected to fall in the future, leading to rises in bond prices, thus boosting expected bond returns relative to the yield.

When using long-period averages rises and falls in bond prices can be expected largely to cancel out. Indeed, as we show in Appendix D, if the yield curve is flat on average the average yield will be identical to the average (geometric) holding return on long-term bonds. However, if there is an upward- (or downward-) sloping yield curve on average (on which issue see our discussion in Section 8), the average yield will systematically under- (or over-) state the geometric mean holding return.[16]

b) The impact of volatility

A further related bias is that when calculating the implied *arithmetic* average holding return on bonds account needs to be taken of the fact that this is quite significantly more volatile than the yield itself: we thus need to apply a volatility correction as discussed above. If we use the historic volatility of the holding return on UK long-term bonds (discussed in more detail in Section 8 below) this implies a fairly modest correction of around one quarter of a percentage point.[17] Over longer holding periods the nominal holding return becomes less volatile but this is offset by the impact of inflation uncertainty: Campbell & Viceira (2002) show that in contrast to equity returns there is little historic evidence of declining variance ratios for long term real bond returns – if anything the reverse has been the case.

c) Default and re-rating risk

An offsetting bias is that the yield on corporate bonds treats both coupons and repayments of principal as guaranteed. With default and re-rating risk this implies that the measured yield systematically *over*states the true expected return. Clearly, the lower the rating of the bond, the more significant this bias is. Table 7.1 gives a numerical illustration, using the formula in Benninga (1997), who uses historic ratings transition probabilities and debt recovery rates for a range of S&P rated bonds. The formula calculates the notional "expected" yield on a bond, where coupon and principal repayments are replaced by their expected values, taking into account the probability that a bond may be re-rated, and ultimately may default (in which case it is assumed to repay bondholders 41% of the principal, the average recovery rate over the period 1975-1995).

Table 7.1
"Expected Yields" on a 20 Year 5% Coupon Bond trading at par.

S&P Rating	Risk-Free	AAA	AA	A	BBB	BB	B
"Expected Yield"	5%	4.95%	4.88%	4.75%	4.43%	3.61%	2.23%

The benchmark for comparison is the risk-free bond. Since it is assumed to be trading at par its yield will equal its coupon of 5%. For highly rated bonds the reduction in the "expected yield" allowing for re-rating and default risk is very small, since the cumulative probability of both being re-rated downwards and then defaulting is so small (bearing in mind that at any point in time there is always a positive probability of being re-rated upwards again), but the adjustment becomes very significant indeed for the lower ratings.

[16] This arises because, for example, over a holding period of a year a 10 year bond will become a 9 year bond. If the yield on a 9 year bond is typically lower than that on a ten year bond the price of the bond will on average rise by more than would be expected if both maturities had the same yield.
[17] The volatility of the annual holding return on long-term bonds since 1840 was around 7%. This implies a volatility adjustment of $0.07^2/2 \approx 0.25\%$.

Rather conveniently the downward bias for A rated bonds and upwards is of a very similar order of magnitude to the volatility adjustment. Thus if the yield curve is flat on average (see discussion in Section 8) the overall bias in using average yields on highly rated corporate bonds as a measure of expected returns is probably close to zero.

8. The Common Components of the Cost of Capital

In this section we examine the components of the cost of capital that are common to all companies – namely the overall market return, and yields on risk-free assets at both short and long maturities. Since the market return was covered extensively in Mason, Miles and Wright (2003) most of this section is devoted to the latter issue, and in particular the term premium on both nominal and indexed bonds.

Key points:

- We have not altered our estimate of the real market return on equities (6.5% to 7.5%) or our estimate of the risk-free rate (2.5%).
- Recent yields on UK indexed bonds give a distorted impression of real yields. Regulated companies still predominantly issue nominal bonds. Thus, given the evidence of bias in indexed yields, risk-free government nominal bonds should be used to provide a benchmark estimate of the term premium.
- In both recent data and over much longer runs of data, there is no obvious stability in term premia. In the twentieth century, and especially in the post war period, the term premium was on average positive and quite substantial (but showed considerable variation); however in the nineteenth century there was a negative term premium. Thus on a purely statistical basis there seems little reason for expecting the current term premium of essentially zero to revert to some historical average value.
- Longer runs of data also provide some insight into the determinants of term premia. Holding returns on long-term bonds in the twentieth century were both much more volatile over short horizons and, for a significant part of the century, distinctly risky at long horizons. Both these features were driven by the properties of inflation. The largest term premia occurred in periods after investors had made disastrous losses on long-term bonds.
- While short-term volatility of holding returns has remained quite high, the longer-term risks of holding nominal bonds have arguably been very significantly reduced in recent years by Bank of England independence. Even shorter term volatility may attract only a modest risk premium if it is associated with stabilisation of the economy.
- Thus analysis of the determinants of term premia appear to reinforce the purely statistically based conclusion that there is no obvious reason to expect term currently low term premia to revert to higher values on a sustained basis.
- If the term premium is indeed close to zero, the best current market-based estimate of the forward-looking real interest rate is the nominal yield on medium-dated bonds, less the Bank of England's inflation target of 2%: thus a figure of around 2 to 2 ½%, remarkably close to that in the benchmark "Taylor Rule".
- A very important caveat is that, while short-term rates and long-term yields are likely to move together in the future, their average level is quite uncertain. Both could in principle be pulled *upwards* towards the historically much more stable equity return. In the heyday of the stock market boom in the 1980s and 1990s real interest rates were significantly higher.
- Thus a more conservative approach that might be to assume a term premium equal to the average over the twentieth century of around ¾%.

Detailed Analysis

The Market Return on Equities

This issue was discussed extensively in Mason, Miles and Wright (*op cit*). We see no reason to change their central estimate for the real arithmetic market return on equities of 6.5% to 7.5%.

This figure was derived from Dimson et al's (2001) estimates of the compound average real return of 5.5% from the major world equity markets over the course of the twentieth century, a figure which is also very close to the historic real return on the UK market. We noted in our discussion that the real equity return appears remarkably stable both over time and across countries.

To this compound average return estimate we add an adjustment to derive the arithmetic average return, which we took to be in the range of one to two percentage points (see discussion in Section 7), depending on the degree of predictability of returns: the upper figure is appropriate if returns are unpredictable.

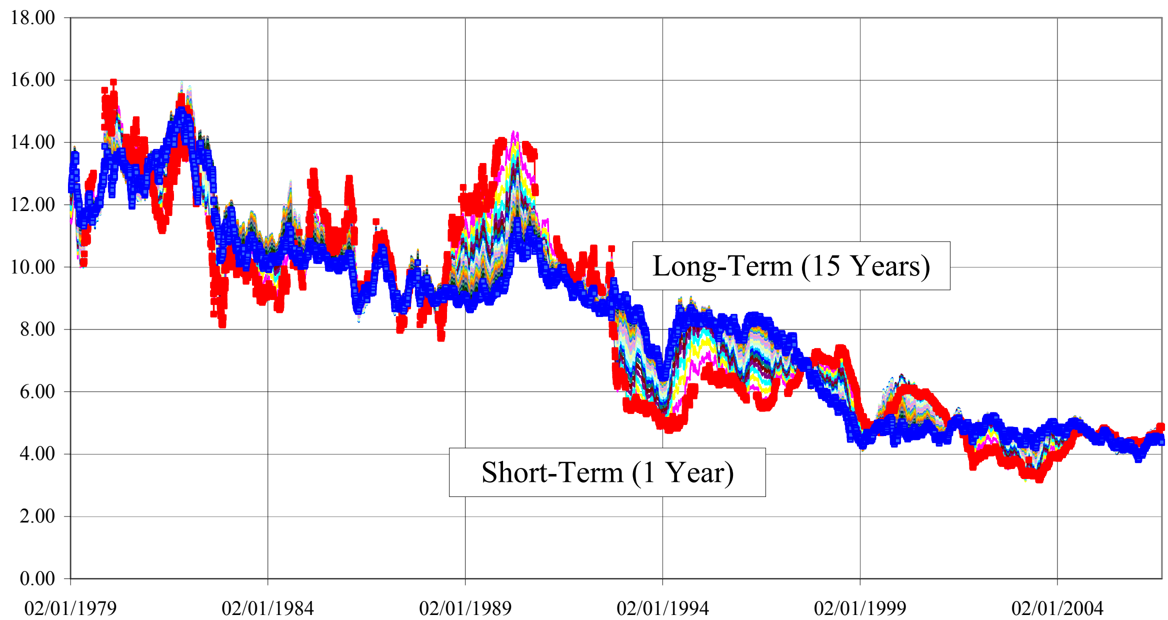
The Real Risk-Free Rate and the Equity Premium

We also see no reason to amend our estimate of the real risk-free rate of 2.5%, although we noted in our earlier discussion that historic average values provide considerably less evidence that this has a stable mean. This figure is widely used by central banks as a benchmark. We note below that it a very similar figure is also implicit in the current term structure of nominal yields.

This figure, combined with the real market return on equities, implies an arithmetic equity risk premium of 4 to 5 percentage points. As discussed in our previous report, the equity premium estimate must be regarded as a less statistically reliable figure because of the lack of any historically stable mean of the risk-free rate.

Chart 8.1

UK Nominal Bond Yields



The Term Premium

Chart 8.1 summarises the link between yields on bonds at a range of maturities, from 1 year up to 15 years.[18] To show the nature of the link more clearly the longest and shortest maturities are highlighted in blue and red respectively. The chart displays the well-known tendency for the long-term rate to be more stable than the short-term rate. This feature is readily explicable if the long-term rate is viewed as a forecast of future short-term rates plus a (possibly time-varying but reasonably stable) risk premium. Thus when, for example, the short-term rate is above the long-term rate (an inverted yield curve) as it was in the late 1980s and early 1990s this is usually interpreted as implying a forecast that short-term rates will fall back. [19]

A striking feature of the recent past (also evident in the corporate yields examined in Section 5) is that differences between yields at different maturities (ie term premia) have all but disappeared. One obvious, and important question for regulators is whether this is to be viewed as purely a temporary phenomenon. A second important question is whether regulators should look at yields on nominal or indexed bonds.

Charts 8.2 and 8.3 break down nominal yields (over a somewhat shorter sample) into indexed yields and the implied inflation rate over the life of the bond. This latter series is derived on the implicit assumption that the term premium applicable to both indexed and nominal bonds is the same. The two charts show that the general tendency for nominal yields to fall in recent years has been due both to falls in the implicit forecasts of inflation (particularly in earlier years) and to falls in indexed yields. The latter have been at unprecedented lows in the recent past, most notably at long maturities.

The recent path of the implicit inflation forecasts lends some support to the widely held suspicion that indexed yields are providing an unduly depressed picture of forward-looking real returns (the usual explanation being the funding requirements on major pension funds). In 2003 the Bank of England's inflation target was officially lowered from 2 ½% to 2%, yet in the period since this change implicit inflation forecasts have risen rather than fallen, to a figure closer to 3%. The most likely explanation is that the gap between nominal and real yields is not purely a forecast of inflation, but also contains a risk premium element (or, put another way, that indexed bonds have traded at an increasing risk *discount*).

Since regulated companies issue barely any indexed debt this suggests that using indexed yields as a benchmark in setting the cost of capital may tend to bias the cost of debt downwards, and that it would be more appropriate to focus on nominal yields, and their associated term premia.

[18] All yields in Charts 8.1 to 8.4 are zero coupon yields from the Bank of England.

[19] Any such a forecast also of course implies that long-term rates themselves will move, thus, as noted above, meaning that at any point in time there is no simple link between yields and expected bond returns.

Chart 8.2

UK Real Bond Yields

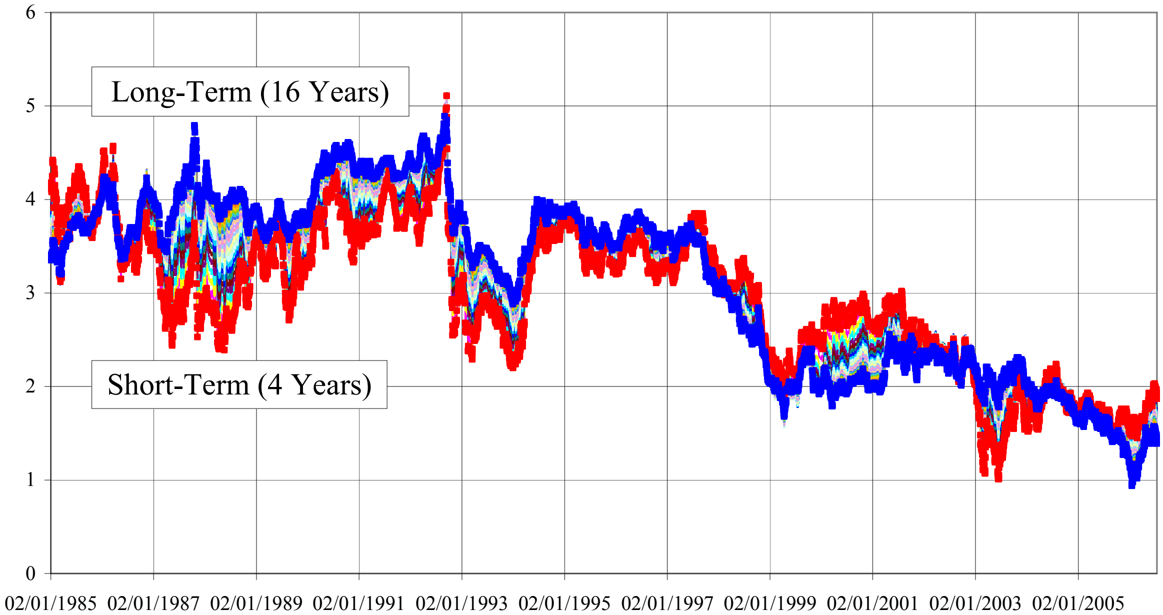


Chart 8.3

Implied Inflation Rates

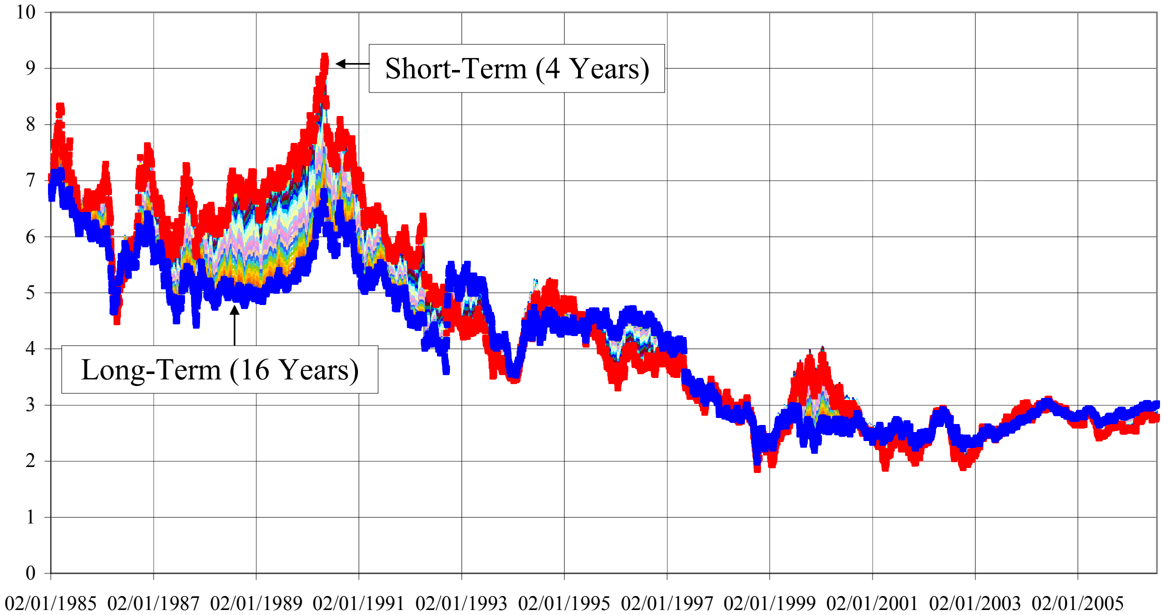


Chart 8.4

Average Term Premia on UK Nominal Bonds

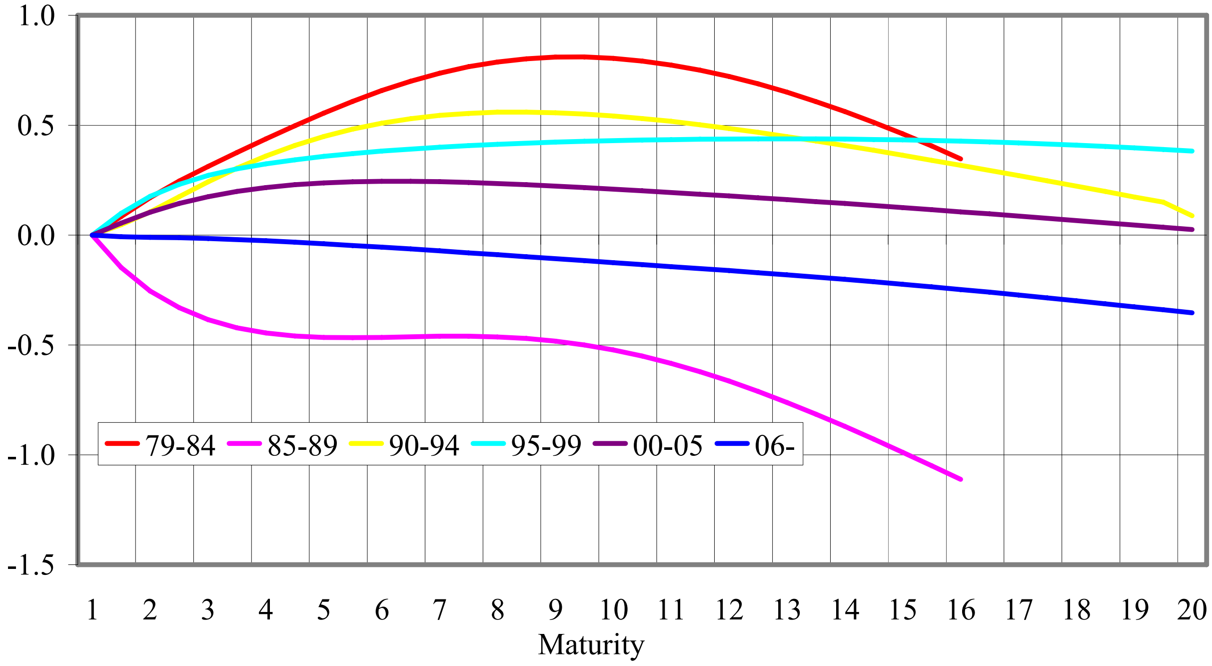


Chart 8.4 shows average term premia in recent years. In most, but not all, of the sub-periods shown the yield curve sloped upwards, albeit with an apparent tendency to display a hump-shaped pattern.[20] It should be noted however that, as averages over a relatively short period, these are unlikely to give an accurate picture of true risk premia, since the yield curve may also have included forecasts of bond price changes. This almost certainly explains the marked average downward slope during the late period 1985-1989, during which there was a significant tightening of monetary policy. But the overall impression from Chart 8.4 is that there is no clear pattern in term premia.

Taking a much longer historical perspective if anything accentuates the impression that the term premia have had no obvious stability. Table 8.1 shows average term premia on long-term bonds in a range of samples since 1840. In the twentieth century, and especially in the post war period, the term premium was on average positive and quite substantial; however in the nineteenth century there was a negative term premium.

Table 8.1. Average UK Long-Term Bond Premia[21] in Different Time Periods

1840-2005	1840-1899	1900-2006	1900-1945	1946-1985	1986-2006
0.22	-0.61	0.69	0.42	1.47	-0.28

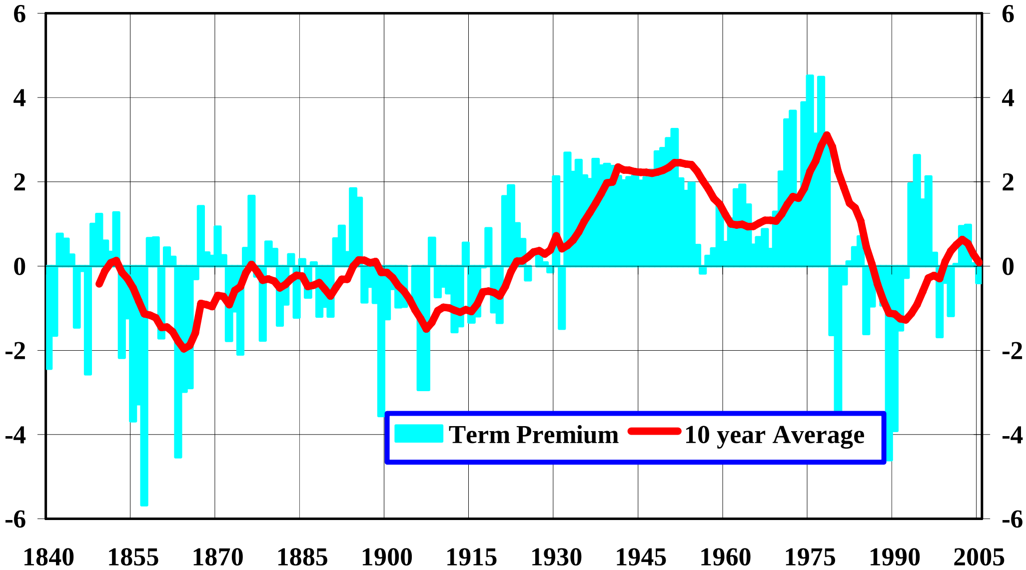
[20] This is also a feature present in some no-arbitrage-based bond pricing models: eg, Dai & Singleton (2000); Cox, Ingersoll & Ross (1985).

[21] Yield on 2.5% consols (ie perpetuities) less treasury bill yield. Source: NBER and Ecowin. Note that (due to the need to make use of available data) these yields cannot be compared directly with the zero coupon yields in Charts 8.1 to 8.4, however the difference is not sufficiently great as to change the story. Perpetuities have infinite maturity but finite duration: over these historic periods the duration of consols ranged from 15 up to 32 years. In the most recent sample shown in Table 8.1, which overlaps with the availability of Bank of England data, the average premium on a 20 year zero coupon bond was almost identical to that on consols.

Chart 8.5 shows the pattern of the term premium over time. It has shown considerable variation, but there is little sign that it reverts to a stable mean. Thus on purely statistical grounds there is no obvious reason to expect currently low term premia to revert to higher values on a sustained basis.

