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Recent Evidence on Beta and the Cost of Capital for UK Electricity Companies

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At the 2000 Distribution Price Control Review, Ofgem estimated the cost of equity for Regional Electricity Distribution Companies (RECs) using the CAPM methodology. A key issue in application of this methodology concerns estimation of the beta coefficient, which measures the degree of riskiness of the company (or industry) relative to the market portfolio.

This Topic presents estimates of beta for the UK Electricity Index using the Kalman Filter technique. We show that using the Kalman Filter technique, the betas for the UK electricity index exhibited a sharp downward trend, falling from around 1.0 in 1993-1997 to around 0.2 in 2000 but, in the most recent months, the betas have started to increase again up to around 0.6 at the end of 2002.

Our Topic employs an "event study" methodology to examine the causes of the changes in beta over recent periods. We present strong evidence to show that there are two important factors that explain the recent changes in UK electricity betas:

- **First, we show that the fall in the UK electricity price index that occurred around the period of the 2000 Distribution Price Control Review caused UK electricity betas to shift downwards. We suggest that the fall in the UK electricity share price index occurred as a result of the significantly lower allowed rate of return that was afforded by Ofgem in this price review rather than as a result of macro-economic or business risk factors.**

- **Second, we show that beta changes occurred as a result of the step increase in variance of the FTSE index returns since around 1998, a reflection of the e-commerce bubble and the recent increase in global economic uncertainty.**

We conclude that recent falls in beta are not likely to be the result of declines in business risk of the UK electricity sector, and hence a decline in the cost of capital, but are likely to be the result of the impact of regulatory events and increase in global uncertainty. It follows that regulators must interpret recent evidence on betas with significant caution.

1. Time Series Evidence on UK Electricity Betas

Beta is a commonly used measurement of the "non-diversifiable" risk of an asset relative to the risk of the market portfolio. It is defined as the covariance over time between returns on an asset and returns on the market portfolio, divided by the variance of returns on the market portfolio.

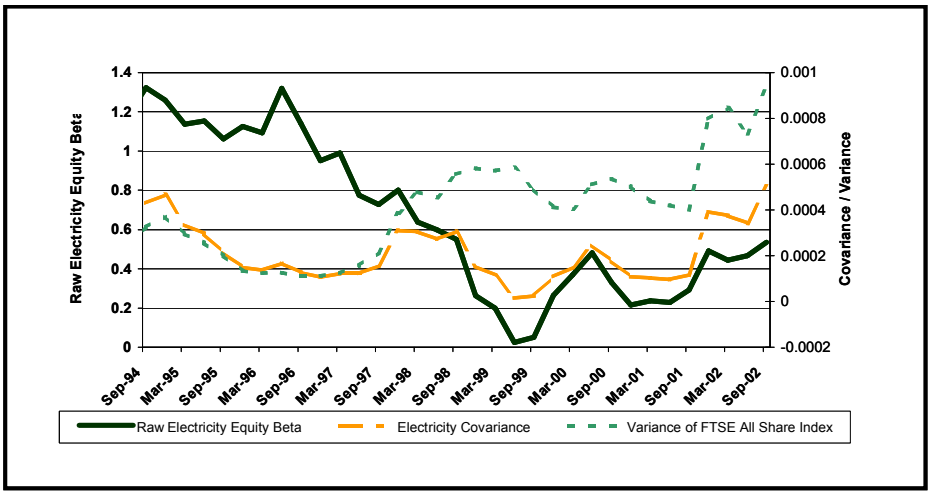
$$Beta = \frac{\mathrm{Cov}(R_E, R_{FTSE})}{\mathrm{Var}(R_{FTSE})}$$

The CAPM theory says that beta is a complete and sufficient measure of the risk that requires compensation in the market. Since CAPM is an expectational model, the relevant beta to be estimated in application of the CAPM should reflect the expected forward-looking risk exposure of the company in question.