Chart 8.5

The UK Term Premium*, 1840-2005

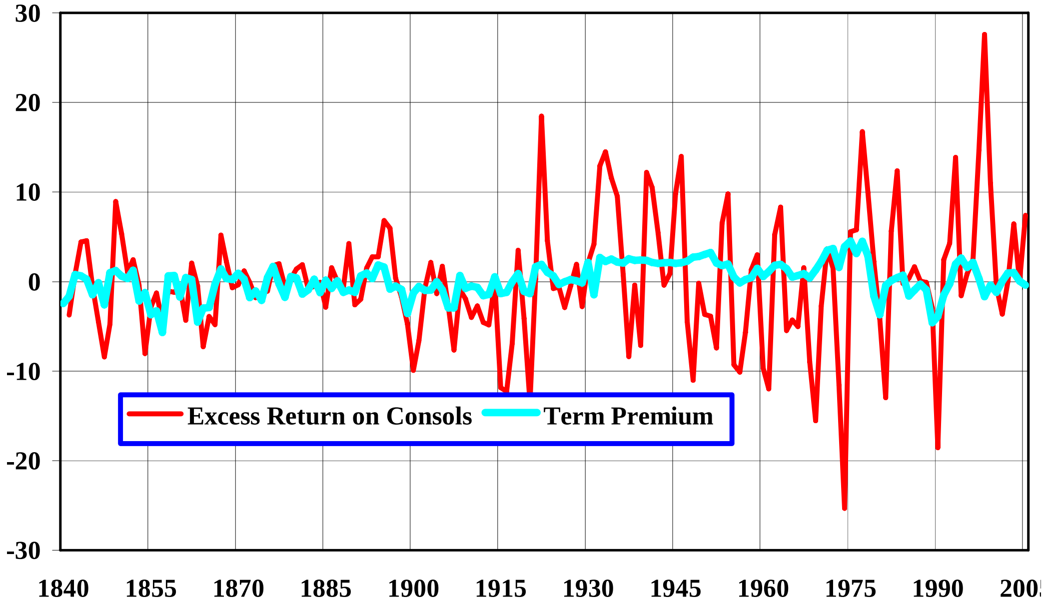


* Yield on long bonds (consols) minus yield on 3 months T-bills. Sources: NBER for yields on Consols and Open Market discount rates to 1938, then 3 month T-bills.

This purely statistically based conclusion is if anything reinforced by some analysis of the determinants of the term premium. Chart 8.6 relates the term premium to the investment *return* earned by bond holders, namely the combination of the interest received and the capital gain or loss on the bond price. It shows a very distinct shift in the behaviour of the investment return between the first and second half of the sample, with very much more volatile bond returns during the twentieth century (reflecting considerably greater movements in yields themselves).

Chart 8.6

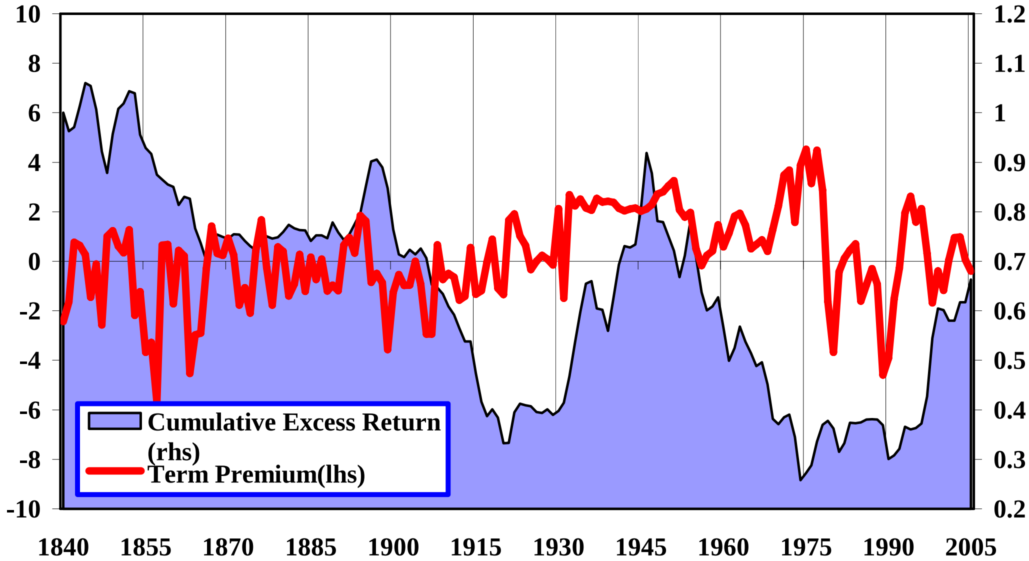
The UK Term Premium and Excess Returns*,1840-2005



* Term premium and sources as previous chart. Excess return calculated as consol coupon return+ capital appreciation less 1 year rate

Chart 8.7

The UK Term Premium and Cumulative Excess Returns*,1840-2005



* Cumulative excess return calculated as ratio of cumulative investments in consols vs short-term bills. Sources as in previous chart.

The explanation for this shift was of course in the behaviour of inflation, and hence nominal interest rates. While there was quite significant short-term volatility in inflation and short-term nominal rates in the nineteenth century there was much greater stability of the price *level* so that short-term movements were normally expected to be reversed. As a result long-term yields were quite stable. Only in the twentieth century did the phenomenon of sustained positive inflation arise. With it came effectively permanent rises in long-term bond yields, and thus significant capital losses. Chart 8.7 shows that these were so significant that, over the full sample of nearly 170 years a strategy of holding bonds would have significantly underperformed a strategy of holding short-term bills: ie, on average bonds earned *negative* excess returns. As a rational response to this experience, yields also became distinctly more sensitive to news about inflation.

Charts 8.6 and 8.7 also show that the term premium largely reflected this experience. In the nineteenth century long-term bonds were viewed as a safe investment, even compared to short-term investments, and thus offered a negative risk premium. But the capital losses of the twentieth century made investors distinctly more wary and led to sustained term premia driven largely by fear of inflation.

While this pattern of behaviour was in part a process of learning (belatedly) from experience, it can also be explained in terms of rational behaviour. Thus Campbell & Viceira (2001) note that for very risk-averse investors the optimal investment is a long-term indexed bond. In the nineteenth century long-term bonds were much closer to being indexed than in the high inflation periods of the twentieth century, thus rationally boosting demand for bonds, and depressing risk premia, compared to the twentieth century. Buraschi and Jiltsov (2005) also show that in a no arbitrage model of bond pricing the changing dynamics of inflation explained a significant part of the rise, then fall of term premia in the post-war period.

This analysis of the determinants of term premia appear to reinforce purely statistically based analysis. It is possible to argue (as does Smithers, 2006) that the term premium in the current century is more likely to resemble that of the nineteenth century than that of the twentieth century. While the short-term volatility of holding returns has remained quite high, the longer-term risks of holding nominal bonds have arguably been very significantly reduced in recent years by the move to quite tight inflation targeting, backed up by the institutional change of Bank of England independence. Even shorter term volatility may attract only a modest risk premium, if any, to the extent that this is driven by short-term movements in real interest rates to control inflation.[22]

The only significant qualification to this conclusion is that it treats the current monetary regime in the UK as if it were permanent. While there is probably no imminent risk of change, it should be borne in mind that the history of UK monetary policy has seen a number of regime shifts over the years. At this stage probably the biggest uncertainty is the unknown timing and impact of joining the euro.

In the absence of any evidence of a significant term premium, probably the best current market-based estimate of the forward-looking real interest rate is the nominal yield on medium-dated bonds, less the Bank of England's inflation target of 2%: thus a figure of around 2 to 2 ½%, based on the most recent figures shown in Chart 8.1 This is remarkably close to that in the benchmark "Taylor Rule", and to the estimate in Mason, Miles and Wright (2003).

[22] In a standard consumption-based asset pricing framework an asset will only attract a risk premium if its return is positively correlated with consumption. If interest rate movements in future are largely dominated by short-term stabilisation of inflation, real interest rates are likely to rise (and hence bonds to suffer poor returns) when the economy is buoyant and hence when consumption is high, thus if anything bond returns and consumption may become negatively correlated.

Of course, this figure could quite easily change, and, given past experience, could change quite quickly. An important caveat to our conclusion on the term premium is that, if it does stay close to zero, while short-term rates and long-term yields are likely to continue to have fairly similar average values in the future, this does *not* tell us what this average level will be. We have already noted Mason, Miles and Wright's (*op cit*) conclusion that the historic evidence for a stable risk-free rate is quite weak. Both short-term and long-term rates could in principle be pulled *upwards* towards the historically much more stable equity return. While market suspicions of the equity market continue this is probably unlikely in the near future, but it should be borne in mind that in the heyday of the stock market boom in the 1980s and 1990s real interest rates were significantly higher, as Charts 8.1 to 8.3 reveal.

Given this risk, which is probably greater on the upside than on the downside, a more conservative approach might be to assume a term premium close to the average over the twentieth century, ie, a figure of around ¾%.

9. Equity Issuance Costs

Introduction

In this section we set out the key ideas and some evidence related to equity issuance costs.

There are two types of costs associated with security issuance:

(1) Direct costs – commission to the investment bank etc.
(2) Indirect costs – 'announcement effect', i.e. revaluation of existing securities

We consider each of these in turn. We also briefly discuss the related question of whether it can make sense for a firm to issue equity in order to sustain its dividend level.

Table 9.1 lists recent share issues above £100m on the London Stock Exchange over the period 2003-2004. It is striking that the number of such issues has been quite small, and the amount of money raised has also been small. In 2004 and 2005 there were only 17 issues per year, with averages of £119m (2004) and £162m (2005) raised per issue.

A possible explanation for this is that, quite apart from the direct costs of issuing equity, on which we summarise available evidence below, the very act of issuing equity may also result in indirect costs. It may be regarded as lowering the value of the firm to existing shareholders (the 'announcement effect'), and hence raising the cost of equity capital.[23] While there is some statistical evidence that this is the case, the evidence is weaker for utilities. The most likely explanation for this statistical phenomenon – informational asymmetries – is also likely to be less important for regulated utilities.

Direct Equity Issuance Costs

Direct costs at IPO stage and subsequent issues of equity are:
- Underwriting fees charged by investment banks in the underwriting process
- Professional fees paid to the advisors, accountants and lawyers in preparing for the issue
- Initial listing fees charged by the exchanges
- Other direct IPO costs such as marketing and PR costs

Oxera Agenda (1994) estimate that underwriting fees generally constitute at least half of all direct IPO costs. These are usually expressed in percentage terms as a gross spread charged by the underwriting syndicate, i.e. the syndicate receive a certain percentage of the issue price of each share sold.

[23] More formally the 'Pecking Order' theory (Myers (1984)) states that there is a pecking order of sources of finance depending on the intensity of informational asymmetries between managers and investors associated with each of the different sources of financing. Thus the order is: internal financing, outside debt financing, then public equity financing.

Table 9.1: Recent Share Issues on London Stock Exchange (£m)

Rights Issue (Over £100m shown)

2006 Total (3) 573.27

Date	Company	Sector	Raised
17/03/06	Laird Group	Electrical Comp & Equip	122.21
22/05/06	Novae Group	Property & Casualty Ins	109.83
15/06/06	Invensys	Electronic Equipment	341.23

2005 Total (17) 2,748.57

Date	Company	Sector	Raised
07/06/05	United Utilities	Water and Sewage	510.32
27/06/05	Laing(John)	Business Support Services	100.10
01/07/05	T&F Informa	Publishing & Printing	318.78
05/07/05	Avis Europe	Rail, Road & Freight	117.16
01/09/05	Aberdeen Asset Mgmt	Asset Managers	228.65
16/09/05	Eircom Group	Fixed-Line Telecom Services	288.44
14/10/05	Logicacmg	Computer Services	401.78
03/11/05	Amlin	Insurance - Non-Life	223.66
09/11/05	Hiscox	Insurance - Non-Life	176.37
28/11/05	Autonomy Corp	Software	153.08

2004 Total (17) 2,021.31

Date	Company	Sector	Raised
22/07/04	Meggitt	Aerospace	185.99
23/08/04	International Power	Electricity	299.74
20/10/04	Prudential	Life Assurance	1,038.62
18/11/04	Beazley Group	Insurance - Non-Life	110.15

2003 Total (14) 2,827.79

Date	Company	Sector	Raised
09/05/03	Xstrata Plc	General Mining	928.31
27/08/03	United Utilities	Water and Sewage	512.42
23/09/03	Royal & Sun Alliance	Insurance - Non-Life	1,008.00
03/11/03	Rexam	Business Support Services	223.79

Further Issues (Ordinary Shares over £100m shown)

2006

Date	Company	Sector	Issue Type	Raised
27/01/06	Mapeley	Real Estate Hldg & Dvlp	Placing For Cash	110.00
20/03/06	Sanctuary Group	Publishing	Placing & Open Offer	109.97
18/04/06	Scottish & Newcastle	Brewers	Placing	210.00
04/05/06	Yell Group	Publishing	Placing	350.00
15/05/06	Medical Property Invest Fund	Real Estate Invest Trusts	Placing & Open Offer	110.04
22/05/06	Xstrata Plc	General Mining	Placing	683.41

2005

Date	Company	Sector	Issue Type	Raised
10/03/05	BAE Systems	Defence	Placing For Cash	360.00
17/03/05	O2	Wireless Telecom Serv	Placing For Cash	374.38
21/06/05	Homestyle Group	Retailers - Soft Goods	Placing & Open Offer	99.39
21/07/05	Gyrus Group	Medical Equip & Supplies	Placing	153.90
05/08/05	Old Mutual	Life Assurance	Placing For Cash	148.93
22/11/05	Man Group	Other Financial	Placing For Cash	126.61

2004

Date	Company	Sector	Issue Type	Raised
16/01/04	Tesco	Food & Drug Retailers	Placing	781.20
05/03/04	Invensys	Electronic Equipment	Placing & Open Offer	470.28
11/05/04	Royal Bank Of Scotland Gp	Banks	Placing For Cash	2,527.82
15/06/04	Royal Bank Of Scotland Gp	Banks	Placing For Cash	145.18
07/07/04	Cairn Energy	Oil & Gas - Explo & Pdn	Placing For Cash	102.93
07/07/04	Friends Provident	Life Assurance	Placing For Cash	232.75
20/08/04	Regus Group	Business Support Serv	Placing & Open Offer	122.61

2003

Date	Company	Sector	Issue Type	Raised
24/06/03	WPP Group	Media Agencies	Placing	100.21
14/07/03	Cobham	Aerospace	Placing For Cash	106.25
08/12/03	Corus Group	Steel	Placing & Open Offer	306.52
17/12/03	East Surrey Holdings	Water and Sewage	Placing & Open Offer	104.58

For IPOs between January 2003 and June 2005, Oxera's estimates of the average underwriting fees for UK and US markets are shown in Table 9.2

Table 9.2
Oxera Estimates of Underwriting Fees

Market	LSE Main	LSE AIM	NYSE	Nasdaq
Sample size	28	43	74	192
Gross spread	3.3%	3.5%	6.5%	7.0%

The fact that fees are higher in US exchanges than in the UK is consistent with other studies (e.g. Torstila (2003)). Oxera's estimate for the initial listing fees is negligible at less than 0.1% of the amount issued. Whilst data on other costs are not available in the public domain, Oxera estimate these costs to be around 3-6% for most issuers, although this would vary according to factors such as the size of issuance.

Hennessy and Whited (2006) calculate the underwriting fees implied from observed corporate financing choices, using a statistical method called the simulated method of moments (SMM). They begin by formulating a dynamic structural model of optimal financial and investment policy for a firm facing the following set of frictions: corporate and personal taxation, bankruptcy costs, and costs of external equity. Given data they estimate the unknown parameters in the structural model associated with the firm's production technology, profitability shocks, and financing costs. The last of these include the three constants λ_i, i = 1,2,3 in the following assumed linear-quadratic cost function for external equity:

$$c = \lambda_0 + \lambda_1 (p - c) + \lambda_2 (p - c)^2$$

where p = gross proceeds from an equity flotation, and c = underwriting fee. Using 1988-2001 data compiled from 2004 Standard and Poor's Compustat industrial files, their findings are,

- The typical firm *behaves as if* facing an underwriter charging a fee equal to \$83,410 for the first million dollars (8.3%) of gross equity proceeds, with the marginal fee having a slope of \$616 per million at that point.
- For small firms, the corresponding estimates are \$107,143 (10.7%) and \$569.
- For large firms the estimates are \$50,332 (5.0%) and \$343.

Other estimates are, for the US:

- Mikkelson and Partch (1986): Underwriting spread and other expenses of the stock offering reported in the prospectus for common stock offerings on NYSE / AMEX average 6% of the proceeds, or 0.7% of the market value of the outstanding common stock (sample number = 62).
- Chen and Ritter (2000): with almost every IPO between \$20 and \$80million, the underwriting spread was found to be exactly 7 %.

For the UK:

- Arnold (2005, p461): For both the LSE Official List and AIM the administrative and transaction costs as a proportion of the amount raised can be anywhere between 5 and 12% depending on the size of issue, and the method used.

For Latin America:

- Zervos (2004) gathered the cost data from a combination of web site searches of stock exchanges and regulatory bodies, security information from Bloomberg, and interviews with securities lawyers, investment bankers, regulators and companies themselves to estimate the direct costs of IPOs for Chile, Mexico and Brazil. In all cases the total costs are decreasing in the issue size. For \$100 million equity issuance, the estimates are shown in Table 9.3.

Table 9.3
Transactions Costs of Equity Issues in Latin America

Cost Category	Chile	Mexico	Brazil
Investment Banking Fee	1.50%	3.50%	4.00%
Legal Fees	0.05%	0.08%	0.02%
Marketing / Disclosure	0.02%	0.06%	0.06%
Rating Agency	0.04%	0.09%	0.12%
Other Fees	0.03%	0.21%	0.19%
Total	1.64%	3.93%	4.39%

The estimates therefore vary widely. For the UK the range 5-12% would however appear to be a reasonable estimate.

Indirect Costs

Stock Market Reaction to Equity Issues

There is on average a statistically significant market reaction when share issues or share repurchases are announced. For example Smith (1986) showed that leverage-decreasing transactions on average are associated with negative announcement effects if new capital is raised (such as with equity issues), while leverage-increasing transactions are associated with positive announcement effects if no new capital is raised (such as with a share repurchase). This observation is difficult to reconcile with traditional 'trade-off' models[24] of optimal capital structure, but is consistent with asymmetric information and agency problem models.

Asquith and Mullins (1986) investigated 531 registered common stock offerings on ASE or NYSE between 1963-1981, of which 266 were by industrial firms and 265 were by utility firms. The study excluded initial offerings. The main findings (which appear to have been reinforced by more recent research) include,

(1) For industrial issues, the average two-day excess return for primary issues was -3%.
(2) This loss was usually a substantial fraction of the proceeds of the stock issue: there was a mean dilution of 31% (where 100% dilution implies a price drop that reduces the value of the expanded firm by an equivalent amount to the entire money raised by the share issue).
(3) For industrial issues, regression results indicate that the announcement day price reduction is significantly related to the size of the equity offering.
(4) Primary stock offerings for public utilities are also accompanied by price reductions, but at a much smaller level (mean reduction of -0.9%, or 12.3% dilution).
(5) For utility issues there is no relationship between the announcement day market reaction and issue size.

Masulis and Korwar (1986) similarly considered 1,406 initial public offerings (excluding rights offerings) on NYSE and AMEX between 1963-1980. Of these, 690 and 716 were by industrials and public utilities respectively. Their estimates of the average announcement period excess returns were -3.25% for industrial firms and -0.68% for public utilities. Using their data on average issue size, we estimate that these correspond to 22.0% and 6.2% of the proceeds being raised, figures which are smaller than Asquith and Mullins's dilution estimates. Smith (1986) reviews some of the recent estimates of the announcement period excess returns, including the two cited above, and

[24] 'Trade-off' theory – Firms identify target debt-equity ratios by weighing costs and benefits of equity against those of debt. For instance, due to tax treatment debt would be preferred in most countries, while equity issuance would mean high capitalisation implying a lower likelihood of financial distress (and hence the share price should go up).

finds that the average returns weighted by sample size for industrials and utilities are -3.14% and -0.75% respectively. There therefore seem to be strong empirical support for the observation that the announcement effect is much smaller for utilities than for industrial companies.

A more recent study is Ritter (2003), who states that the indirect costs may, at times, be much larger than the direct costs. He observes that numerous studies have documented that in the USA there is an announcement effect of −2%, on average, for seasoned equity offerings. As with Asquith and Mullins, Ritter also observes that larger issues have more negative effects, although he cautions that these estimates are likely to be underestimated, as if there is an unusually negative reaction then the issue size may well be reduced by the time the deal is completed.

Possible Explanations

A range of explanations have been produced for this phenomenon. Most are however relatively easy to dispose of; only those based on frictions and informational asymmetries appear to have some basis both in theory and in the data.

1. "Increased supply": This argument is essentially a naïve application of textbook microeconomics. In a normal market a shift in the supply curve will lower the price because consumers need to be persuaded to buy more by lower prices. However, in efficient, well diversified financial markets, the market share price should equal the fundamental value of the firm, so there is in effect a horizontal demand curve.
2. "Equity dilution": Equity issues may lower the share of earnings accruing to existing shareholders. However if security sales are properly priced, old shareholders should receive a fair price for their reduced share of earnings, and hence they should be indifferent.
3. Change in capital structure: Equity issuance leads to reduced leverage, and possibly a fall in after-tax earnings per share. However if that was the case then the firm would not reduce leverage.
4. Asymmetric information: This explanation appears to have a stronger basis, so we deal with it more thoroughly in the next section.

Asymmetric Information (Myers and Majluf (1984))

The essence of this argument (a simplified mathematical version is given in Appendix E) is that managers, who have superior information to shareholders, are more likely to issue shares when they think the firm is over-valued, while optimistic managers, for whom the current share price is too low, may cancel or defer issues. While shareholders do not have the precise information that managers have, they *do* know that managers will face this incentive. Thus the act of issuing equity can be viewed as an adverse signal to shareholders, causing the share price to fall. Knowing this, managers will be less likely to resort to share issues, even when investment projects yield excess returns.

Cross-sectional studies seem to support this theory. These generally show that there is less of a negative reaction when:
- A firm can convince the market that there is a good reason for issuing equity. (Ritter (2003))
- A firm has a high q, reflecting good investment opportunities (the effect is insignificantly different from zero). (Jung, Kim and Stulz (1996))
- The economy is in an expansionary segment of the business cycle, where there may be less adverse selection risk. (Choe, Masulis and Nanda (1993))
- The issuance follows shortly after an earnings report, at which time there is presumed to be less asymmetric information. (Korajczyk, Lucas and McDonald (1991))

Cornett and Tehranian (1994) tested this theory using commercial banks' share issues. Some bank issues are necessary to meet capital standards set by banking regulators, while others are voluntary. If asymmetric information is a major cause for the fall in share prices after equity issue, then one should find that the necessary issues have much smaller, if any, drop in prices, as these issues convey no information about managers' views. Cornett and Tehranian indeed find that the necessary issues caused a much smaller drop in prices than the voluntary ones.

Asquith and Mullins' statistical evidence cited above, in which there is a clear contrast between the results for industrial firms and utilities, also appears consistent with informational asymmetries. They note:

> "…equity issues by utilities are more fully anticipated. **This could be due to the disclosure required by regulated firms and/or the fact that many utility issues are motivated by the necessity of making investments to service customer demand while simultaneously maintaining debt ratios within a range mandated by regulation.** Such a capital structure process would predict forthcoming equity offerings and would also imply that the change in leverage produced by an equity issue is temporary.
> Another potential explanation is that the smaller announcement day effect is due to the fact that public utility industries are composed of relatively homogeneous firms. **Many sources of valuable inside information (research and development, the value of natural resources, etc.) are absent for most utilities.** Key determinants of the value of utilities include cost structures, production technologies and marketing demographics, that are relatively well known and intensively studied by security analysts." (emphasis added)

Is the announcement effect a true cost of equity issuance?

If the announcement effect is truly caused by asymmetric information, then it can be argued that this is not really the cost of equity issuance but a result of the firm's likely future performance. In Ritter's (2003) words,

> "If this 2% drop is viewed as a cost of an equity issue, then external equity capital is very expensive. On the other hand, if this 2% drop would have occurred when the basis for management's opinion regarding firm value was disclosed in some other manner, then the downward revaluation is not a cost of the equity issue for long-term shareholders. … When a firm raises external equity capital, it not only conveys information about whether management thinks the firm is overvalued or not, but also suggests that something will be done with the funds raised. If the market interprets the equity issue as implying that a new positive net present value project will be undertaken, the announcement effect could be positive. On the other hand if the market is concerned that new equity issue leads to higher agency problem, then the announcement effect could be interpreted as causally linked to the equity issue, in which case external equity is in fact very expensive."

Long-run performance

Studies such as Loughran and Ritter (1995) find that firms conducting seasoned equity offerings typically have high returns in the year before issuing. However during the five years after issuing, the returns under-perform by 3.4% per year relative to a size- and book-to-market-matched benchmarks. Possible reasons include:
- Issuing firms have lower risk as a result of decreased leverage, and therefore should have low returns. (Eckbo, Masulis and Norli (2000))
- 'Market-timing' – i.e. firms can successfully time their equity offering to take advantage of 'windows of opportunity', issuing equity when the share price is perceived to be over-valued. (See for example for evidence, Baker and Wurgler (2000))
- Investors and managers are systematically over-optimistic at the time of issue – after all, for most of the issuers, good things have been happening to the stock price in the year prior to issue (though markets should then learn).
- The market is systematically under-reacting to the information conveyed by corporate financing announcements (arbitrage may be costly as it will be long term).

Estimating the Impact on the Cost of Equity

An obvious question is then how these issuance costs affect the cost of equity in the WACC calculation. Ofwat (2004) states that in its March 2004 report, "NERA explicitly added a 0.3% margin to the cost of equity to recover the costs of issuing equity in its study for Water UK."

Consider (following NERA's approach) the Dividend-Growth Model of equity price. If the required rate of return is r, the initial dividend payment is D and its growth rate is g, then the price of the share is given by

$$P = \frac{D}{r - g} \tag{1}$$

Thus for an investment of P, investors would expect dividend payouts of $D(1+g)^i$ in year i. However if it costs cP to issue the equity, then the net proceeds raised is $(1\text{-}c)P$. As investors will still expect $D(1+g)^i$ payouts, we have for the actual required rate of return r',

$$(1 - c)P = \frac{D}{r' - g} \tag{2}$$

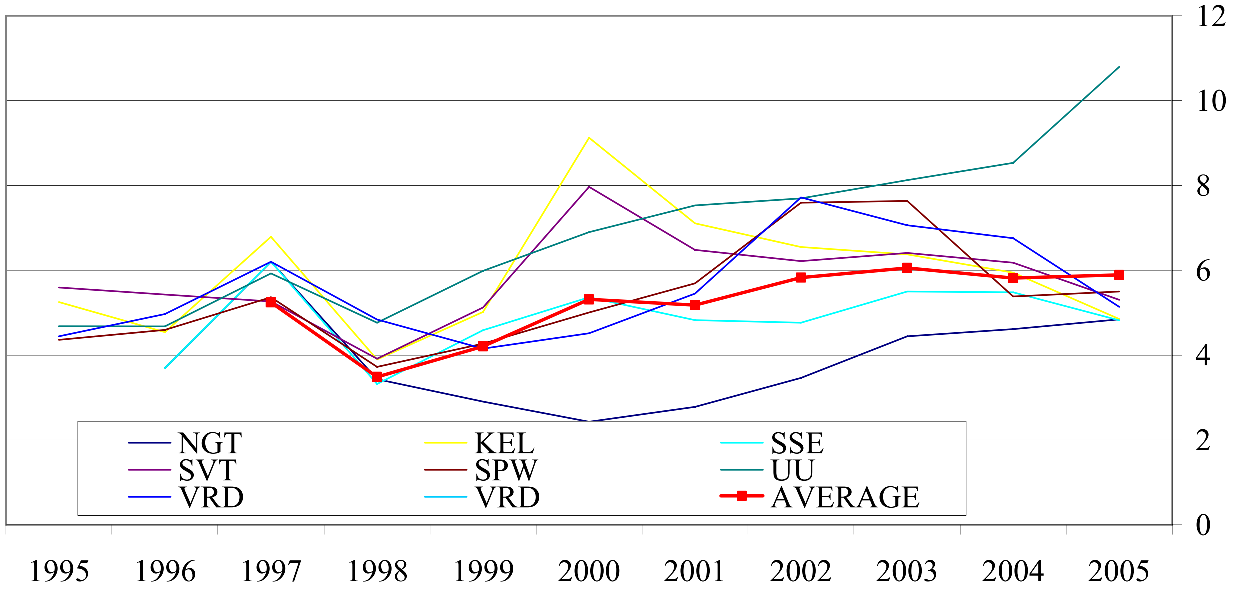
Replacing P in (2) with that in (1) yields a formula for the actual required rate of return,

$$r' = \left(\frac{r - g}{1 - c}\right) + g \tag{3}$$

Chart 9.1 shows the recent pattern of the dividend yield for our sample of companies (excluding the unregulated companies Centrica and IPR)

Chart 9.1

Dividend Yields



With a required real return to equity investors in line with the range of 6.5% to 7.5% given in Section 8, the average dividend yield of around 6% for this group of companies only leaves room for a growth rate of dividends of 0.5% to 1.5%.

What costs should be included in assessing the impact on the cost of equity using the formula above? We would argue that while the announcement effect may be a deterrent to existing shareholders it should not be included in the calculation of cost of equity. The value of the equity capital may have reduced by the total issuance cost, but the actual cash raised for new projects is only reduced by the direct costs. If this is the case, with a required real return to investors of 6.5%, using the formula in (3) our 5-12% direct cost estimates would imply a corresponding increase in the cost of equity by 30 to 80 basis points.

Ofwat (2004) chose not to explicitly price in the issuance costs in its estimation of WACC:

> "[The costs of issuance] are only directly incurred at the time of issuance for the specific tranche of finance being raised, and should not be extrapolated across the whole of the capital base. We do not therefore consider that a specific quantum should be added as a margin. We have assumed a cost of capital towards the higher end of a plausible range and this should cover issuance costs."

"Maintaining the Dividend"

One explanation that has been offered for United Utilities' recent equity issue is that it was required in order to "maintain the dividend". This type of explanation goes back to what is viewed in the academic world as a rather out-dated view of dividends. Litner (1956) conducted a series of interviews with corporate managers about their dividend policies, which he summarised in four 'stylised facts' (Marsh and Merton (1987)):

- Firms have long-run target dividend payout ratios. Mature companies with stable earnings (*sub* growth companies) generally pay out a higher (lower) ratio.
- Managers focus more on dividend changes than on absolute levels.
- Dividend changes follow shifts in the long-run, sustainable earnings. Managers 'smooth' dividends. Transitory earnings changes are unlikely to affect dividends.
- Managers are reluctant to make dividend changes that might have to be reversed.

These alleged features of managerial behaviour raised the obvious question: does the level of dividends affect the value of the share, and if so, what is the appropriate level of dividend?

<u>Miller and Modigliani (1961)</u>

Miller and Modigliani's answer to this question was a clear-cut no. Their argument for price indifference to the level of dividend is as follows. Consider a firm that has an investment plan, which will be financed from borrowing and retained earnings. Any surplus cash will be paid out as dividends. Now the firm is also considering increasing its dividend payments without altering its investment and borrowing policies. Then the extra dividend payment can only be financed through a share issue. As the total value of the firm is unchanged it means that the value of individual share must decrease, i.e. there is a transfer of value from the old shareholders to the new. The extra cash dividend then must just offset the capital loss for the old.

Thus an increased dividend is a way of converting some of their equity into cash without affecting their portfolio value. However they can also do so by simply selling part of their share holdings. In the absence of taxes, transaction costs and other market imperfections, investors do not need dividends to get their hands on cash, and so will not place a higher value on high dividend-paying shares. Therefore the level of dividends should not affect share values.

<u>Other Views</u>

Some believe that an increase in dividend payout increases the firm value. One of the reasons is market imperfections due to regulations or transaction costs. For example for trusts and endowment funds, dividends are regarded as 'spendable income', while capital gains are 'additions to principal'. For others dividend payments are a cheaper source of cash income than selling part of their holdings. Another reason is management incentives: for mature companies with plenty of cash flow but few profitable investment opportunities, higher dividend payouts are alleged to signal a more careful, value-oriented investment policy. (See La Porta *et al.* (2000))

Others believe that whenever dividends are taxed more heavily than capital gains, firms should pay the lowest possible cash dividend.[25] One should certainly never issue new shares to fund dividend

[25] Current US tax rates: 20% on capital gains and 30.5-39.1% on dividends. However pension funds are untaxed, while the effective tax rate on dividends for large corporations is 10.5%, making them actually prefer dividends.

payouts. However in the US at least IRS rules prevents firms from always using share repurchase and paying zero dividend.

A third group (e.g. Miller, Black, Scholes) claim indifference by arguing that, if companies could increase their share price by distributing more or less cash dividends, then they would have already done so. However they still need to explain the level of dividends chosen in the face of high taxation. One possible explanation is as follows: low-dividend companies are more attractive to highly taxed individuals, while those that pay high dividends will have a greater proportion of tax-exempt institutions such as pension funds as their shareholders. The latter group of investors are sophisticated investors who monitor the performance of the managers and if necessary act to replace them. Thus having these shareholders is a signal of a well-managed company. (See Allen *et al.* (2000))

Conclusions

There is evidence that in general, an announcement of an issue results in a decline in the share price. One theoretical explanation is due to asymmetric information, where managers only issue shares when they view that the shares are over-priced in the market, and an announcement of an equity issue reveals this information.

It is important to stress that this effect should be much lower for regulated companies whose decision to issue shares is much less affected by the market price, and who also arguably possess much less in the way of valuable inside information. Indeed to the extent that equity issues are enforced by the regulator in order to maintain a given level of gearing the informational problem should in principle largely disappear. There is empirical evidence that suggests that for utility firms, the effect of a share issue on share price is much smaller; this is also borne out by the contrasting impact of new issues on bank share prices depending on whether the new issues was or was not required by regulators.

However equity issuance still incurs direct costs such as underwriting fees and professional fees. These are estimated to be anything up to 5-12% for UK markets. Taking this into account the cost of equity may need to be increased by 30 to 80bp. One caveat is that the notionally direct costs of equity issuance may be inflated by the *in*direct costs, to the extent that underwriting costs factor in a share price fall, and marketing costs are incurred in order to attempt to offset adverse signals. Thus to the extent that, for the reasons given above, indirect costs due to asymmetric information may be relatively low for regulated companies, this may in turn result in lower direct costs.

A related question is whether utility companies should issue shares to stabilise dividend levels. Views on this differ. Theoretically, without market imperfections, Miller and Modigliani show that dividend levels should not affect the share price. However with regulatory effects or transaction costs, some argue that higher dividends are favoured by investors, while others argue that with higher dividend tax, one should certainly not use share issues to fund dividends.

10. Regulation, the cost of capital and capital structure

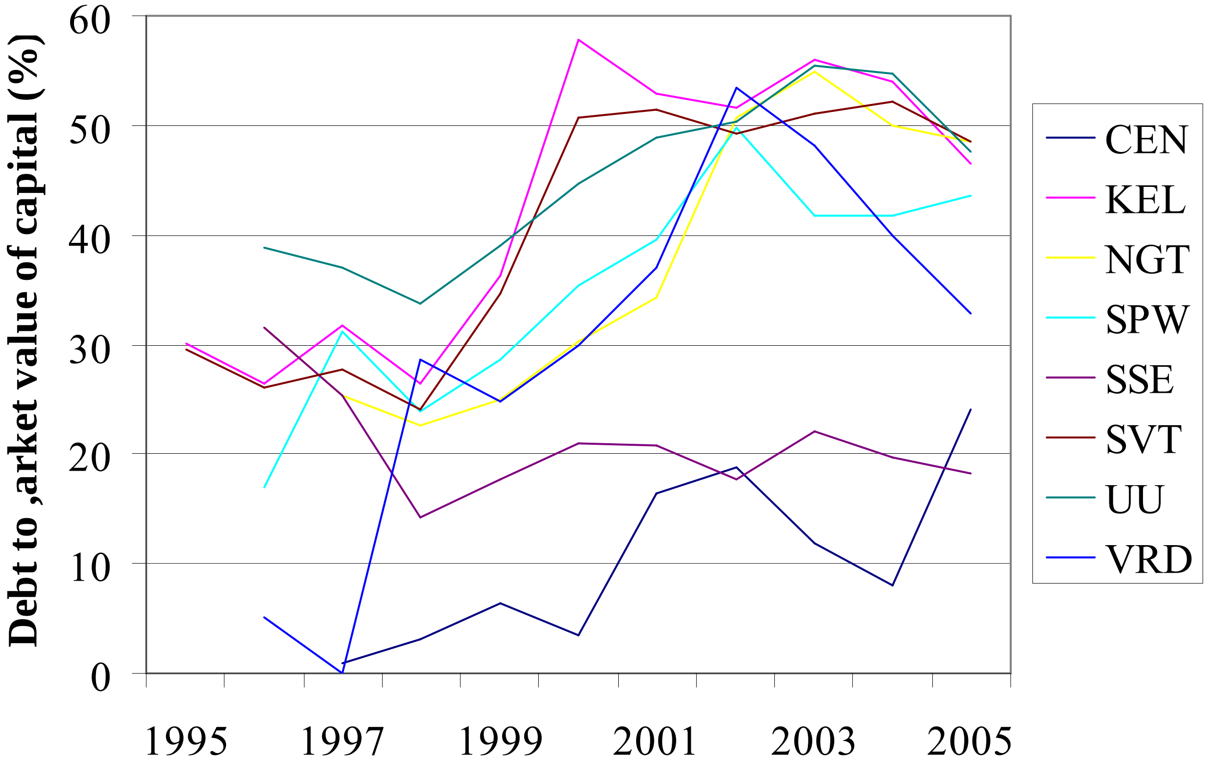
Summary

There has been a clear trend, particularly noticeable among the water and electricity distribution companies, to increase gearing. In this section we examine whether there is any evidence that movements in gearing appear to have had the predicted effect, in line with the Miller-Modigliani theorems, of raising the cost of equity capital. In a preliminary analysis of data for the nine companies examined in previous sections we find, if anything, the reverse to be the case. But the picture is clouded by what appears to be a strong negative relationship between asset betas and gearing. We also discuss whether regulation itself may affect gearing, and examine the issue of regulatory risk.

Detailed Analysis

At privatisation, the average gearing level for eight of the nine companies[26] analysed in Sections 2 and 4, was 25%; a number now have gearing levels in the range 50-70% (depending on the measure used). Chart 10.1 shows ratios of debt to the market value of capital for the period 1995-2005. In most, but not all, cases there has been a considerable rise in gearing over the period.[27]

Chart 10.1
Debt to the market value of capital (%), 1995-2005.



[26] We have no gearing data for International Power.
[27] In Appendix B we compare the market-based measure of gearing used here with two alternative balance sheet measures.

Should this rise in gearing cause concern for the regulator? Any concern runs, potentially, in two directions.

1. Does increased gearing affect the cost of capital: specifically, does higher gearing lead to higher capital asset pricing model (CAPM) betas?
2. Does regulation (the allowed cost of capital and the price controls that result) affect the regulated firm's choice of gearing?

The more general question is: how do regulation, the cost of capital and capital structure interact?

Does increased gearing affect the cost of capital?

The first of these two directions calls into question the empirical standing of the Modigliani-Miller theorems (MM-theorems; Modigliani and Miller (1958, 1963)). These theorems lie at the heart of corporate finance, and address the question: what is the relationship between a firm's financial decisions and its total stock market value? There are three, related theorems.

1. The market value of a firm is invariant with respect to its debt-to-equity ratio.
2. A firm's cost of equity capital is an increasing, linear function of its debt-to-equity ratio.
3. The market value of a firm is independent of its dividend policy.
4. (A corollary of these three theorems is that the equity holders of a firm are indifferent about its financial policy.)

Hence, a firm's value is determined solely by its cash flows (and the discount rate) i.e., by its assets; it is wholly independent of the composition of the liabilities used to finance those assets. The MM theorems also imply that the average cost of capital is independent of the volume and structure of debt, and equals the return required by investors for firms of the same "risk class". Even though debt may appear cheaper than equity, due to the absence of a risk premium, increasing leverage does not reduce the average cost of capital to the firm, because its effect would be precisely offset by the greater cost of equity capital. As a result, investment decisions can be totally decoupled from their financing: they should be guided only by the criterion of maximizing firm value. The cost of capital to be used in rational investment decisions is its total cost, as measured by the required rate of return on fully equity-financed firms of the same risk class.

The MM theorems require three conditions to hold:

1. Taxes are neutral (i.e., the same on all sources of income).
2. Bankruptcy does not entail any real liquidation costs for the company nor any reputation costs for its directors.
3. Financial markets are perfect: competitive, frictionless and free of any informational asymmetry.

The real value of the MM theorems is their identification of the conditions that have to hold in order for a firm's capital structure to matter.[28] As Miller (1988) has stated:

"the view that capital structure is literally irrelevant or that 'nothing matters' in corporate finance, though still sometimes attributed to us (and tracing perhaps to the very provocative way we made our point), is far from what we ever actually said about the real world applications of our theoretical propositions. Looking back now, perhaps we should have put more emphasis on the other, more upbeat side of the 'nothing matters' coin: showing what *doesn't* matter can also show, by implication, what *does*" (p. 100, emphasis by the author).

There is a substantial literature attempting to verify empirically whether the MM theorems hold. An immediate failure of the MM theorems is that, once taxes are taken account of (see e.g., Hamada (1972)), the prediction is that all firms should be 100% debt financed. While this extreme prediction can be mitigated somewhat by including e.g., bankruptcy costs, the current view is that these are not large enough to explain the low observed levels of gearing. A more promising idea is that there are informational or agency reasons why 100% gearing is not chosen by firms. There is

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28A secondary contribution of the MM theorems is the method of argument: Modigliani and Miller established arbitrage as a method of proof in finance.

now an extensive literature examining this possibility theoretically and empirically. There is also a reasonable amount of evidence that dividend policy influences firms' market values. But the evidence is mixed as to whether the influence is positive or negative. Gordon (1959), Ogden (1994), Kato and Loewenstein (1995), and Lee (1995) find positive effects, while Easton and Sinclair (1989) find a negative relationship.

There are very few papers that attempt to test the second MM theorem: that a firm's cost of equity capital is a linear function of its debt-to-equity ratio. In large part, this is due to the conceptual problem of attributing any change in an equity beta to a change either in leverage, or in the underlying asset beta. Since the latter is unobservable, there is a fundamental identification problem.

Bearing this conceptual problem in mind, we can try to see if there is any relationship between gearing and equity betas for UK regulated companies. Charts 2.1 to 2.3 in Section 2 showed that for the nine companies we examined equity betas, on the whole, fell over most of this period (although it is possible that betas are increasing towards the end of the sample). Combined with increased gearing levels, this seems to imply that asset betas have fallen over the period (although, as we discuss below, there may be other factors to consider).

To assess more directly the relationship between gearing and betas, Chart 10.2 pools the observations for all the companies (giving a total of 63 observations), and plots equity CAPM betas against the ratio of debt to the market value of capital. The straight line in the chart is the trend line (drawn using an ordinary least squares fit). Chart 10.2 suggests that any relationship that might exist between gearing and the CAPM beta is negative: higher gearing appears to be associated with *lower* equity betas. Two points should be noted. First, the relationship is quantitatively fairly large. From the OLS regression, an increase in gearing of 10% leads to a fall in the equity beta of 0.067. Secondly, the explanatory power of the regression is fairly low: the R-squared is 14%. Nevertheless, the estimate of the slope, -0.0067, is statistically different from 0, at the 95% confidence level (the standard error is 0.002).

In Chart 10.2, the equity beta used for a company in a particular year is the arithmetic average of that firm's betas during that year. We have repeated the analysis using a number of different beta figures, varying the window length over which the average beta is calculated for each firm and each year. There is very little change in the overall outcome: equity betas are negatively related to gearing levels, with a slope coefficient on the OLS trend line of between -0.0054 (i.e., a 10% increase in gearing decreases the equity beta by 0.054) and -0.0067.[29]

[29] We repeated the analysis using 25 different window lengths, starting from a window length of 1 day (taking the value of beta on the last day of the year) to a window length of the entire year (taking the arithmetic average beta during the year), and intermediate window lengths of 11 days, 21 days, 31 days etc..

Chart 10.2
Equity betas against debt/market value of capital (pooled sample).