Applications of the CAPM in regulatory settings typically estimate beta by undertaking ordinary least squares (OLS) regressions of stock returns against a market index. However, since the relative riskiness of the stock may change over time, these historical measures of beta are only estimates of the true "expected" beta implicit in the current share price.

In the following analysis we derive estimates of beta for the UK electricity sector by regressing historic returns for this sector against the FTSE All-Share Index. Figure 1 shows a time series of UK electricity equity beta estimates alongside their constituent parts, the covariance of the FTSE Electricity Index with the FTSE All-Share Index, and the variance of the FTSE All-Share Index. Each series is calculated using weekly returns data and one years worth of historic data.

Figure 1
Time Series Evidence on Equity Beta for UK Electricity Sector



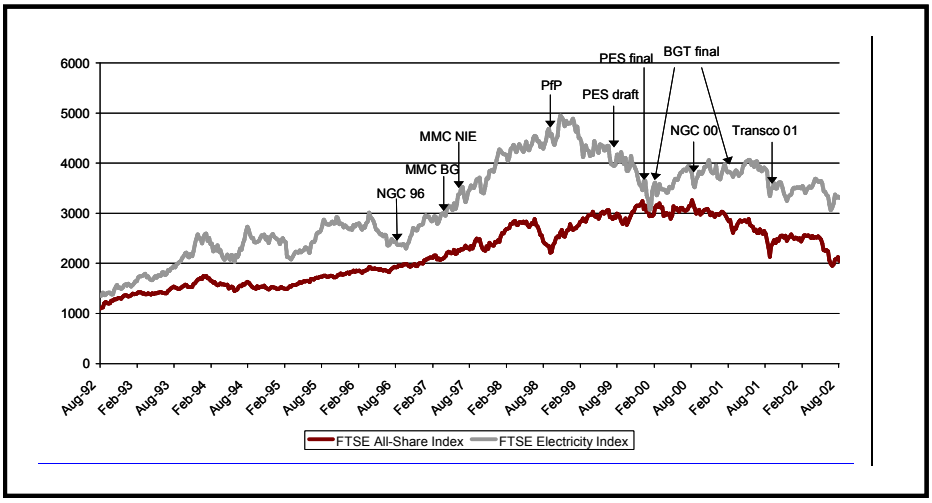
In this chart we observe that equity betas for UK electricity companies have declined from a peak of over 1.0 pre-1997 to close to zero around 1999 before rising back up to around 0.5 in the latter part of 2002.

An analysis of the time series of the constituent components shows that there are two main factors that contribute to this change in the UK electricity beta estimate over this time period. First, it is clear that there has been a step increase in the variance of the FTSE All Share Index, starting in late 1998 and increasing further in 2002. This reflects a number of factors most notably, the e-commerce boom and crash in 1999 and 2000, and more recently, the global economic downturn. The second factor that is evident from Figure 1 is that the covariance of the FTSE Electricity Index and the FTSE All Share Index dipped towards zero around late 1999/early 2000 before rising upwards to its pre 1997 levels more recently.

2. Impact of Regulatory "Events" on Share Prices and Beta

It is important to understand why the covariance of the FTSE Electricity Index and the FTSE All Share Index has changed over the period and whether this reflects a real change in the underlying riskiness of the electricity sector over this period. In order to do this, NERA have analysed the reaction of the FTSE All Share Index and FTSE Electricity Index over the period since 1994 to significant events, both regulatory and business, that might have impacted on share price behaviour over this period.

Figure 2
Electricity Share Price Behaviour and Regulatory Events



It is clear from figure 2 that the relationship between the FTSE Electricity Index and the FTSE All Share Index changed around August 1998, when the FTSE All Share index fell sharply but the FTSE Electricity Index continued to rise. Around October 1998, however, the movement of the two series reversed again when FTSE Electricity Index started to decline significantly against the FTSE All Share Index, a trend that was maintained over a two year period up until mid 2000.