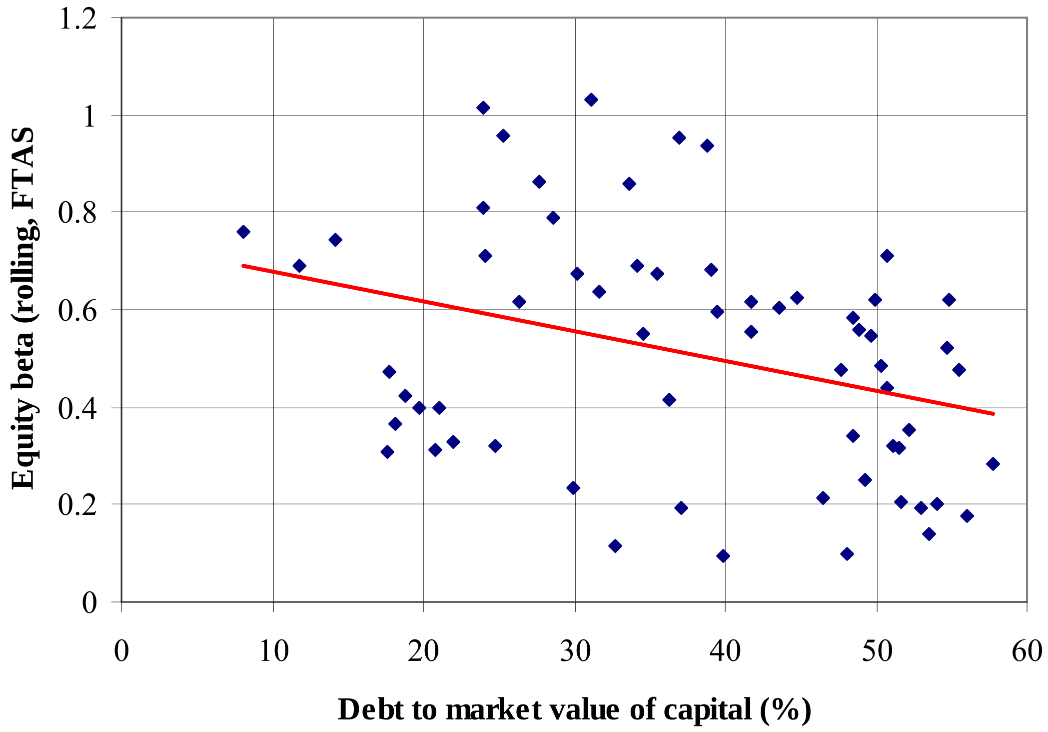
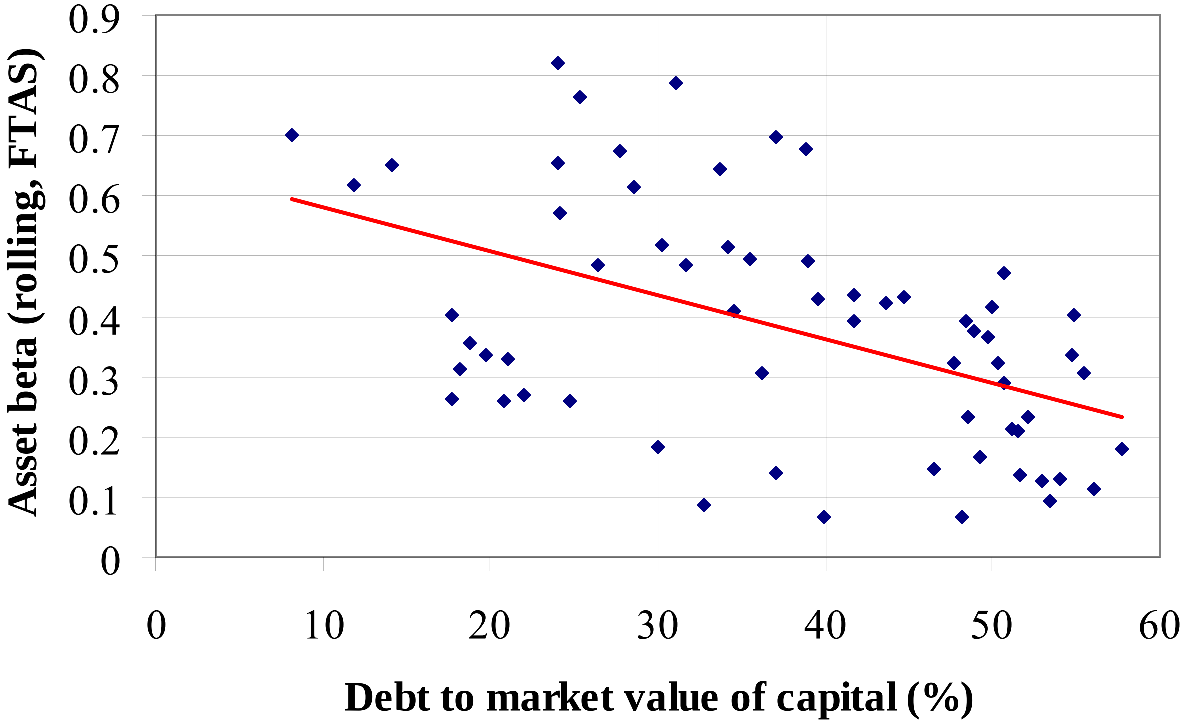


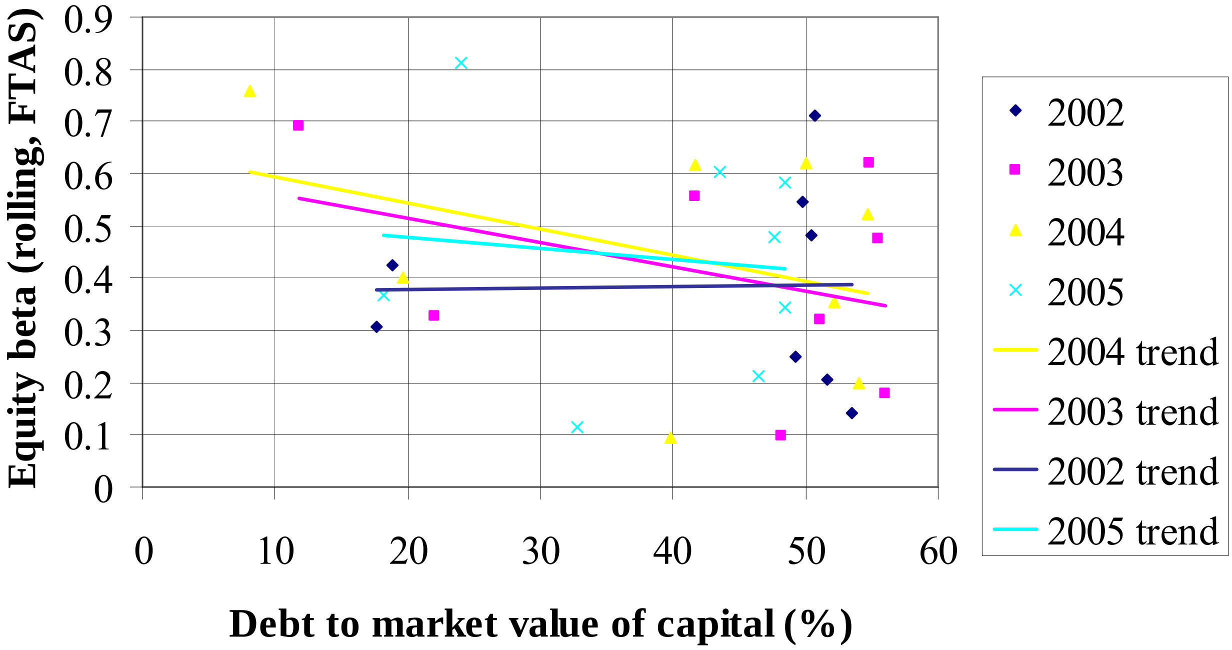
Chart 10.3 shows the same plot, but using *asset* (i.e., unlevered) betas. This shows a negative, and slightly stronger, relationship between leverage and asset betas. From the OLS regression, an increase in gearing of 10% leads to a fall in the asset beta of 0.077. This estimate is statistically different from 0 at the 95% confidence level. The explanatory power of the regression is somewhat higher than for the equity beta regression: the R-squared is now 28% (which is still not especially high).

Chart 10.3
Asset betas vs debt/market value of capital (pooled sample)



If asset betas have decreased over the sample, then that might confound any positive relationship that exists between gearing and equity betas (at a given asset beta). To check this possibility, Chart 10.4 plots equity betas versus the debt to market value of capital ratio cross-sectionally i.e., year-by-year. For legibility, only 4 years are plotted: 2002-2005, along with linear trends. Again, the chart suggests that any relationship that might exist between gearing and equity betas is, mostly, negative. Only in 2002 does there appear to be a positive relationship (but this is not significant).

Chart 10.4
Asset betas vs debt/market value of capital (last 4 years)



Charts 10.1 to 10.4 provide an informal analysis of the relationship between gearing and betas for the UK electricity distribution companies, over the period 1995-2005. A more formal analysis would use panel data techniques to control for firm- and year-specific effects. However, it seems unlikely that the MM prediction of a linearly increasing relationship between gearing and equity betas would be supported empirically in this sample.

We know of two other papers that investigate empirically the relationship between financial leverage and the CAPM beta, using a sample of US firms in selected two-digit and four-digit SIC industry classifications. Marston and Perry (1996) use a series of cross-sectional analyses over three sub-periods over the interval 1974-1988, comparing asset betas regression results to those predicted by the Hamada (1972) leverage adjustment. They find that, for firms with higher levels of leverage, estimated asset betas are lower than the asset betas calculated using Hamada's method. Faff et al. (2002) undertake a similar exercise, using time series techniques on a sample of 348 US firms over the period 1979-1994. They note that the Hamada adjustment implies that the relationship between asset and equity betas is given by

$$\beta_e = \beta_a (1 + D/E)$$

where β_e is the equity beta, β_a is the asset beta, and D/E is the debt-to-equity ratio.[30] Hence the Hamada method to calculate asset betas is to combine information on the average debt-to-equity ratios with an estimate of the firm's (levered) equity beta to produce the theoretically implied asset beta. Faff et al. (2002) compare this to a time series version of the standard market model,

$$R_t = \alpha + \beta_e R_{mt} + e_t,$$

where R_t is the rate of return on an asset in period t; α_i is the intercept term; β_e is an estimate of the equity beta (i.e., systematic risk) of the asset; R_{mt} is the rate of return on a market index in period t; and e_t is a mean zero random error term. Substitution of the expression for the equity beta into this equation gives

$$R_t = \alpha + \beta_a R_{mt} + \beta_a (D/E_t * R_{mt}) + e_t.$$

This equation includes the Hamada restriction, and can be compared to the unrestricted regression equation

$$R_t = \alpha + b R_{mt} + \gamma (D/E_t * R_{mt}) + e_t.$$

The Hamada restriction corresponds to the hypothesis that $b = \gamma$ in this regression equation.

Faff et al. find that the Hamada-calculated asset beta is invariably larger than their estimated asset beta counterpart, with a sample average difference of ten per cent (4.8 per cent) when the no taxes (tax-adjusted) framework is employed. They find that the difference between empirical and theoretical betas is largest for firms with higher leverage. Finally, 40 per cent (29.3 per cent) of their sample rejects the null hypothesis that $b = \gamma$ in the no taxes (tax-adjusted) case; the hypothesis is more likely to be rejected for stocks with high gearing.

Table 10.1 reproduces part of table 1 in Faff et al. (2002). The results are reported with firms grouped into quartiles according to their debt-to-equity ratios. The table gives the average debt-to-equity ratio for each quartile; the equity betas (estimated in the usual way); the asset betas estimated using the unrestricted regression equation; and the Hamada-calculated asset beta. As the table shows, the estimated asset betas are always below the Hamada-calculated asset beta; and the difference (in percentage terms) is greatest for firms with higher gearing.

[30] This assumes no tax adjustment. Faff et al. (2002) present results both with and without tax adjustments.

Table 10.1
Regression results from Faff et al. (2002).

	Debt/equity	Estimated equity beta	Estimated asset beta	Hamada asset beta
1st quartile	0.2854	1.0444	0.7936	0.8134
2nd quartile	0.8564	1.0934	0.5370	0.5947
3rd quartile	1.7618	1.1152	0.3442	0.4119
4th quartile	13.0729	1.1937	0.0941	0.1309

In summary, both Marston and Perry (1996) and Faff et al. (2002) find systematic departures from Modigliani-Miller, particularly for firms with high gearing levels. They also find that estimated betas are below calculated betas for these firms. But these results carry a number of provisos. One weakness of both papers is their failure to exploit the panel nature of their data. Marston and Perry runs cross-sectional regressions for three different time periods; Faff et al. use time series techniques on their panel of 348 firms and 16 years. Panel techniques would give a much greater ability to control for firm- and year-specific effects.

Does regulation affect gearing?

There has also been little research on the second direction of causation: how regulation affects the regulated firm's choice of gearing. Until recently, virtually all of the literature on rate of return regulation made the implicit assumption that the regulated firm is wholly financed with equity, and hence did not consider at all the issue of capital structure. A small number of recent papers relax this assumption. The main focus has been to study how the regulated firm might use its capital structure to influence how the regulator sets the price. The general idea is that firms benefit from high gearing levels because this will make the regulator set a high regulated price to ensure that the firm does not become financially distressed, with consequent disruption to services. See, for example, Taggart (1981) and (1985), Dasgupta and Nanda (1993), Spiegel (1994), and Spiegel and Spulber (1994) and (1997).

There is only one paper, to our knowledge, that considers the possibility that the regulator is aware of the feedback between prices and capital structure. De Fraja and Stone (2003) argue that, when this feedback is included, a number of conclusions follow. First, the regulator should take a view on the optimal capital structure of the regulated firm, as this may affect the cost of capital, and therefore, ultimately, the price paid by consumers. Secondly, a strict price cap mechanism, which literally allows no cost sharing between consumers and shareholders, is sub-optimal in their model. The optimal price system should instead allow for some sharing of risk; in particular, consumers should pay more when there are adverse cost conditions.

A driving force for these conclusions is the assumed risk preferences of stake-holders. De Fraja and Stone assume that consumers and shareholders are risk averse, managers are risk neutral, and debtholders are infinitely risk averse (and hence the firm should never be liquidated). An increase in leverage in their model reduces the overall cost of capital, which gives the regulator room for price reductions. But there is a trade-off: an increase in leverage also reduces the amount of equity capital that can be used as a buffer to absorb negative cost shocks. Once the equity capital falls below a certain level, the expected price can be lowered only at the expense of greater price variability. Since consumers are risk averse, this is socially undesirable. The regulator must therefore trade-off the *level* of prices (which is *lower* with increased leverage) with the *variability* of prices (which is *higher* with increased leverage).

Dr Fraja and Stone's conclusions have to be qualified by the simplifying assumptions made in their model. In particular, their regulator is fully informed about all aspects: costs, managerial effort, the cost of equity, etc.. This means that the regulator can set exactly the correct prices, capital structure, and even managerial wages (to ensure efficient effort in cost reduction). In practice, of course, there are significant information asymmetries between the regulated firms and the regulator. It is an open question as to how the analysis of De Fraja and Stone will change once this crucial feature is included.

A further way in which regulation can affect the regulated firm's choice of capital structure is through 'stranded asset risk' resulting from a lack of regulatory commitment. 'Stranded asset risk' arises when the market value of the assets used to provide regulated services fall below the regulatory value of those assets. This may occur because of a fall in market demand (and where the revenue loss associated with that fall cannot be made up elsewhere), or where the regulator writes down the regulatory value of the assets without permitting the amount written-off from being recovered from customers.

The central message of asset pricing theory is that only factors that co-vary with the "market portfolio" (in the Capital Asset Pricing Model, or CAPM) or portfolios/factors (in an Arbitrage Pricing Theory, or APT, model) in equilibrium affect a firm's cost of capital. Hence 'regulatory risk' arises only when the regulator's actions co-vary with the market portfolio(s). Any regulatory action that has an effect that can be diversified does not contribute to risk. So, to the extent that a reduction in demand that leads to the fall in the market value of the assets is related to market wide events—such as national income, or real interest rates—then such an event may imply greater beta risk. However, if the event that causes asset stranding is largely specific to the customers served by the network, or if the stranding is regulator-driven, then it would not affect beta risk.

Whether there is a stranded asset risk premium in regulated firms' betas is, ultimately, an empirical question. The attribution of empirical beta estimates to their component parts would be an interesting conceptual and empirical task.

The incentive effect of gearing

A further regulatory concern about a rise in gearing is that it might affect the incentives of managers to work efficiently. For example, the 2004 DTI report states that

"Shareholders play an important role in driving managers to respond to the efficiency incentives of the RPI-X regime. The corporate governance model of shareholder ownership provides a clear structure for decision making. However, these incentives can be reduced or removed in highly geared structures, through a loss of shareholder pressure." (paragraph 99)

This statement cannot be entirely correct. Even in 100% debt-financed firms, managers have incentives to exert effort provided that bankruptcy has some personal cost for them (such as the cost of finding another job, loss in reputation, etc.). If managers exert no effort at all, then it is likely that profits will be insufficient to meet the interest payment on debt. In this case, bankruptcy follows and the managers incur the associated costs. Instead, if managers work hard enough to ensure that interest payments can be met, then they avoid the personal costs of bankruptcy. So, debt does create some incentives for managerial effort. The higher is the level of debt, the more powerful are the incentives created: the harder managers have to work to meet the interest payments.

One version of this point lies behind Jensen's (1986) theory of free cash flow. Jensen argues that managers in profitable companies are likely to waste money on inefficient investments. Increasing leverage commits managers to returning cash to claimholders, and so decreases the scope for inefficient investment. This theory has subsequently been developed extensively in a number of papers (see e.g., Bolton and Scharfstein (1990), Hart and Moore (1995), Zwiebel (1996), and Hart and Moore (1998)). In all of these papers, the basic insight is the same: the requirement to meet interest payments limits the scope for inefficient actions by managers.

In principle, debt may be more effective than equity for providing incentives. Equity creates incentives to the extent that shareholders are effective in monitoring the effort of managers. Shareholders suffer, however, from the incentive to free-ride. Monitoring managers is costly for a shareholder: it requires time and effort to check the performance of the firm, work out whether poor performance is bad luck or due to managerial slack, etc.. Each shareholder would prefer some other shareholder to carry out the costly monitoring exercise. Since all shareholders think in this manner, the amount of shareholder monitoring is inefficiently low. If free-riding is very prevalent, then equity is very poor at creating managerial incentives. Indeed, this is one reason why managerial compensation is used to give managers incentives: if shareholders were effective monitors, performance pay would not be necessary.

In fact, the situation is more complicated even than this. Recent work has shown that it can be beneficial to have a mix of equity and debt. For example, Gumbel and White (2005) show that debt and equity are complementary instruments which should be held by different investors, since that results in more information collection by investors. Equity- and debt-holders exert positive externalities on each other, correcting failures that would occur if the firm were 100% financed by either equity or debt.

Conclusions

The evidence points to a declining relationship between gearing and equity betas: a rise in gearing is associated with a decrease in equity betas for the eight companies we examine over the period 1996-2005. This is contrary to the pure Modigliani-Miller theorem, which predicts that equity betas should be linearly increasing in gearing. One possible explanation of this is that the regulator has caused *asset* betas to decline as gearing levels have risen. (Since we see equity betas declining with gearing, clearly asset betas also decrease as gearing rises.) Concern has been expressed about levels of gearing, by the Treasury and the DTI amongst others. The Ofgem/Ofwat report "Financing Networks" has noted that, in the event of bankruptcy,

"it is not possible to rule out the possibility that a regulator may be asked by the Special Administrator to consider a case for re-opening price limits" (paragraph 80)

One hypothesis is that the combination of stated concern about gearing, and the inability of the regulator to commit against bailing-out a bankrupt firm, has lead the market to lower its perception of the asset risk of the electricity distribution companies. Paradoxically, the attempt by the regulator to limit the "dash for debt" may actually have sped up the process.

11. A Comparison of Recent Regulatory Approaches to the Cost of Capital

Summary

In this section we compare the assumptions and the outcomes of five recent cost of capital estimations in 2002-5. The five studies are: Competition Commission report on BAA (November 2002), CC report on mobile network operators (February 2003), Ofgem's DPCR4 (March 2004), Ofwat's Periodic Review 04 (2004) and Ofreg's Transmission and Distribution Price Control (December 2005).

Detailed Analysis

Table 11.1 summarises the different approaches.

Different regulators prefer different measures of cost of capital. Ofgem, for example, prefer the 'Vanilla' WACC for the reason that, "Adopting the traditional post-tax cost of capital would double count the benefits of the interest tax shield". Ofreg and Ofwat on the other hand use the post-tax WACC, while the Competition Commission refer to the pre-tax WACC as their measure of cost of capital. Most regulators set the real cost of capital, the exception being the CC's reports on MNOs and LPG supplies which both calculate the nominal WACC.

In real 'Vanilla' WACC terms, estimations of base cost of capital (i.e. before adjustments for idiosyncratic factors) vary widely between 3.1% (the bottom range for Ofreg) and 10.3% (the top range for CC MNO). Ofreg's estimate is lower than Of gem's due to their lower estimates for equity beta (all other input values are the same). However in their final proposal for the base rate, Ofreg in fact adopts Ofgem's proposed value. Ofwat's base rate estimate is slightly higher than Ofgem's due to their higher estimate of the equity risk premium, although this is partially offset by their lower estimation of the debt premium in the water industry. Even after stripping out expected inflation, the CC's estimates are generally higher since, whilst both their cost of debt and cost of equity estimates are broadly in line with the regulators' (except for the top range for the MNOs), much lower gearing ratios (e.g. 0.1 for MNOs as opposed to 0.5-0.6 for the regulators) mean that the cost of equity (which is higher than the cost of debt) contribute much more in the calculation of the weighted average costs of capital. The same factors apply, albeit to a lesser extent, to their WACC estimates for LPG suppliers.

The range for the proposed pre-adjustment costs of capital is, however, much narrower as both Ofgem and Ofwat disregard their lower end of the calculated range ("the CAPM evidence appears to conflict with market reality" (Ofwat)), while CC take mid-values of their ranges. The base real 'Vanilla' WACCs then range from 5.1% (Ofgem's bottom range) to around 9-10% (CC upper estimates for LPG suppliers and MNOs respectively).

Finally the base rates are adjusted by idiosyncratic factors associated with each industry to produce the final estimates of the WACC. Ofreg, for example, propose a reduced rate for the transmission portion of the regulatory asset base compared with the distribution portion, resulting in the overall blended post-tax return of 4.78%. Ofwat adjust their post-tax WACC estimate of 5.1% with small company premiums of 0.3-0.9%, graded by the size of regulatory capital value, to account for factors such as higher costs of raising capital. The CC recognise that "a degree of smoothing of the downward trend in the ERP would be appropriate" (CC BAA), and readjusts their estimates by adding back 25bp to the overall real pre-tax WACC for both BAA and the MNOs. This results in the MNO real pre-tax WACC estimate of 11.25%. For BAA, the CC adds a further 25bp to compensate for special factors linked to T5, resulting in the final WACC estimate of 7.75%.

Table 11.1. WACC Comparison[1],[2]

		Ofgem DPCR3 (1999)			Ofgem[3] DPCR4 (March 2004)			Ofreg[4] T&D RP4 (Dec 2005)		Ofwat[5] PR04 (2004)			CC[6] BAA (Nov 2002)		
		Low	High	Actual	Low	High	Actual	Low	High	Low	High	Final	Low	High	Mid
A	Risk-free rate	2.25	2.75	2.50	2.25	3.00	3.00	2.25	3.00	2.5	3.0	-	2.50	2.75	
B	Debt premium	1.85	1.70	1.85	1.0	1.8	1.1	1.0	1.8	0.8	1.4	-	0.9	1.2	
C	Pre-tax cost of debt = A+B	4.10	4.45	4.35	3.25	4.80	4.10	3.25	4.80	3.30	4.40	4.30	3.40	3.95	
D	Post-tax cost of debt = C×(1-K)	2.87	3.12	3.05	2.28	3.36	2.87	2.28	3.36	2.31	3.08	3.01	2.38	2.77	
E	Equity risk premium	3.25	3.75	3.5	2.5	4.5	4.5	2.5	4.5	4.0	5.0	-	2.5	4.5	
F	Equity beta	1.0	1.0	1.0	0.6	1.0	1.0	0.3	0.6	1.0	1.0	-	0.8	1.0	
G	Pre-tax cost of equity = H/(1-K)	7.86	9.29	8.57	5.36	10.71	10.71	4.29	8.14	9.29	11.43	11.00	6.43	10.36	
H	Post-tax cost of equity = A+(E×F)	5.50	6.50	6.00	3.75	7.50	7.50	3.00	5.70	6.50	8.00	7.70	4.50	7.25	
J	Gearing	0.5	0.5	0.5	0.5	0.6	0.575	0.5	0.6	0.55	0.55	0.55	0.25	0.25	
K	Corporation tax	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	
L	Pre-tax WACC = (C×J)+(G×[1-J])	6.0	6.9	6.5	4.3	7.2	6.911	3.8	6.1	6.0	7.6	7.3	5.67	8.76	7.21
M	Post-tax WACC = (D×J)+(H×[1-J])	4.2	4.8	4.5	3.0	5.0	4.838	2.6	4.3	4.2	5.3	5.1	3.97	6.13	5.05
N	Vanilla WACC = (C×J)+(H×[1-J])	4.8	5.5	5.2	3.5	5.9	5.545	3.1	5.2	4.7	6.0	5.8	4.23	6.43	5.33

Notes

(1) The shaded areas in rows A-K are the regulator-determined input values. The shaded areas in rows L-N are the regulators' preferred WACC estimates.

(2) All calculations are for the real cost of capital, except for CC MNO (2003) which calculates the nominal WACC. CC's estimate range for the real risk-free rate is 2.5-2.75%, and the corresponding real pre-tax WACC estimate range is 7.7-14.4%.

(3) **Ofgem** discards the lower range of the resulting **Vanilla WACC** estimation, with the final adopted range of **5.1-5.9%**.

(4) **Ofreg** makes an adjustment for the transmission portion of the RAB, leading to the final **post-tax WACC** estimation of **4.78%**.

(5) **Ofwat** discards the lower range. The final **post-tax WACC** estimate is **5.1%, plus small company premiums of 0.3-0.9%** graded by the size of RCV.

(6) **CC** adds a 25bp premium reflecting a degree of smoothing of the downward trend in ERP, and a further T5-related uplift of 25bp, resulting in a **pre-tax WACC** estimate of **7.75%**.

(7) As with CC BAA (2002), an ERP smoothing premium of 25bp lifts **CC**'s the mid-point estimate of the **real pre-tax WACC** to **11.25%**.

Sources

Ofgem, "Electricity Distribution Price Control Review: Background information on the cost of capital", March 2004

Ofreg, "Northern Ireland Authority for Energy Regulation: Northern Ireland Electricity (NIA) – Transmission and Distribution Price Control 2007-2012" Proposals Paper, 14 December 2005

Ofwat, "Future Water and Sewage Charges 2005-10: Final Determinations" Periodic Review 2004

Competition Commission, "BAA plc: A report on the economic regulation of the London airports companies (Heathrow Airport Ltd, Gatwick Airport Ltd and Stansted Airport Ltd)", 29 November 2002

Competition Commission, "Vodafone, O2, Orange and T-Mobile: Reports on references under section 13 of the Telecommunications Act 1984 on the charges made by Vodafone, O2, Orange and T-Mobile for terminating calls from fixed and mobile networks", 18 February 2003

Table 11.1. WACC Comparison, Continued[(1),(2)]

		CC[(7)] MNO (Feb 2003)		CC LPG (June 2006)			
		Low	High	Low 30% gearing	Low 50% Gearing	High 30% gearing	High 50% gearing
A	Risk-free rate	5.1	5.3	4.2	4.2	4.9	4.9
B	Debt premium	1.0	4.0	1.5	2.0	1.5	2.0
C	Pre-tax cost of debt	6.10	9.30	5.70	6.20	6.40	6.90
D	Post-tax cost of debt	4.27	6.51	3.99	4.34	4.48	4.83
E	Equity risk premium	2.6	4.6	3.0	3.0	5.0	5.0
F	Equity beta	1.0	1.6	0.78	1.02	1.04	1.36
G	Pre-tax cost of equity	11.00	18.09	9.34	10.37	14.43	16.71
H	Post-tax cost of equity	7.70	12.66	6.54	7.26	10.10	11.70
J	Gearing	0.1	0.1	0.3	0.5	0.3	0.5
K	Corporation tax	0.3	0.3	0.3	0.3	0.3	0.3
L	Pre-tax WACC	10.5	17.2	8.25	8.29	12.02	11.81
M	Post-tax WACC	7.4	12.0	5.78	5.80	8.41	8.27
N	Vanilla WACC	7.5	12.3	6.29	6.73	8.99	9.30

Estimates for Input Values

Risk-free Rate – These are mostly estimated from current index-linked gilts (e.g. Ofgem quotes: 2.2-2.3% (June 2002), 1.65-1.99% (Jan 2004); CC quotes for June 2002: 2.28% (5 year), 2.32% (10 year), 2.16% (30 year)). Other estimates include NERA's[31] 2.6% (current) and 3.1% (historical) (Ofgem), and Smithers and Co's[32] 2.5% (Ofwat). However all agree that the current estimate is likely to be low, due to high equity market volatility and pension funds' minimum funding requirement factor. CC further investigate an assertion that "historic yields may be more important than current yields as a predictor of future yields, since yields may revert towards the mean" (CC BAA). All parties adopt a range of around 2.25-3.0% (real).

Debt Premium – These are estimated from the current spreads on publicly traded debts (e.g. 0.93% and 1.36% for short and long maturities in the UK (Ofgem); April 2002 spreads for a typical AA-- company in the transportation sector of 69bp (1 year) up to 165bp (30 year) (CC BAA); debt premium for Orange in June 2002 of 5.17% as opposed to the average for Jan to June of 3.66% (CC MNO)). Both Ofgem and Ofwat however suspect that the current spread level is too low due to low supply of bonds. CC refer to Oftel's comment that "the promised yield was an inaccurate proxy for the debt premium since … where the probability of default was significant … the expected rate on debt (and therefore the cost of debt) was lower than the promised yield" (CC MNO). They however also cite T-Mobile's response that this impact is far smaller than implied by Oftel, e.g. 40-60bp as opposed to 200bp or more even for BBB or Baa debts. Overall, a much higher premium was set for MNOs than others, reflecting the then market state.

Equity Risk Premium – These are estimated from historical data. For example Ofgem quote Smithers & Co's aggregate market return estimates of around 5.5% (geometric average) and thus 6.5% to 7.5% (arithmetic average). Ofwat refer to CEPA/EE's[33] estimates of 3.5-5.0%; and CC quote Dimson *et al.*[34] Charts of geometric ERPs of 2.3% (UK), 4.0% (US) and 2.9% (world), and arithmetic ERPs of 3.6%, 5.3% and 3.9% respectively (CC BAA). The CC point out that the ERP historical estimations are sensitive to the holding period assumed, with estimates ranging from 0.4% to 6.8% relative to gilts for different periods in the last century (ibid). These figures are crosschecked with estimates from the dividend growth model: for example the CC's DGM estimate for the FT All Share Index in April 2002 is 2.7-3.0%, while for Ofwat, NERA's[35] (Mar 2004) DGM estimate for the real post-tax cost of equity of 9.7% suggests that "a cost of equity towards the top of the CAPM derived range is appropriate" (Ofwat). The CC also refer to survey data (e.g. Welch's[36] forecast of 5.3-5.7% (arithmetic) for 5 to 10 year horizons). However both they and Ofgem consider the "robustness of survey data ... to be an issue" (Ofgem). With the exception of Ofwat all estimate the ERP range to be 2.5-4.5% (real), while Ofwat adopt a higher range of 4-5%.

Equity Beta – These are estimated for each industry by regression using historical data. Ofgem quote Wright's[37] daily estimate of 0.49 – 0.70 for electricity & water. Ofreg use the LBS data to estimate that Viridian's beta has fallen from 1.1 to 0.3 in the period 1994-2004. Ofwat's estimates for the water industry vary from 0.9 in early 1990s to 0.4 in July 2004. CC's July-Sep 2002 figure for BAA beta is 0.71, while their figures for Vodafone include 1.55 (Sep 92) and 0.91 (Sep 02). CC discuss issues related with beta estimation using historical data, such as frequency of the data used (i.e. monthly versus daily), the choice of time period of the data used, and whether beta is affected by international expansion of the company concerned (CC MNO). Ofgem refer to Smithers & Co's

[31] National Economic Research Associates (August 2003), "UK Water Cost of Capital: A final report for Water UK"
[32] S. Wright, R. Mason and D. Miles (2003), "A study into certain aspects of the cost of capital for regulated utilities in the UK", Smithers & Co Ltd.
[33] Cambridge Economic Policy Associates / Europe Economics
[34] Dimson, Marsh and Staunton (2002), "Global evidence on the equity risk premium", unpublished
[35] Update of the Aug 2003 report.
[36] I. Welch (May 1998), "Views of financial economists on the equity risk premium and other issues", Anderson Graduate School of Management, UCLA
[37] S. Wright and Smithers & Co (Mar 2004), "Beta estimates for: Scottish & Southern Energy, Viridian Group, Centrica, International Grid Transco, United Utilities, Kelda Group, Severn Trent"

observation that the estimates of beta are unstable over time. Indeed they quote, "The Smithers & Co report presents … issues for consideration, which have to be weighed when interpreting the data … all other things being equal, parameter instability might make beta estimates more uncertain into the future and hence more weight might be given to the unconditional expectation of unity (beta = 1)". Overall most choose a range around 1.0, with the exception of Ofreg (a lower range) and CC MNO (a higher range). In their LPG assessment, CC work in terms of the asset betas (which they estimate to be in the range 0.6 to 0.8) but then factor in the impact of higher gearing on equity beta so that even their lower estimate of asset beta results in an equity beta above one on their higher gearing assumptions.

Gearing – All refer to actual financial gearing ratios. For example Ofwat estimate the industry average to be 59% on the net debt:RCV measure for 2003-04. CC's estimates of BAA group's gearing are 25.65% (book values) and 21.9% (market values) on 31 March 2002, while the ratios for the MNOs are 10% for Vodafone and 10-13% for O_2. However Ofgem and Ofwat also note ratios consistent with target credit ratings: "Recent evidence[38] indicates that one of the leading credit rating agencies considers that debt to RAV gearing in the range of 60-65% is consistent with target A3 (A-) ratings for comparable regulated network businesses." (Ofgem). As already commented, the regulators all adopt gearing values within 50%-60% range, while the CC adopts lower ratios for BAA and MNOs (25% and 10% respectively).

Views of the Fama French Model

CC consider in its report for MNO the use of the Fama and French[39] three-factor risk model as an alternative to the single-factor CAPM. They cite Charles Rivers Associates' (CRA) comment that there are some empirical evidence and academic references that the CAPM is not empirically robust and does not provide a reliable estimate of cost of capital. CRA's own test shows that by adding a second factor of value component, their two-factor model explains over 50% of the variation in returns of UK companies compared with about 10% for the CAPM. Using this model, CRA's estimates for the post-tax cost of equity for the MNOs are 1-2% higher than the CAPM estimates.

CC on the other hand also cite a number of academics who disput whether the Fama and French criticisms of the CAPM are valid.[40] For example Gregory *et al*.[41] reject the validity of the three-factor model for the UK and state that "as noted by Fama and French[42] the three-factor model has no foundation in finance theory, but is merely a statistical model that summarizes the empirical regularities that have been observed in US stock returns. They also acknowledge that the success of the three-factor model is fully consistent with both a rational model of returns in which size and value components reflect unobserved systematic risk factors, and an irrational model in which they capture the systematic mispricing of stocks". The mispricing view is also held by Shiller[43]. In their LPG report CC also cite lack of statistical evidence for a small firm effect in the companies they examine.

Finally the CC cites Oftel's September Statement *Effective Competition Review* where they refer to the debate in the finance literature on whether multi-factor models may provide a more accurate estimate of the cost of capital than the CAPM. Oftel's conclusion is that no consensus has emerged. Oftel therefore consider the CAPM to be the most appropriate approach for this inquiry, given the broad acceptance and use of this model.

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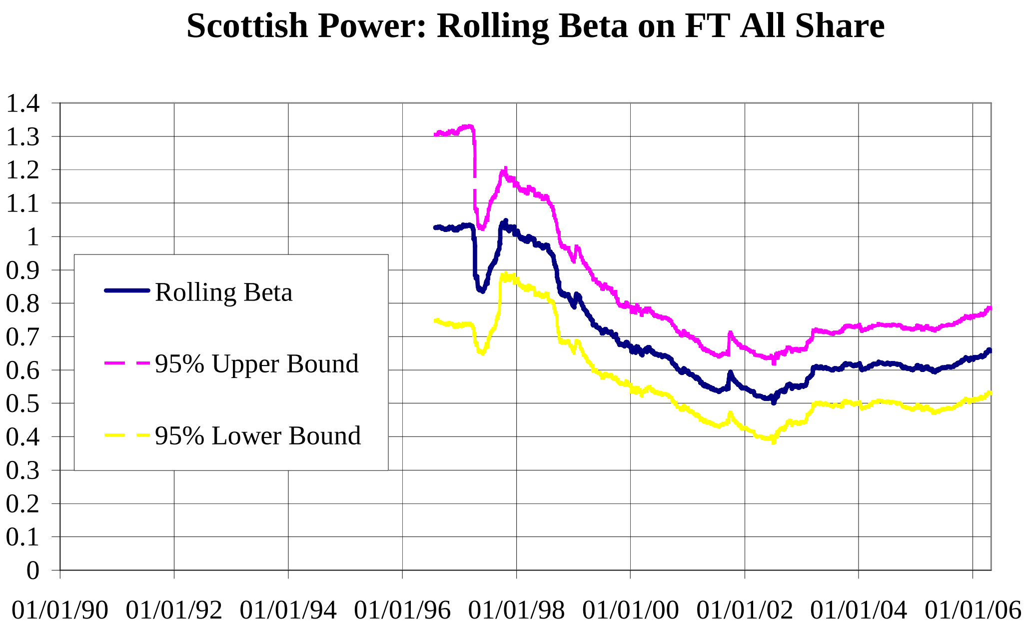
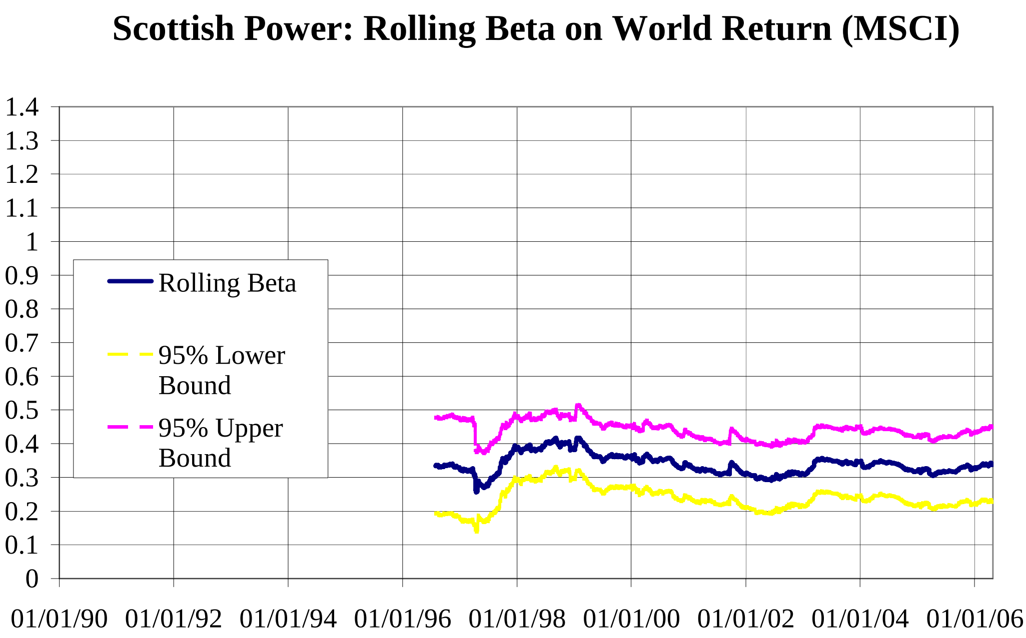
Appendix A. Detailed Beta Estimates for Individual Companies

In the following charts we show, for each company:

- **Top Panel**: rolling equity beta estimates using FT All share as market meaure, with 95% confidence intervals based on rolling Newey-West standard errors.
- **Central Panel:** rolling equity beta estimates using MSCI world index (expressed in sterling) as market meaure, with 95% confidence intervals based on rolling Newey-West standard errors.
- **Bottom Panel:** A comparison of alternative estimates. "Spot" Kalman filter estimates assume that beta is a random walk, with innovation uncorrelated with either the market return or the residual in the CAPM equation. The chart also shows 95% confidence intervals around spot estimates. The charts also show estimates assuming that beta is a sixth order polynomial in time. All of the above estimates are available for the full sample. In contrast rolling OLS estimates are based on a preceding sample of data of two to five years. Rolling samples for rolling Kalman Filter and polynomial estimates are set consistently with rolling samples for OLS estimates.

- **Chart A1**


Scottish Power: Rolling Beta on FT All Share
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Rolling Beta
95% Upper Bound
95% Lower Bound
01/01/90
01/01/92
01/01/94
01/01/96
01/01/98
01/01/00
01/01/02
01/01/04
01/01/06


Scottish Power: Rolling Beta on World Return (MSCI)
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Rolling Beta
95% Lower Bound
95% Upper Bound
01/01/90
01/01/92
01/01/94
01/01/96
01/01/98
01/01/00
01/01/02
01/01/04
01/01/06

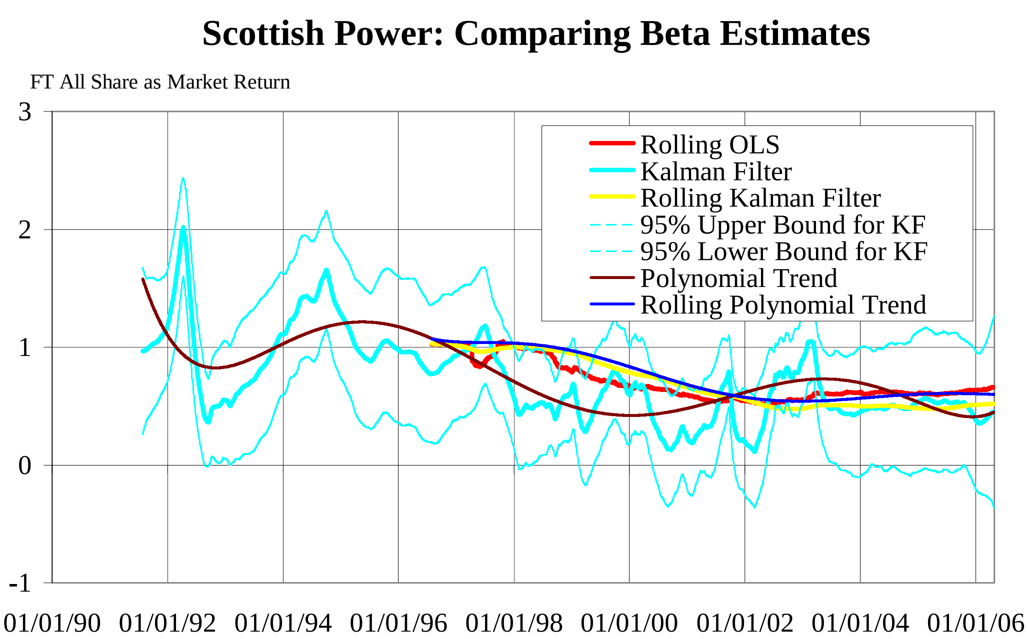
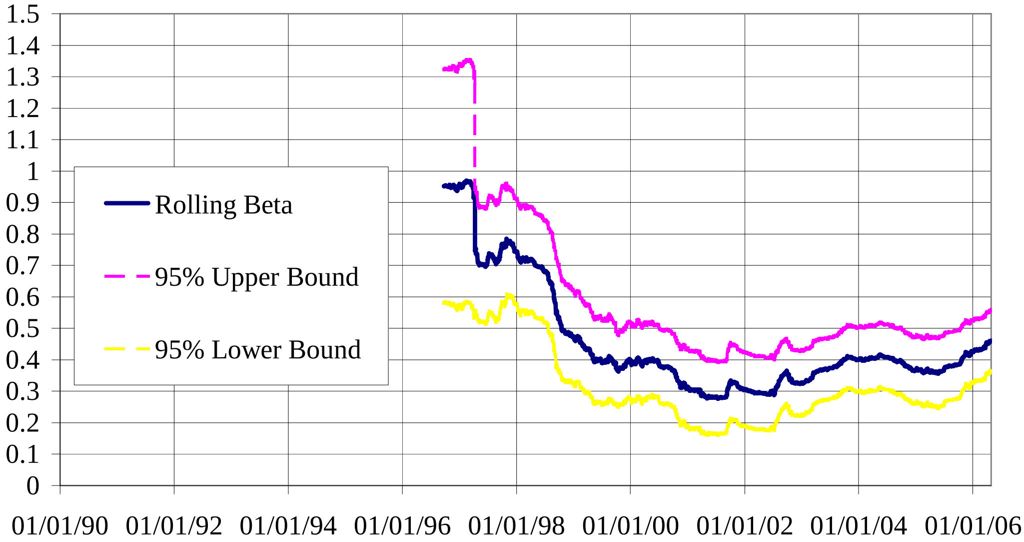
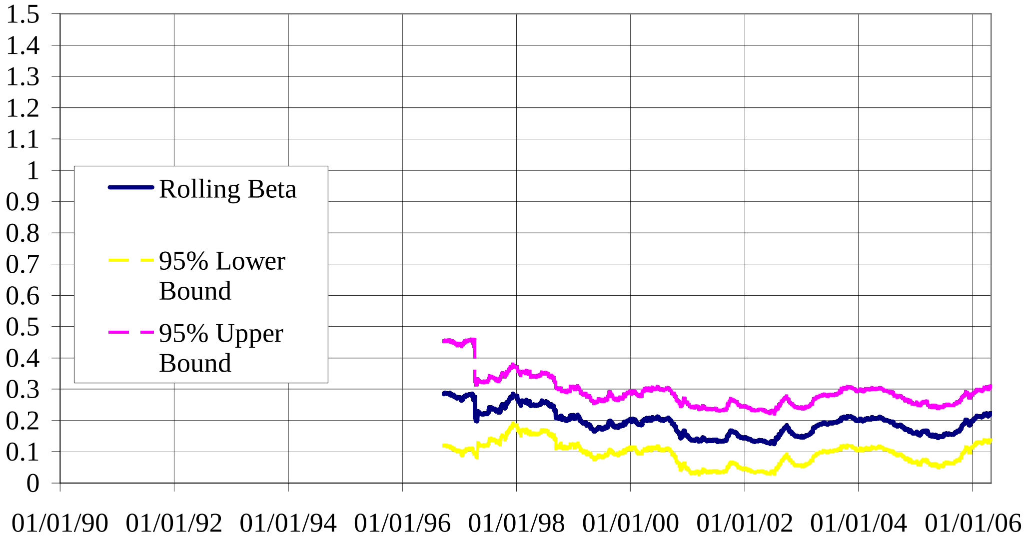

Scottish Power: Comparing Beta Estimates
FT All Share as Market Return
3
2
1
0
-1
Rolling OLS
Kalman Filter
Rolling Kalman Filter
95% Upper Bound for KF
95% Lower Bound for KF
Polynomial Trend
Rolling Polynomial Trend
01/01/90
01/01/92
01/01/94
01/01/96
01/01/98
01/01/00
01/01/02
01/01/04
01/01/06

Chart A2

Scottish & Southern: Rolling Beta on FT All Share



Scottish & Southern: Rolling Beta on World Return (MSCI)