The decline of the FTSE around August 1998 is widely attributed to the impact of the Russian devaluation crisis at this period, which understandably affected the wider stock market but not the UK electricity index. The decline of the FTSE Electricity index from October 1998 onwards, however, is not easily explained by macro-economic factors but can be explained by regulatory factors as shown in Figure 2 above. In particular, the first downward movement of the FTSE Electricity Index coincided with the release of the UK Water Regulator's (Ofwat) first announcements on the Water Price Review in 1999 which set the climate for significant price cuts to water consumers and consequent lower expected returns to water sector investors. At the time of Ofwat's announcements, it was widely regarded that Ofgem would follow Ofwat's lead in setting a lower allowed rate of return in the 2000 Distribution Price Control Review (DPCR3). Ofgem's draft proposals in May 1999 and Ofgem's final price decision at the end of 1999 confirmed the lower allowed rate of return on distribution assets and this lower allowed rate of return was combined with other elements of Ofgem's methodology, such as tougher assumptions regarding cost efficiencies, and led to a continued decline in equity investor returns in the electricity industry up until around February 2000.

As can be seen from Figure 2, it was not until mid 2000 that the movements of the FTSE All Share and FTSE Electricity Indices started to show similar movements to each other. In the finance literature, the situation in which a company's stock price primarily reacts to industry or company specific news (over a sustained period of time), rather than to movements in the market as a whole is known as "decoupling". Kolbe (2000), in particular, has argued that decoupling can cause significant biases in estimates of the true beta of a stock.[1]

It seems clear then that, as a result of the impact of the regulatory price review in 2000 and the consequent decoupling of the FTSE All share and FTSE Electricity share indices over the period 1998-2000, estimates of beta for the electricity index that use data from this period will be lower than in other periods. The extent to which these beta estimates are good approximations for the true expected beta depends on whether such events are deemed to be exceptional. In the case of the DPCR3, the argument that this was an exceptional event seems clear cut on the basis that, at most, such an event can only be expected to take place every 5 years and given the step change in the regulator's assumptions in 2000 on such factors as the industry cost of capital and efficiency targets, it would be reasonable to assume that investors would not expect that every price review would have such a significant impact on future earnings.

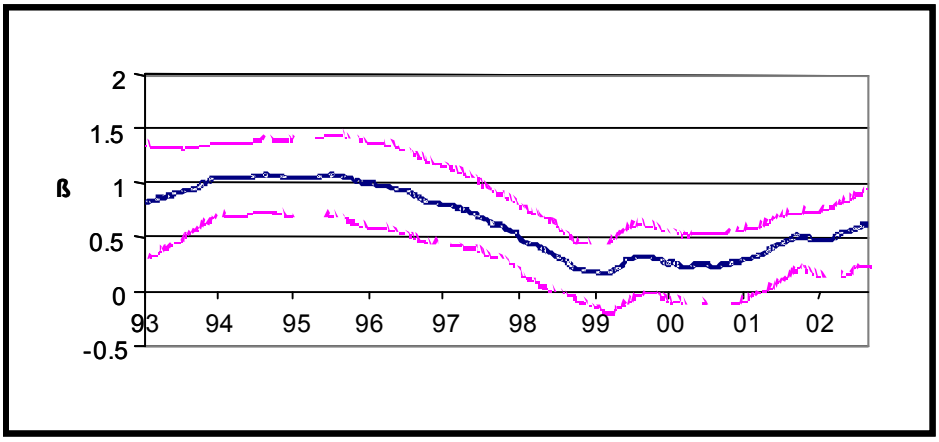
3. Estimating UK Electricity Betas Using the Kalman Filter

It is not easy to correct for the impact of such factors as the Price Review and abnormally high levels of market volatility using conventional estimation techniques. Excluding the share price data over the period in which decoupling or excess market volatility occurred is equivalent to assuming that such events never happen, and including the data is equivalent to assuming that they happen every price review period. An alternative and more sophisticated technique that attempts to capture the time varying nature of beta, and avoids the need to use long run time series data, is based on the Kalman Filter. Two recent academic papers have estimated betas for regulated UK Utility Companies using Kalman Filter techniques.[2] Both papers show strong evidence that betas change significantly over time and that they are influenced by external events and regulatory action.