Scottish & Southern: Comparing Beta Estimates

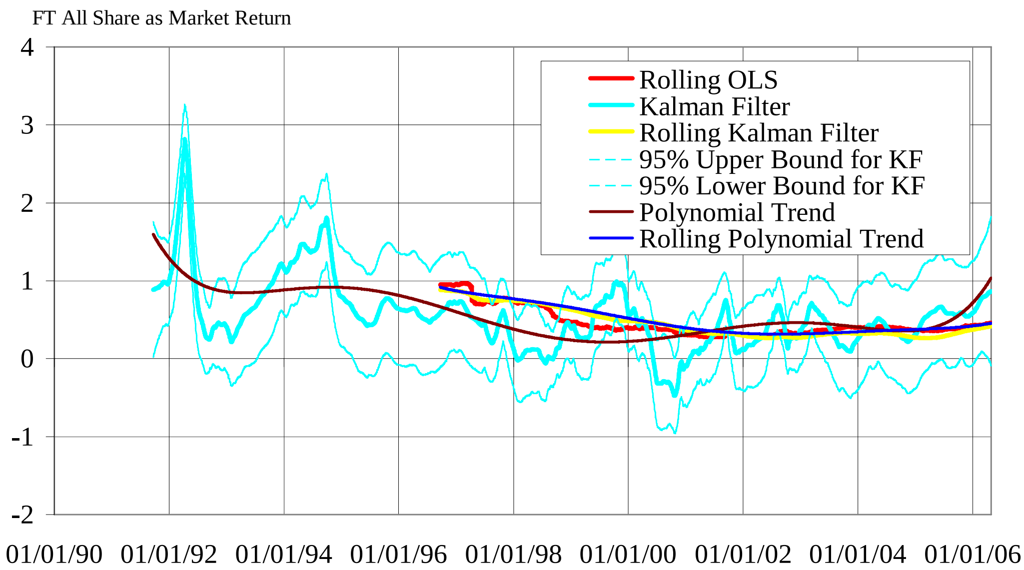
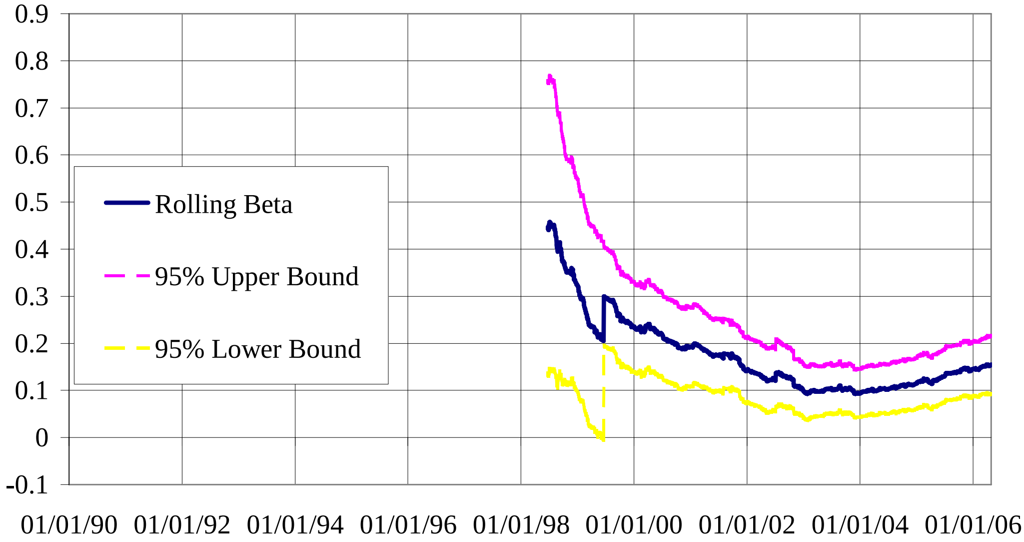
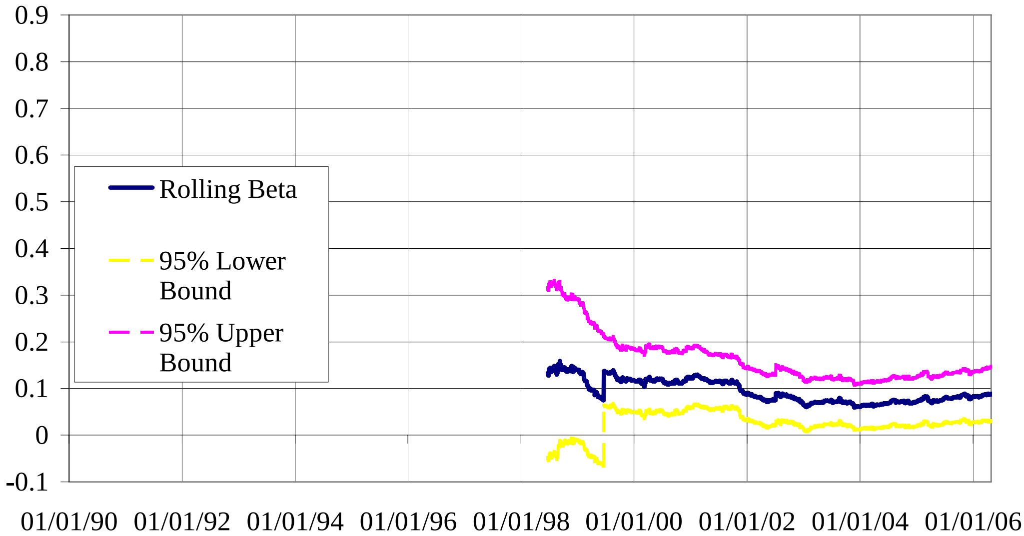


Chart A3

Viridian: Rolling Beta on FT All Share



Viridian: Rolling Beta on World Return (MSCI)



Viridian: Comparing Beta Estimates

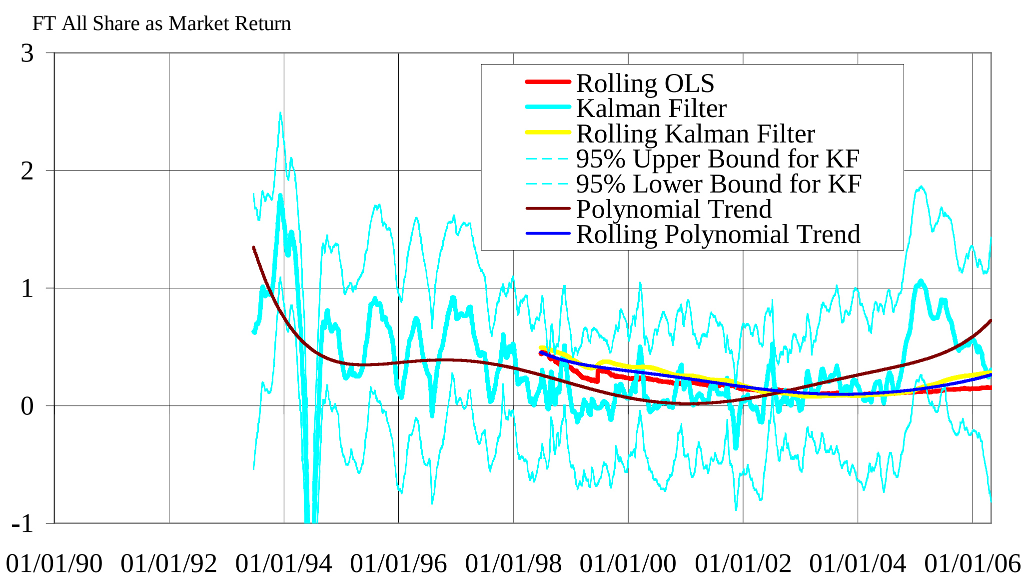
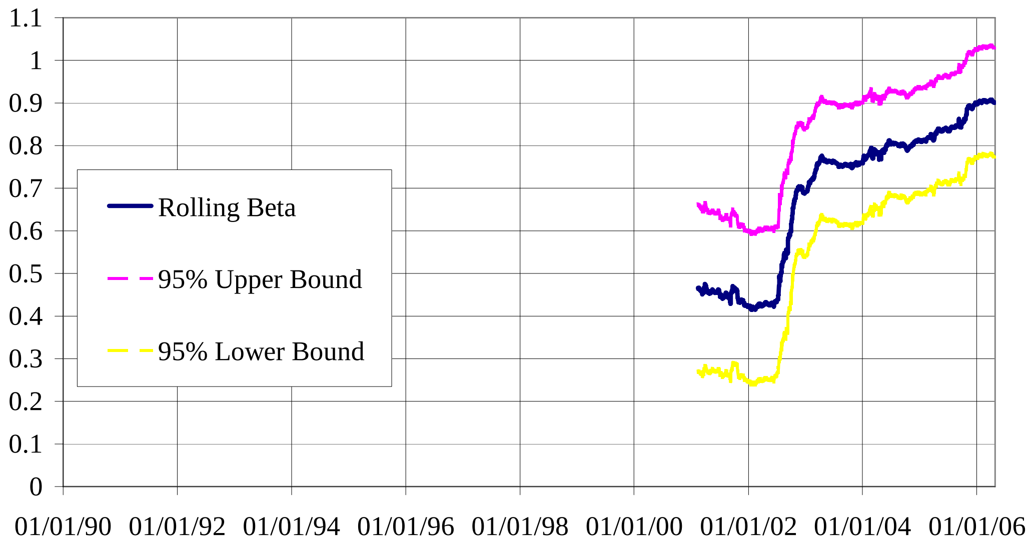
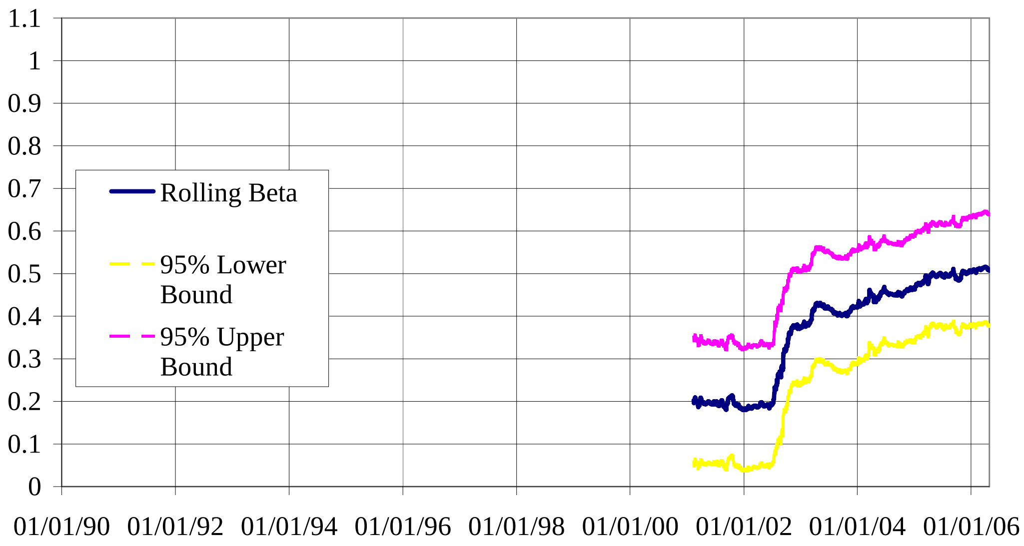


Chart A4

Centrica: Rolling Beta on FT All Share



Centrica: Rolling Beta on World Return (MSCI)



Centrica: Comparing Beta Estimates

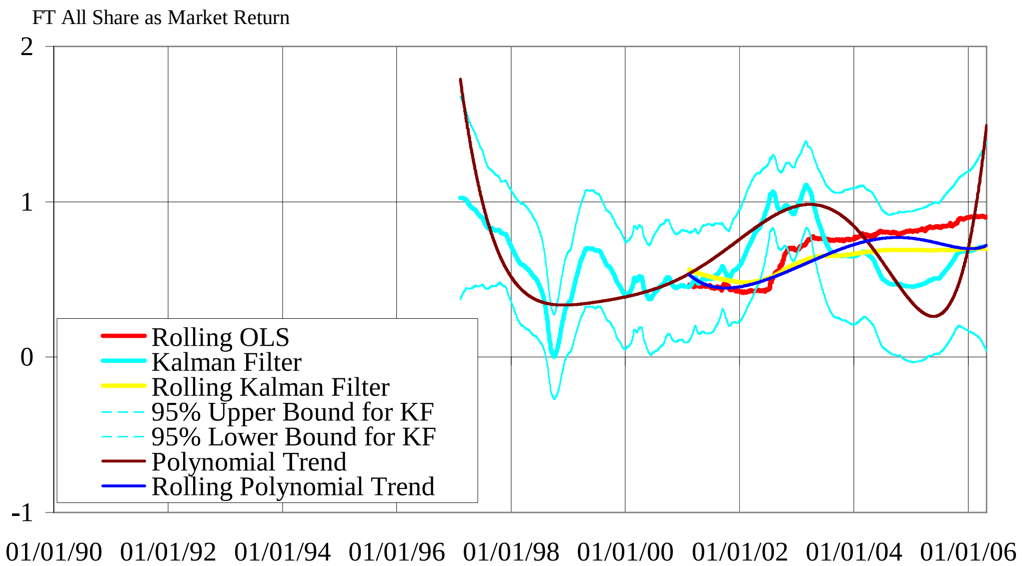
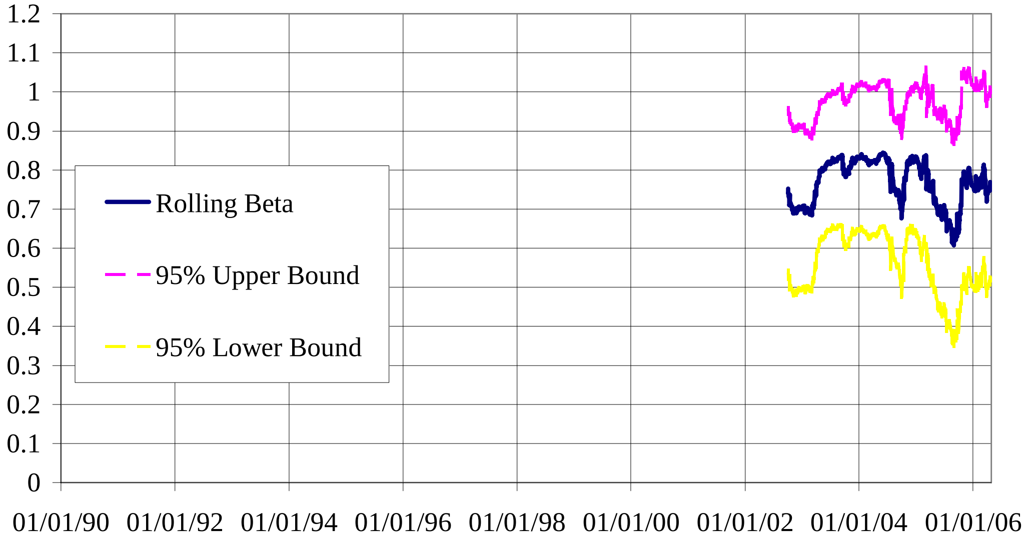
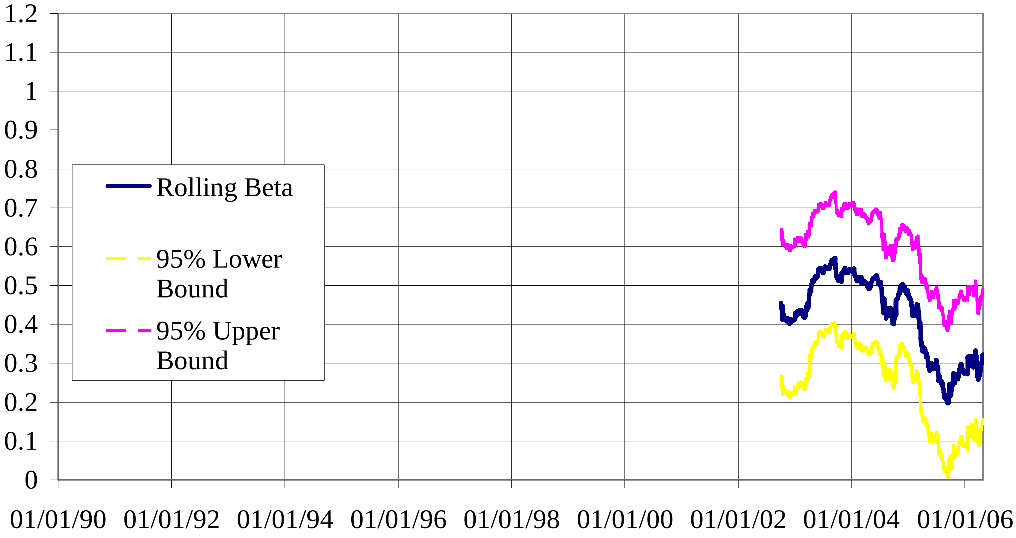


Chart A5

International Power: Rolling Beta on FT All Share



International Power: Rolling Beta on World Return (MSCI)



International Power: Comparing Beta Estimates

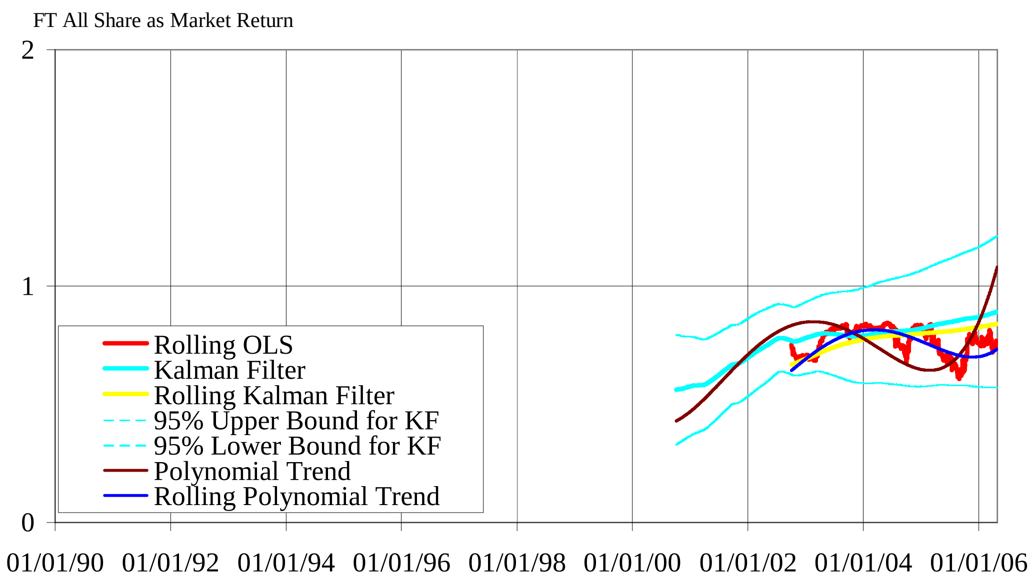
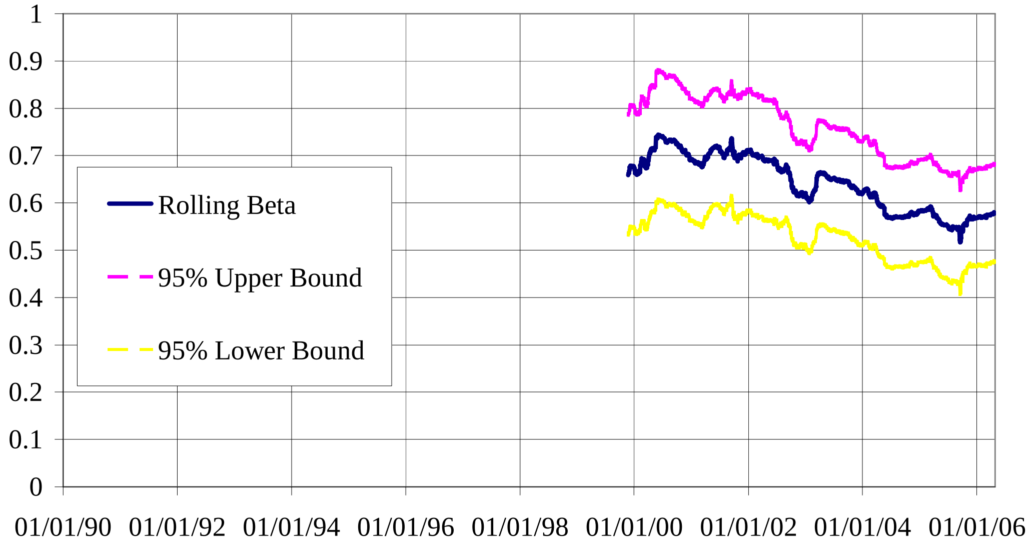
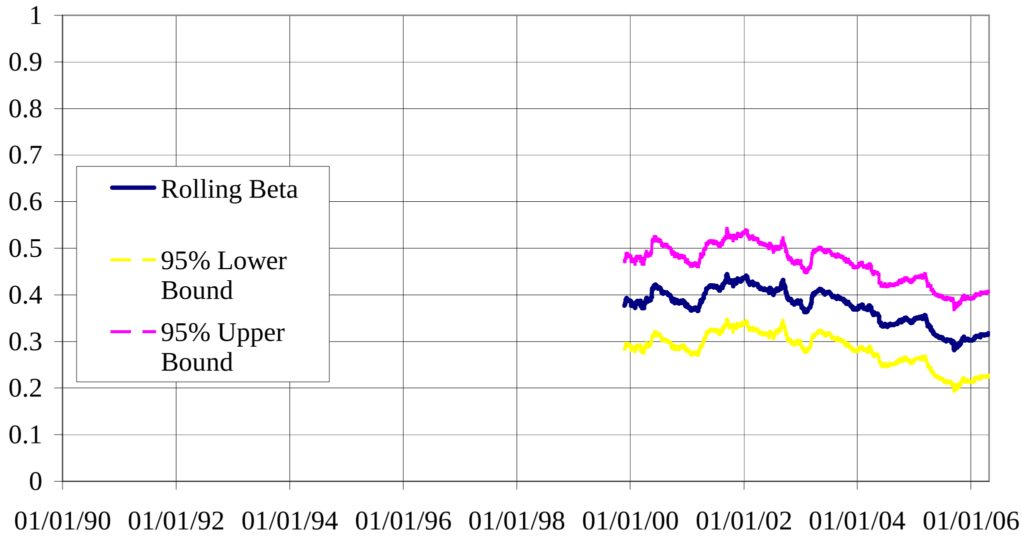


Chart A6

National Grid: Rolling Beta on FT All Share



National Grid: Rolling Beta on World Return (MSCI)



National Grid: Comparing Beta Estimates

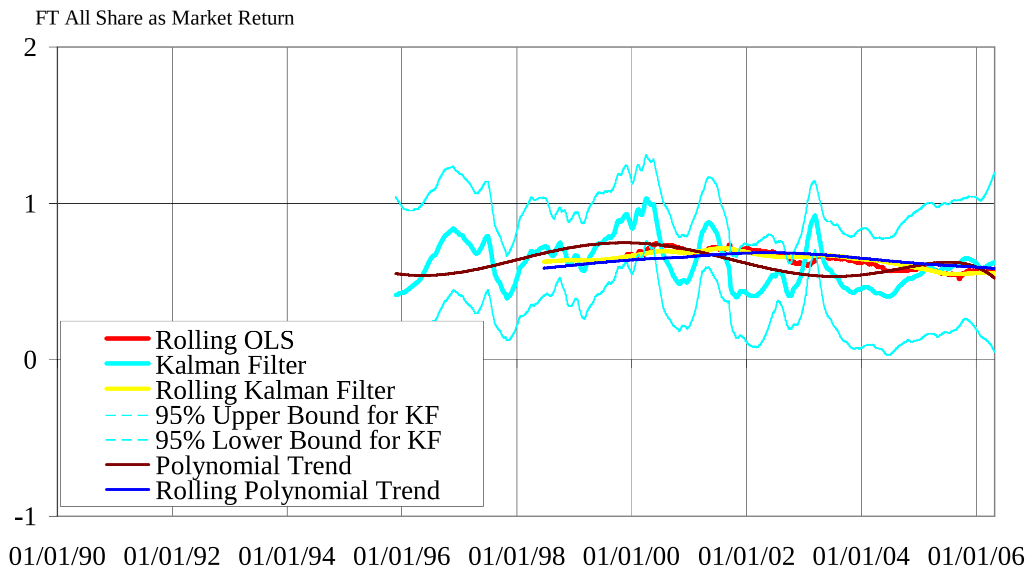
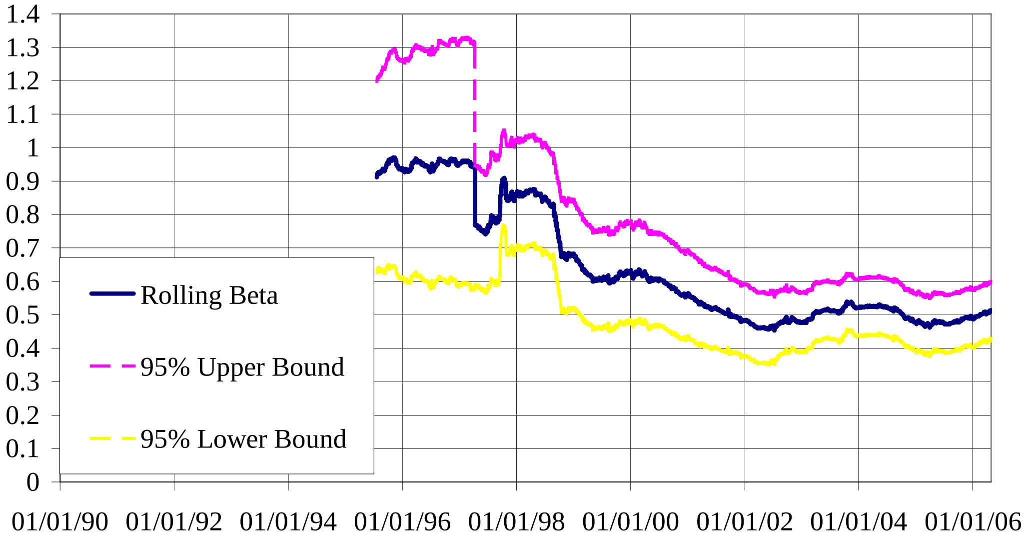
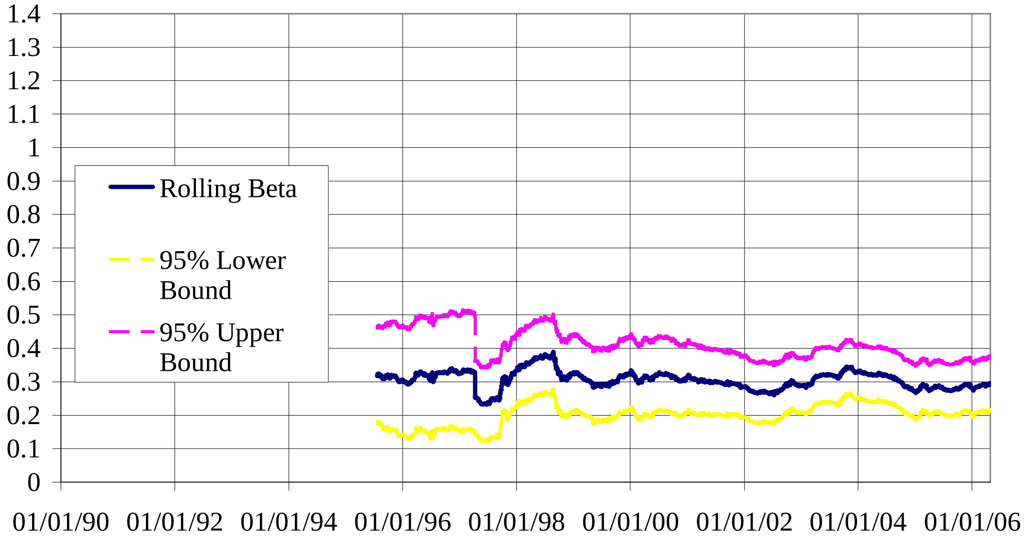


Chart A7

United Utilities: Rolling Beta on FT All Share



United Utilities: Rolling Beta on World Return (MSCI)



United Utilities: Comparing Beta Estimates

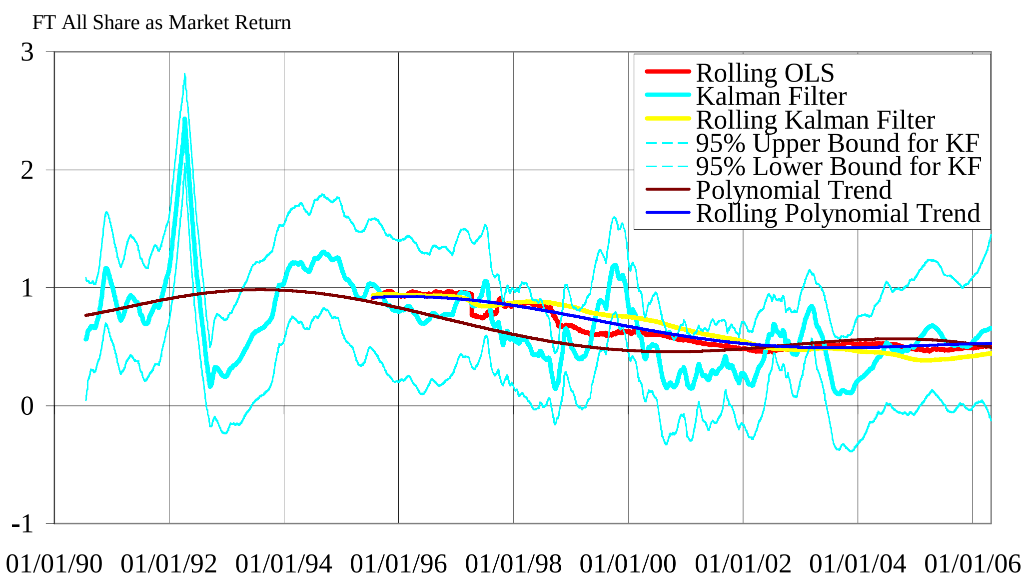
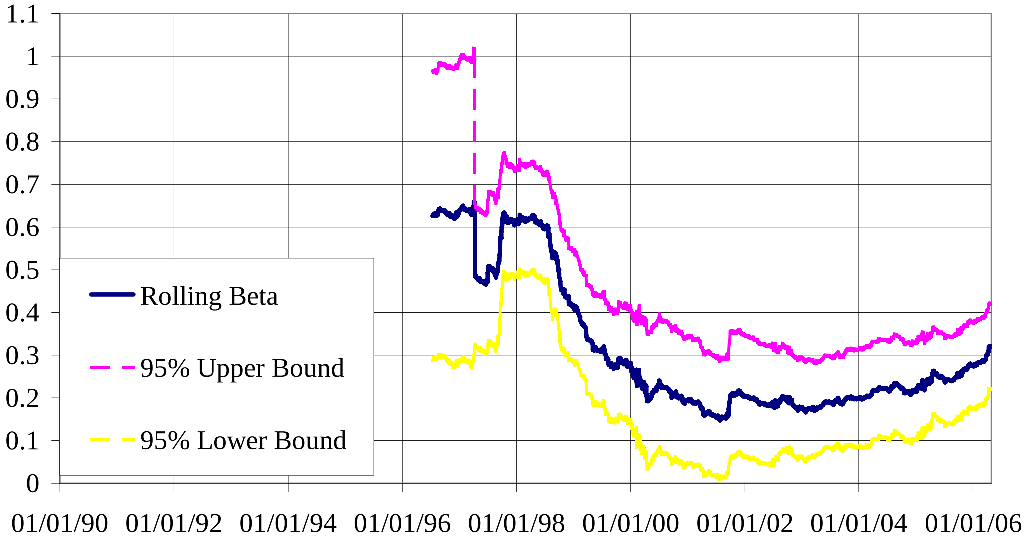
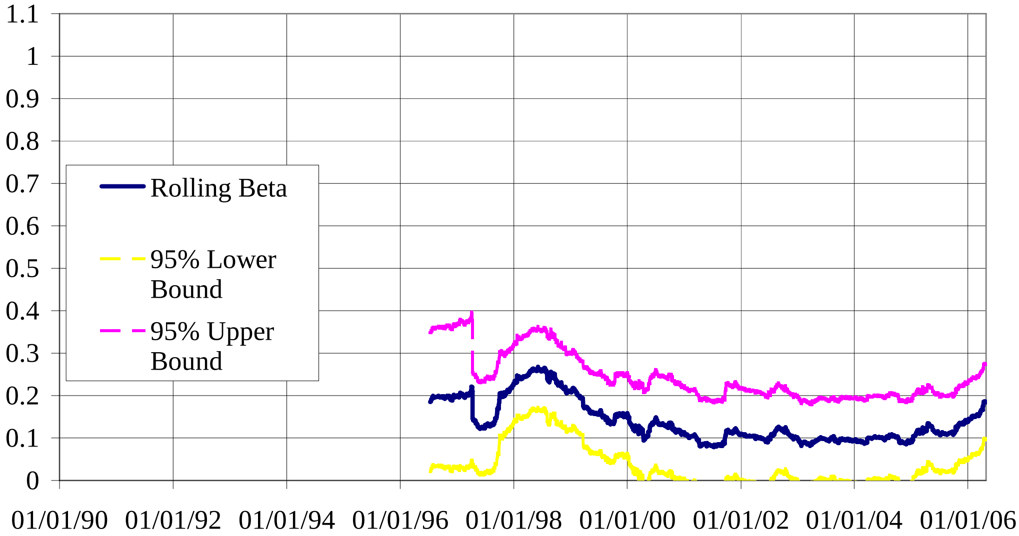


Chart A8

Kelda: Rolling Beta on FT All Share



Kelda: Rolling Beta on World Return (MSCI)



Kelda: Comparing Beta Estimates

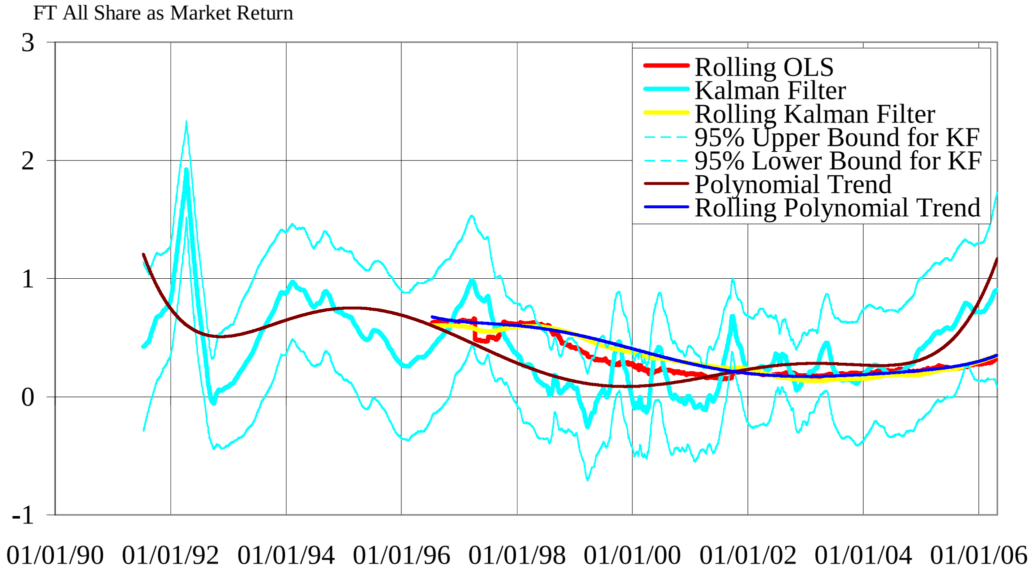
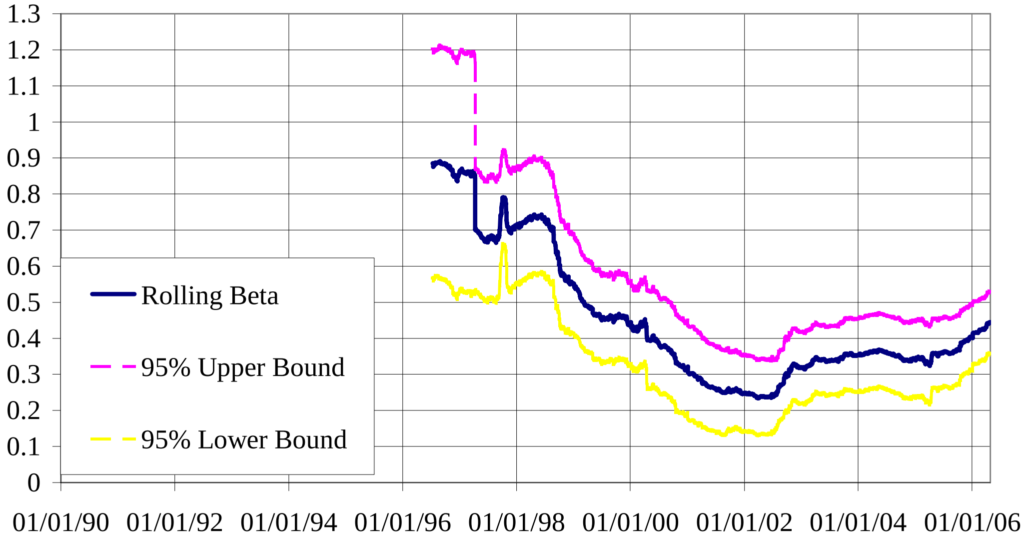
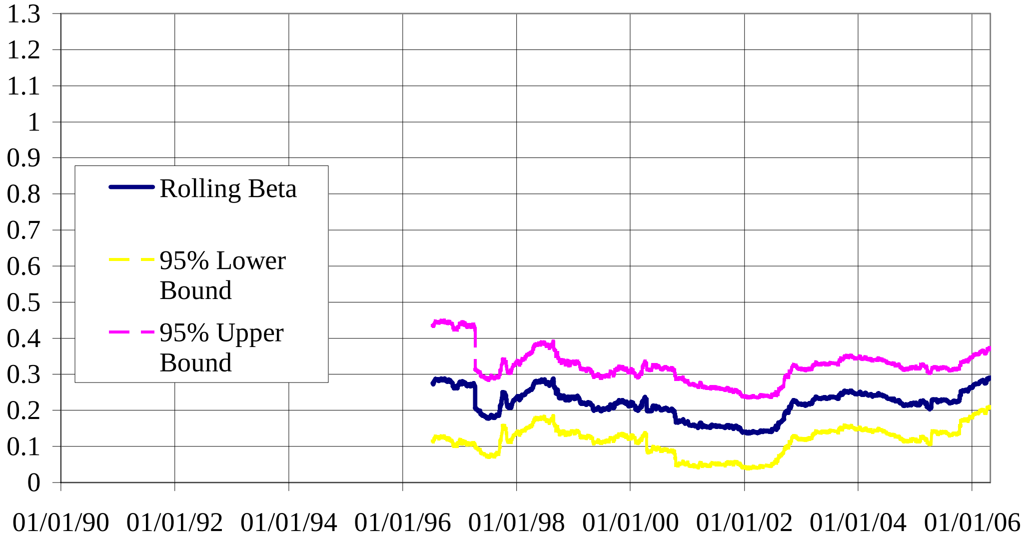


Chart A9

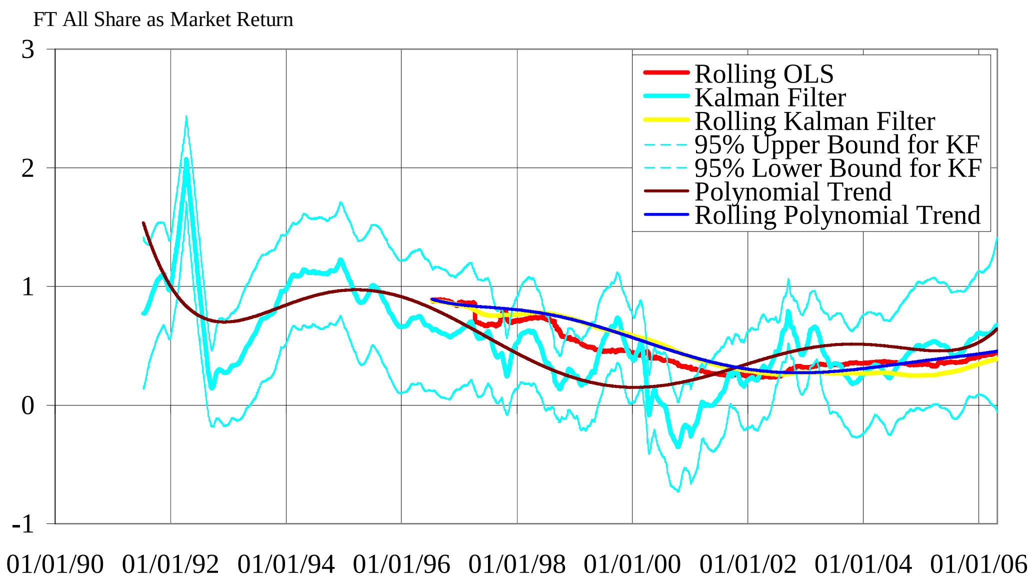
Severn & Trent: Rolling Beta on FT All Share



Severn & Trent: Rolling Beta on World Return (MSCI)



Severn & Trent: Comparing Beta Estimates



Appendix B. Alternative Gearing Measures for Individual Companies

In the following charts we show, for each company:

- Ratio of total debt to total capital (as reported in balance sheets)
- Ratio of reported balance sheet debt to net fixed capital
- Ratio of reported balance sheet debt to total market value (sum of balance sheet debt and market value of equities)

The source for all series are reported balance sheets collated by Grant Thornton.

NB. The dataset does not include balance sheets for International Power.