Kalman filter techniques have the advantage over OLS moving window estimates of beta time series in that they can be used to capture the impact of specific events on beta estimates at the time they occur. The OLS moving window technique estimates beta time series using overlapping periods and so when an event occurs that affects market or company returns, the effect on beta is diffused over many periods. By contrast, the Kalman Filter gives greater sensitivity of the estimates to news coming to the market, eliminates the need to determine the appropriate length of the window required for the beta estimation, and hence reduces averaging bias.[3]

The following chart shows results of beta estimations for the electricity industry when estimated using the Kalman Filter. The time path of the beta estimated is for weekly returns on the FTSE Electricity index using the FTSE All Share index as the market portfolio. The estimation period starts on 1 January 1993 and ends on 30 August 2002 giving 504 data points. The bold line represents the beta estimates and the dotted lines correspond to 95% confidence intervals.

Figure 3
Electricity Industry Kalman Filter Beta



The "Kalman-Filter beta" estimates presented in Figure 3 show a very similar pattern to the beta "OLS beta" estimates presented in Figure 1 above with a peak of above, hovering around 1 in the mid 1990s with a dip close to zero in late 1999. The value of the Kalman Filter tool, however, lies in its ability to estimate beta for discrete sub-periods within this time horizon and to examine more precisely the impact of the e-commerce bubble, uncertainties brought by periodic reviews and increase in market volatility.

To separate the impact of the late 1990s from the rest of the estimation period we divide the period in question into three sub-periods. The first sub-period starts on 1 January 1993 and ends on 28 October 1998 (304 data points). The second sub-period covers the period of 29 October 1998 to 24 November1999 (56 data points). The third one corresponds to the rest of the sample, i.e., 25 November 1999-30 August 2002. The dates for the second period are chosen to be consistent with evidence presented in Figure 2 that showed that the release of Prospects for Prices on 28th October 1998 was a significant "regulatory event" that led to a fall in returns to (water and) electricity sector investors.

Figure 4
Electricity Industry Kalman Filter Beta 3 Sub Periods

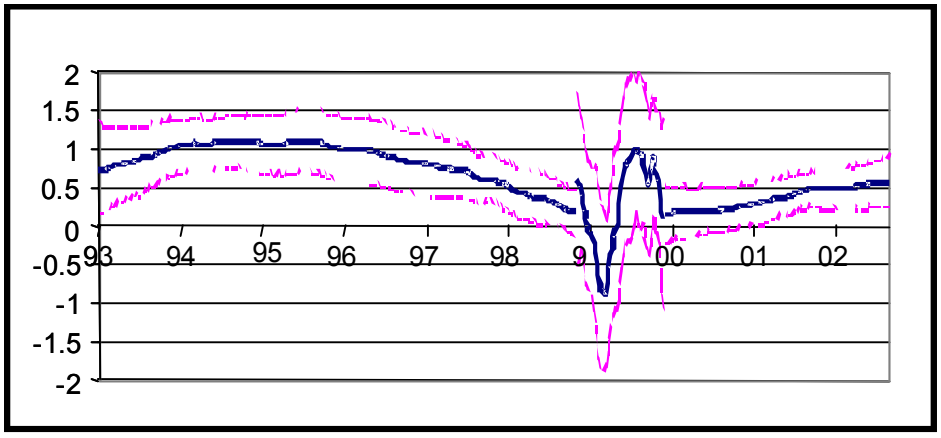


Figure 4 confirms that the late 1990s were a period of high instability. The estimates show high and short-lived variations in beta, which are not detected by the estimates for the whole sample (Figure 3).

To obtain some feel for the significance of the events of the late 1990's and early 2000's and the potential bias that such events can introduce to beta estimates we assume that, save for the changes being introduced here, the betas are constant over the whole time horizon. We then look to capture the characteristics of each sub-period by defining dummies as follows:

$$D_1 = \begin{cases} 1 & \textit{in the period of} \quad 29.10.1998 - 24.11.1999 \\ 0 & \textit{otherwise} \end{cases}$$

$$D_2 = \begin{cases} 1 & \textit{in the period of} \quad 25.11.1999 - 30.08.2002 \\ 0 & \textit{otherwise} \end{cases}$$

The above dummies are used in the linear regression of UK electricity returns against market returns:

$$R_{it} = \alpha + \chi_1 D_1 + \chi_2 D_2 + \beta R_{Mt} + \gamma_1 . D_1 R_{Mt} + \gamma_2 . D_2 R_{Mt} + \varepsilon_t$$

The estimates of β, γ_1 and γ_2 are presented in Table 1.

Table 1
Impact of Regulatory Events and Market Volatility on Beta

Coefficients	Value	Standard Error	t Stat
β (Non-diversifiable risk)	0.69	0.08	8.63
γ_1 (Regulatory price review dummy)	-0.32	0.18	-1.76
γ_2 (Excess market volatility dummy)	-0.29	0.11	-2.57

The results in Table 1, are consistent with the Kalman Filter estimates of the beta time path, and give a clear picture of the underlying situation. The average equity beta for the whole period 1 from 1993 to 2002 is 0.69. But, as shown by the value of γ_1 in Table 1, the net impact of the "regulatory event" which we assume lasted from 29.10.1998 to 24.11.1999 is to reduce the beta by around 0.3. Table 1 further shows that the impact of the increase in market volatility, which we assume lasted over the period 25.11.1999 to 30.08.2002 and capture by the use of a dummy variable γ_2, is to reduce the beta estimate by 0.3 during that time.

4. Conclusions

The main conclusion that emerges from this paper is that that there are two important factors that explain the recent changes in UK electricity betas:

- First, we show that the fall in the UK electricity price index that occurred around the period of the 2000 Distribution Price Control Review caused UK electricity betas to shift downwards. We suggest that the fall in the UK electricity price index occurred as a result of the significantly lower allowed rate of return that was afforded by Ofgem in this price review rather than as a result of macro-economic or business risk factors.

- Second, we show that beta changes occurred as a result of the step increase in variance of the FTSE index returns since around 1998, a reflection of the e-commerce bubble and the recent increase in global economic uncertainty.

It follows that regulators must interpret recent evidence on betas with significant caution. In particular, if estimates of beta include time periods when there were high levels of market volatility, other estimates of CAPM parameters such as the equity risk premium must also reflect the same time periods. [4]

As a practical matter, we suggest that Kalman Filter techniques might be preferred to the conventional long run 'moving window' regression techniques as a way to capture and demonstrate the impact of specific events such as regulatory price reviews on the beta estimate and to "correct" for the impact of such events.

Endnotes

[1] L. Kolbe (2000) "Direct testimony and exhibits on stranded cost recovery and on cost of capital for public service company of New Mexico", Utility Case No. 3137

[2] Buckland and Fraser (1999) "Political and Regulatory Risk in the UK Electricity Utilities: Beta Sensitivity in the Electricity Distribution Industry", Aberdeen Papers in Accountancy, Finance and Management: Working Paper 99-5. Francis, Grout and Zalewska (2000) "The Impact on the Stock Market of Changes in Regulation of Companies", Department of Economics and Leverhulme Centre for Market and Public Organisation, University of Bristol.

[3] The Kalman Filter (KF) is a time series analysis tool. The idea is to express a dynamic system in a particular form called the state-space representation. The KF is an algorithm for sequentially updating a linear projection for the system. Among other benefits, the algorithm provides a way to calculate exact finite-sample forecasts. By contrast, estimating beta based on long run observations of historic returns is a 'static' technique. One estimates the average value of the beta for a period believed to be correct (e.g., 2 years), when there is no guarantee that beta is constant over that time. The application of the Kalman Filter to estimation of time varying coefficients is outlined, for example, in Zalewska-Mitura and Hall (1999).

[4] During periods of high market volatility, estimates of beta for utility stocks may be lower because if they are seen as safe haven stocks, but estimates of equity risk premia will be higher.

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