Chart B1

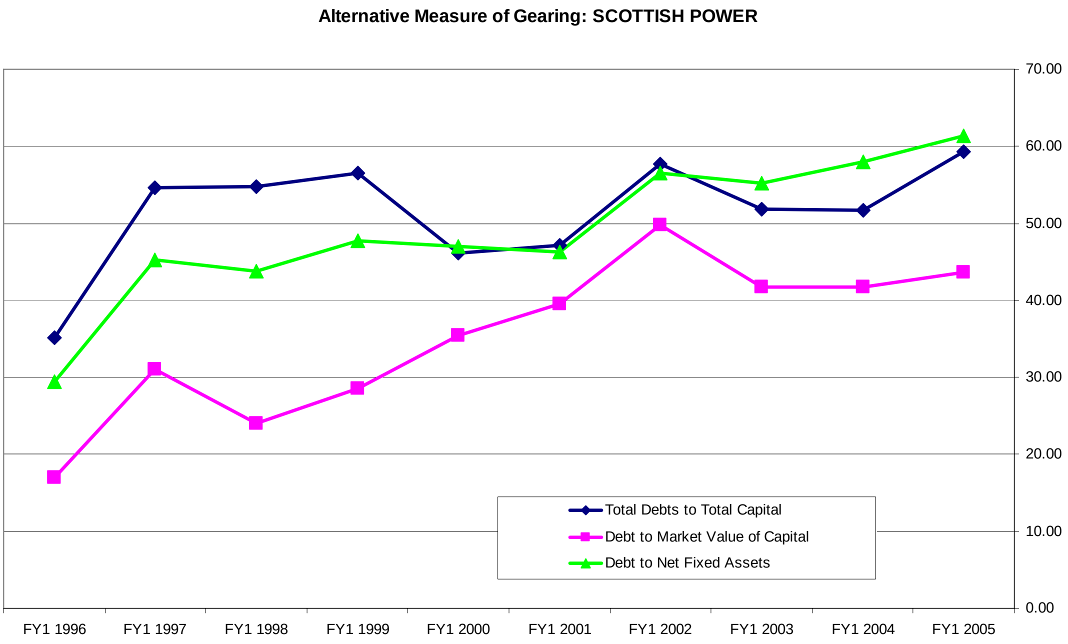


Chart B2

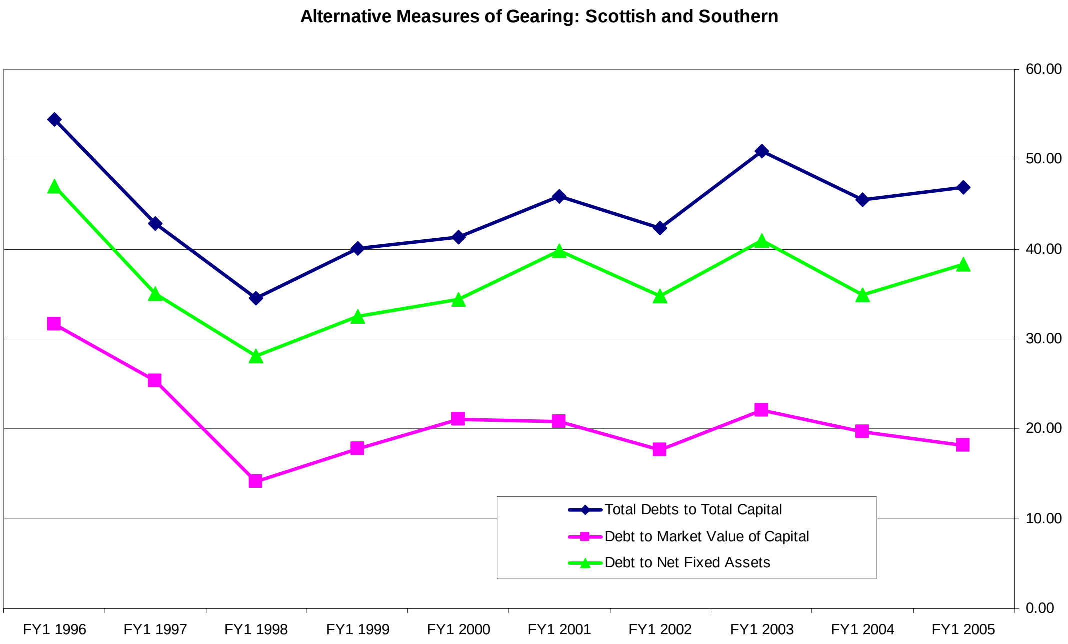


Chart B3

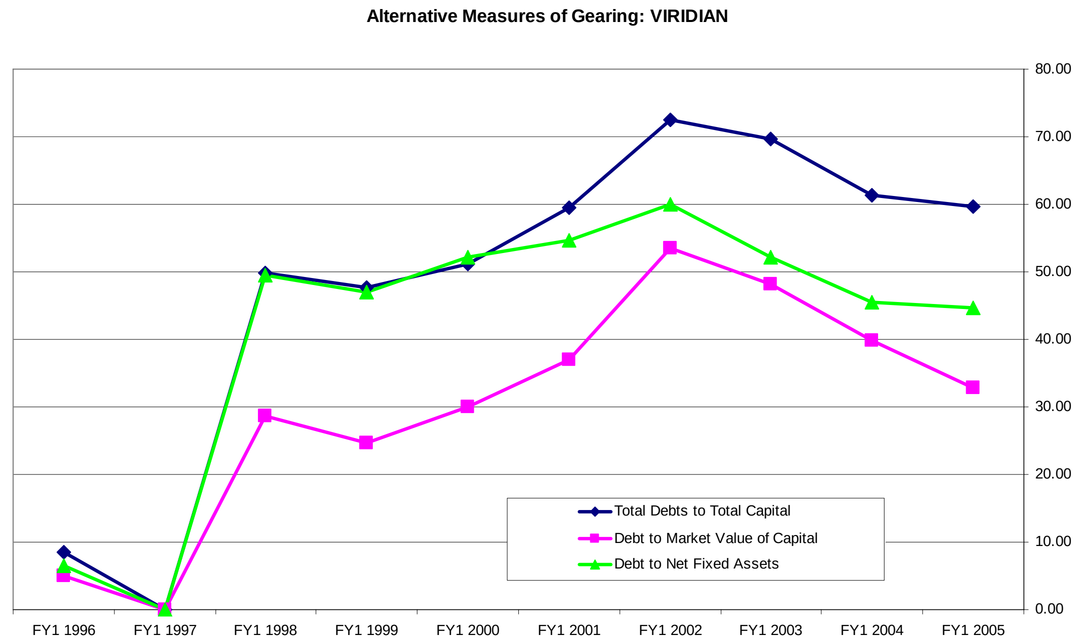


Chart B4

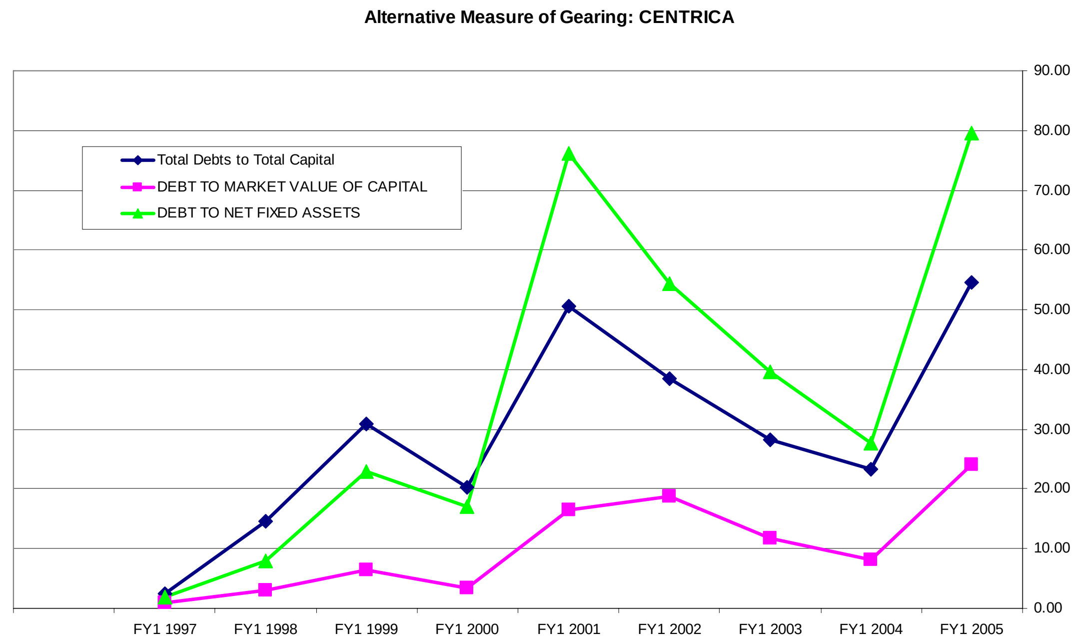


Chart B6

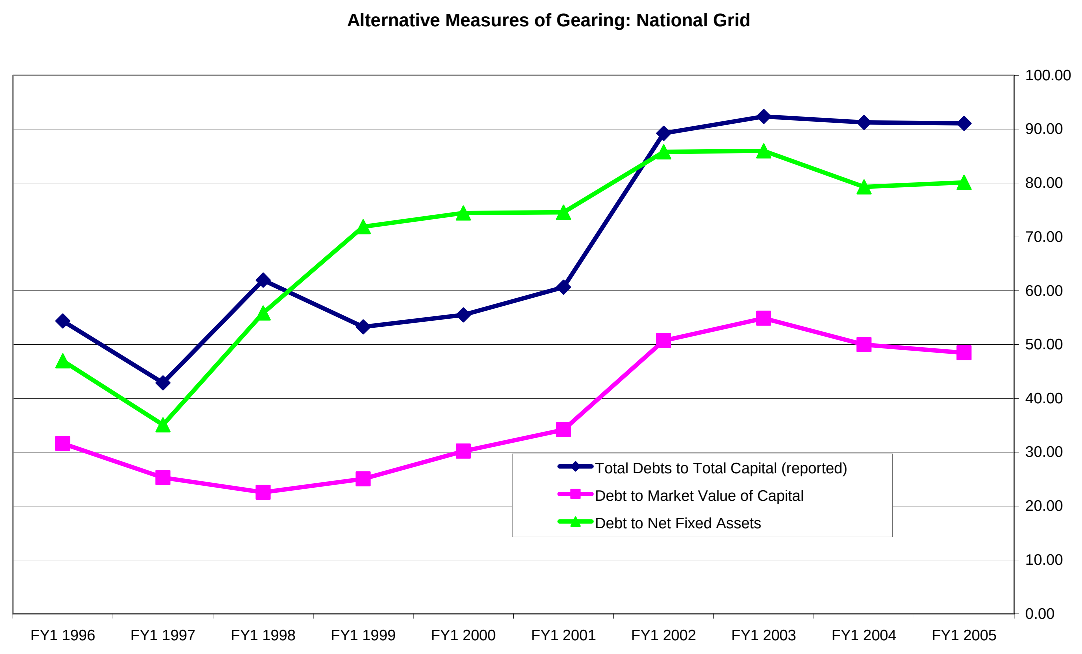


Chart B7

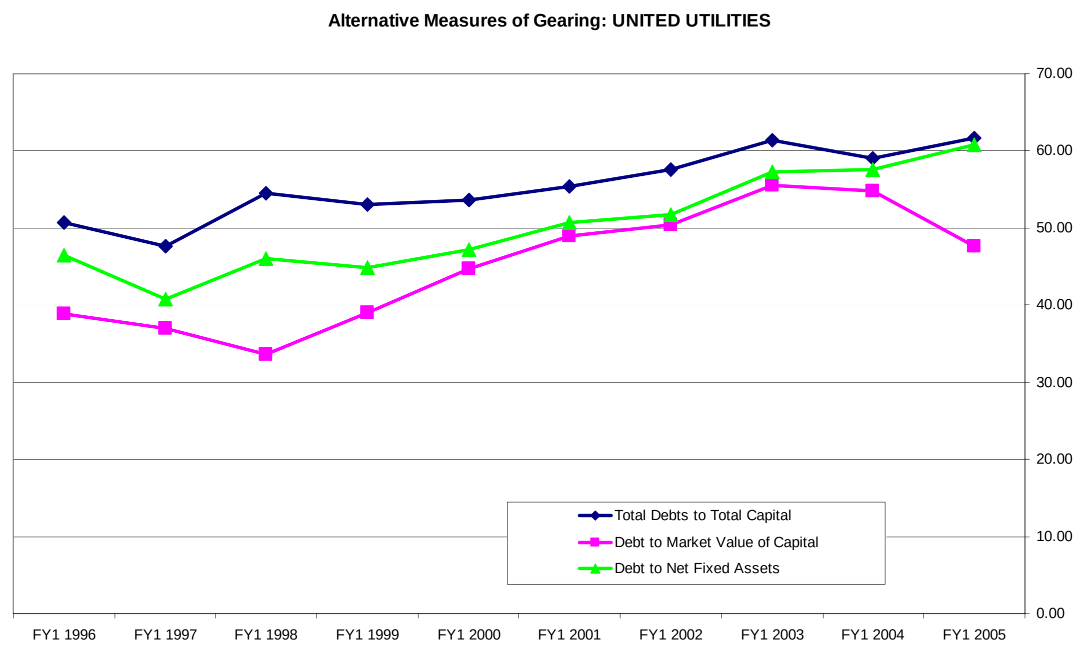


Chart B8

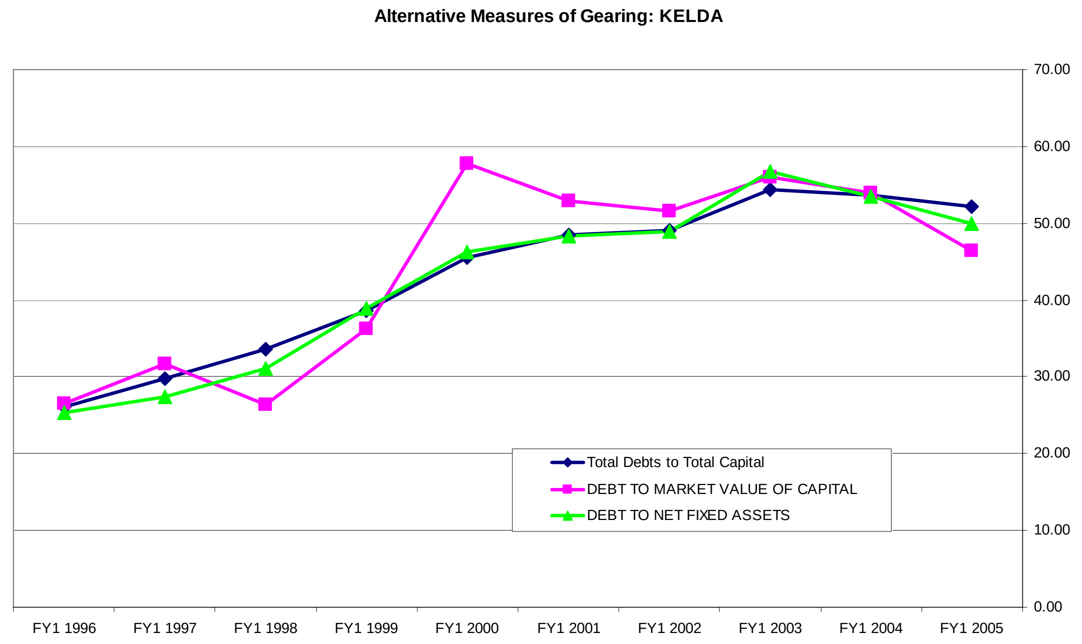
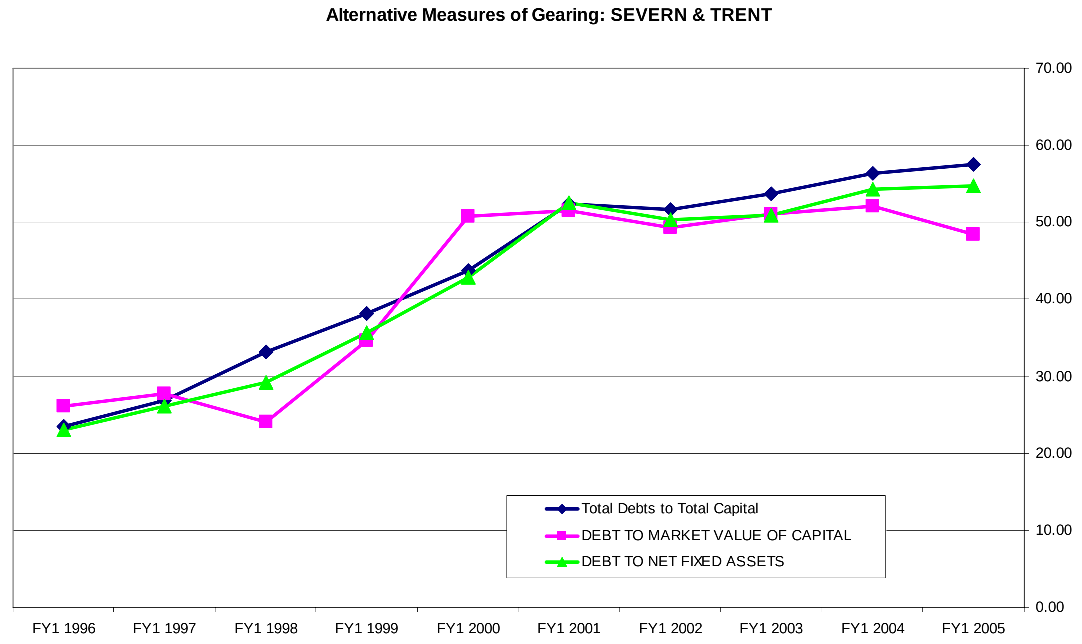


Chart B9



Appendix C. Geometric vs Arithmetic Averaging, and the Role of Return Predictability

Let R_{jt} be the return on some financial asset, defined by

$$1 + R_{jt} = \frac{P_{jt} + D_{jt}}{P_{jt-1}} \tag{1}$$

where P_{jt} is the price of the asset, and D_{jt} is any dividend or other income generated by the asset.

Standard theory requires that the appropriate measure of any given return used in deriving the cost of capital should be $E(R_{jt})$, i.e. the true arithmetic mean. This requirement holds whatever the nature of the process that generates R_{jt}.

In contrast, historical studies frequently quote two alternative, but closely related, measures. One is what is often rather loosely described as the "geometric mean"; the other is the arithmetic mean of the logarithmic return.

It is very commonly assumed that returns are lognormal (inter alia, this deals with the skewness of returns, and rules out returns of less than –100 %), i.e., letting lower case letters define log returns,

$$r_{jt} \equiv \log(1 + R_{jt}) \sim N(E(r_{jt}), \sigma(r_{jt})) \tag{2}$$

but standard properties of the lognormal distribution imply that

$$1 + E(R_{jt}) = exp\left(E(r_{jt}) + \frac{\sigma^2(r_{jt})}{2} \right) \tag{3}$$

implying, to a linear approximation the following relationship between the arithmetic mean return, and the arithmetic mean log return

$$E(R_{jt}) \approx \log\left(1 + E(R_{jt})\right) = E(r_{jt}) + \frac{\sigma^2(r_{jt})}{2} \tag{4}$$

The latter is in turn closely related to the "geometric mean" or compound average return, $G(R_{jt})$ defined by

$$1 + G(R_{jt}) = exp(E(r_{jt})) \tag{5}$$

But, again, to a linear approximation,

$$G(R_{jt}) \approx \log(1 + G(R_{jt})) = E(r_{jt}) \tag{6}$$

with the omitted terms biasing the approximation downwards by a fairly trivial amount.[1] The geometric mean return is a natural metric of returns viewed from the perspective of an investor: an investment with a positive geometric mean return will grow over time.

Thus, as an illustration, suppose that the volatility of log returns is 0.2,[2] a rough ballpark figure for a range of equity markets, according to figures from Dimson et al (2001). The implied difference between the arithmetic and log (hence geometric) means will approximately equal $0.2^2/2$ = 0.02, or two percentage points. The

[1] The mean log return is an unbiased measure of the continously compounded average return.

[2] Note, in passing, that the appropriate measure of volatility, $\sigma(r_{jt})$ is the standard deviation of log returns; in contrast $\sigma(R_{jt})$, the standard deviation of absolute returns will be larger.

difference between the two measures of mean returns is therefore non-trivial. For higher estimates of volatility, the gap rises sharply: *eg*, for volatility as high as 0.3, the gap increases to approximately $0.3^2/2 = 0.045$, or 4 1/2 percentage points.

In contrast the difference between mean log returns and the geometric mean return is very small: if, for example, $E(r) = 0.06$, the compound average return will equal 6.18%.

Note that the relationship between geometric and arithmetic average returns implies the somewhat counter-intuitive result that, in principle, an asset may have a negative geometric mean return (ie, over long periods, an investor in the asset will lose money), but at the same time a positive arithmetic mean return.

One issue that is frequently raised is whether the choice of time period can affect the estimate of $E(R_{jt})$, since arguably regulation should be framed in terms of fairly long periods. It turns out that the crucial issue is, as in many contexts, whether returns are predictable or not. Thus, consider the expectation of the five year return, under the same assumptions of log-normality

$$1 + E(R_{jt}(5)) = exp\left(5E(r) + \frac{\sigma^2(r_{jt}(5))}{2}\right) \quad (7)$$

where $\sigma^2(r_{jt}(5))$ is the variance of (non-annualised) log returns over five years. Annualising the five year return,

$$\left[1 + E(R_{jt}(5))\right]^{1/5} = exp\left(E(r) + \frac{\sigma^2(r_{jt}(5))}{10}\right) \quad (8)$$

The variance ratio at horizon k is defined as

$$VR(k) = \frac{\sigma^2(r_{jt}(k))}{k\sigma^2}$$

Substituting into the expression for the annualised expected five year return

$$\left[1 + E(R_{jt}(5))\right]^{1/5} = exp\left(E(r) + \frac{VR(5)\sigma^2}{2}\right) \quad (9)$$

If log returns are unpredictable, then the variance ratio will be unity at all horizons and the horizon will not affect the adjustment. However if the variance ratio declines with the horizon (which must in turn imply some form of predictability) the adjustment will fall proportionately to the variance ratio.

Appendix D Holding period returns vs yields

Using continuous compounding, the price of an N -period zero coupon bond is given by

$$P_t^N = \exp(-r_t^N N)$$

Working with lower case letters as logs, the log holding period return in period $t+1$ is

$$\begin{aligned} h_{t+1}^N &= p_{t+1}^{N-1} - p_t^N \\ &= -r_{t+1}^{N-1}\left(N-1\right) - \left(-r_t^N . N\right) \\ &= r_t^N + \left(N-1\right)\left(r_t^N - r_{t+1}^{N-1}\right) \end{aligned}$$

Taking unconditional expectations of the one period holding return

$$Eh^N = Er^N + \left(N-1\right)E\left(r^N - r^{N-1}\right)$$

so if there is an upward- (or downward-)sloping yield curve the mean log yield under- (or over-)states the mean log holding period return.

At the long end of the yield curve however this bias is likely to be quite small since the slope of the yield curve (in either direction) is usually close to zero. However the holding period return will be much more volatile than the yield. The conditional variance of the one-period ahead log holding return will be $(N-1)^2$ times the conditional variance of the yield.

Both formulae are more complicated for coupon bonds, but these can always be viewed as portfolios of zero coupon bonds with strictly positive weights on different maturities (representing coupon payments and repayment of principal).

Appendix E Asymmetric Information and Equity Issues

Let n and N be the number of new and existing shares, A be the value of the assets, and I and R be the proposed investment and the present value of the resulting cash flows. Investors do not know the true value of the asset, so their expectation is $E[A]$, where A is the true value of the firm. If $E[A]>A$, the firm is over-valued.

Assuming risk-neutral investors, the number of new shares issued is such that the share of the total firm sold to new shareholders equal their investment,

$$\frac{n}{N+n}(E[A]+R)=I \qquad \text{(A1)}$$

Existing shareholders support the issue if their reduced share in the enlarged firm is worth at least the true value of their current holdings,

$$\frac{N}{N+n}(A+R)\geq A \qquad \text{(A2)}$$

Solving (1) for n yields the number of new shares in terms of the investors' expectation of the asset value $E[A]$,

$$n(E[A])=\left\{\frac{I/(E[A]+R)}{1-I/(E[A]+R)}\right\}N \qquad \text{(A3)}$$

Here $n(E[A])$ is decreasing in $E[A]$. Substituting this into (2) and tidying up yields the following relationship,

$$\frac{R}{I}\geq\frac{A+R}{E[A]+R} \qquad \text{(A4)}$$

Now for a pessimistic manager, $E[A] > A$, and hence the RHS of (4) is less than 1. Theoretically then the existing shareholders will benefit from new share issues even when the investment return is negative. In reality the manager may be prepared to issue shares just to leave it in the bank. On the other hand for an optimistic manager for whom $E[A] < A$, the RHS of (4) is greater than 1. Therefore depending on the profitability of the investment and how much the share price is under-priced, it may be rational for the manager to delay the issue until the price recovers even when $R – I > 0$.

Appendix F Results of Panel Regressions on Yields in Grant Thornton Database

Tables F.1 and F.2 report the results of random effects GLS panel regressions with yields and spreads (relative to gilts) from the Grant-Thornton database, estimated over the sample 2002 to 2005.

Table F.1
Random effects GLS regression (Yield as dependent variable)

Yield	Coefficients	Std. Error	z	P>|z|	[95% Conf. Interval]	
Coupon	1.00	0.11	9.40	0.00	0.80	1.21
Duration	2.61	0.02	124.6	0.00	2.57	2.65
Convexity	-28.99	0.17	-168.4	0.00	-29.3	-28.7
Issue Size	-5.80	0.28	-20.68	0.00	-6.4	-5.3
Time Dummy	-0.14	0.00	-98.72	0.00	-0.14	-0.13
Rating	0.06	0.00	18.80	0.00	0.05	0.06
Constant	187.2	4.10	45.61	0.00	179.2	195.3
	Cross-Sectional R-Squared		0.33	Time Series R-Squared		0.85
	Number of Groups		48	Number of Observations		50592

Table F.2
Random effects GLS regression (Spreads as dependent variable)

Spreads	Coefficients	Std. Error	z	P>|z|	[95% Conf. Interval]	
Coupon	0.07	0.04	1.68	0.09	-0.01	0.15
Duration	0.26	0.01	21.70	0.00	0.24	0.28
Convexity	-2.84	0.09	-31.82	0.00	-3.02	-2.67
Issue Size	-0.78	0.11	-7.22	0.00	-0.98	-0.56
Time Dummy	-0.19	0.00	-166.5	0.00	-0.19	-0.18
Rating	0.09	0.00	36.78	0.00	0.08	0.09
Constant	25.11	1.59	15.76	0.00	21.98	28.23
	Cross-Sectional R-Squared		0.18	Time Series R-Squared		0.50
	Number of Groups		48	Number of Observations		50592

The rating variable assigns a value to individual ratings categories as shown in Table F.3 overleaf. The coefficient is expressed in units of a percentage point, thus as the rating indicator increases by one the yields regression implies an increase in yield by 6 basis points, while the spreads regression implies an increase of 9 basis points. Both of these estimates imply a rather low impact of credit rating compared to the average premia on A-rated bonds shown for this period in Chart 6.1; but the estimate is almost certainly biased downwards by the restriction that the impact of credit rating be linearly increasing in the rating category.

Table F.3
Ratings Variable Used in Panel Regressions

Rating	Numerical Value
AAA	1
AA+	2
AA	3
AA-	4
A+	5
A	6
A-	7
BBB+	8
BBB	9
BBB-	10
BB+	11