The Allen Consulting Group

Empirical evidence on proxy beta values for regulated gas distribution activities

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Report to the Essential Services Commission of Victoria

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Executive summary

Introduction

The Essential Services Commission of Victoria (ESC) has engaged the Allen Consulting Group (ACG) to provide data analysis relating to the estimation of equity beta for gas distribution businesses as an input to the ESC's consideration of an appropriate beta to apply in its Final Decision on the *Gas Distribution Price Review, 2008-12*.

The brief requires ACG to review and critique the methods that have been proposed or used in recent studies to improve the precision of beta estimation and, in light of the conclusions reached on those methodological issues, to assemble and review the available empirical evidence on equity betas of gas and other energy transmission and distribution businesses. We have also been asked to address specified matters or to provide specified information, including information on betas computed against the world share market and betas computed using return measured over a shorter interval for the relevant security and market than the standard one-month period (i.e. using weekly and daily returns).

As part of the brief, we have not been asked to advise the Commission on the most appropriate equity beta to use for a regulated gas distributor. Hence, we do not address matters such as whether stability and predictability may be promoted by requiring a hurdle to be satisfied before the beta is changed from the previous level,[1] or the economic costs and risks of under and over investment in assets and under and over utilisation of assets.[2] Rather, these are matters for the Commission to consider, along with others, informed by the empirical analysis presented herein. We note that in several previous advices, our view has been sought on how such matters should influence the beta that is adopted for regulatory purposes, and accordingly the conclusions presented in this report may differ to those expressed under a more expansive scope of work.

Review of methodological issues

Gray and Officer considered that reliance on mechanical beta estimates (such as the estimates provided by the Australian Graduate School of Management Risk Measurement Service) can lead to inappropriate conclusions.[3] They concluded that:

- Outliers and 'unrepresentative events' such as the 'technology bubble' should be excluded;
- Longer time series of data should be used;
- Portfolio betas should be calculated;
- Some consideration could be given to foreign data; and

[1] C.f. National Electricity Rules, clause 6A.6.2(j)(4).

[2] C.f. Expert Panel on Energy Access Pricing (2006), Report to the Ministerial Council on Energy, April, p.117.

[3] Stephen Gray and Bob Officer (17 April, 2005), *The Equity Beta of an Electricity Distribution Business*, Report prepared for ETSA Utilities.

- The Blume adjustment should be applied.

Gray *et al* came to similar recommendations on many of these methodological issues, including that a longer time period be applied in beta estimation,[4] that techniques be used to address the potential bias caused by outliers, that data not be drawn from unrepresentative periods and that the Blume adjustment be applied. Addressing these recommendations in turn:

- *Outliers* – while we agree that applying techniques to minimise the influence of outliers has the potential to improve the reliability of beta estimates and hence should be undertaken, the adjustment techniques applied should be those that have support in the financial economics and econometrics literatures. We consider there to be alternative techniques to the technique applied by Gray and Officer in the report cited above that have greater support in this literature. However, we have presented the results of using the Gray and Officer approach to adjusting for outliers to demonstrate the implications of this alternative approach.
- *Unrepresentative periods* – we also agree that data should not be drawn from periods that are considered to be unrepresentative of the future – the relevant period being the period during which technology-related stocks underwent a boom and then subsequent bust – and note that this is consistent with previous advice we have provided.
- *Time period of observations* – we agree that it is appropriate to draw on a longer time period for estimating betas than the standard 4 or 5 years in order to improve the reliability of the beta estimates. While the normal concern with using longer time periods when estimating betas is that the firm may have changed and hence the beta may not be relevant to the future, there is less reason to expect the beta for the benchmark regulated utility business to change. However, the ability to use longer time periods of data is constrained in the context of Australian energy transmission and distribution, where only AGL had data for more than seven years once the technology bubble period is eliminated.
- *Portfolio betas* – we also agree that it is useful to compute industry portfolio betas, noting that such betas have a higher degree of precision (in the same way that averaging betas across a group of comparable entities improved precision) and permits standard errors of the group to be computed in a straightforward manner.
- *Foreign data* – we also agree that betas computed for foreign firms (against their home indices) should be given some consideration, but that it is preferable to place most reliance on firms listed on the Australian share market (with the relative weight assigned between each dependent upon the quality of the data that is available from home-listed firms).

[4] Stephen Gray, Jason Hall, Jerry Bowman, Tim Brailsford, Robert Faff and Bob Officer (May, 2005), *The performance of alternative techniques for estimating equity betas of Australian firms*, Report prepared for the Energy Networks Association.

- *Blume adjustment* – the 'Blume adjustment' refers to the technique whereby initial (or raw) beta estimates are moved towards one, which is used in a number of public (mechanical) beta data services.[5] The rationale for applying the Blume adjustment derives from an observed tendency for betas to regress towards one over time, with the two rationales for this tendency being error in the original beta estimates (i.e. so that part of the observed regression towards one is merely the unwinding of an error) and a regression in the true beta of the firm towards one over time due to management initiatives. However, in our view, the rationale for applying the Blume adjustment in the context of the estimates presented in this report is weak, in particular:

    - by focussing on the central estimates of betas for a set of comparable entities,[6] or the beta estimated for the portfolio comprising a set of comparable entities, already implies that individual beta estimates are 'regressed' towards a mean and that some of the error in the individual beta estimates is removed – the difference being that the betas are regressed towards the mean of the group of comparable entities rather than the mean for the overall market; and

    - there is no case for the regression towards a beta of one due to management actions being applicable to a benchmark regulated utilities – a benchmark regulated utility is assumed to only undertake the regulated activities and have a constant level of gearing, and so the levers that management have to alter a firm's beta (i.e. change scope of operations or gearing) are unavailable.

  However, we present sensitivities that demonstrate how the application of the Blume adjustment would change our results so that the Commission understands the implications of making or not making this adjustment.

Gray and Officer also presented beta estimates from applying their preferred method as discussed above to a set of Australian comparable entities. Their central estimates of beta were around one for the most restrictive definition of an outlier, and rose to somewhat higher than one as more observations were treated as outliers (their results are reported in section 2.10).

[5] The application of the technique involves taking a weighted average of the raw beta estimate and the beta for the market (of 1), with weights of 0.67 and 0.33 commonly used. The Bloomberg and Merryl Lynch beta estimation services provide raw and Blume-adjusted beta estimates.

[6] The term 'central estimates' is used to refer to the group of measures of central tendency for a distribution, including the mean and median result.

A UK study by Smithers & Co. measured beta against the Morgan Stanley Capital International (MSCI) Index, which is a world stock market index and which, for Australian firms, is likely to result in lower beta estimates. We note, however, that if a beta that is measured against a world share market index is to be used, then a different version of the CAPM would be required, given that the version in common use for Australian regulators assumes segmented capital markets and hence domestic-oriented inputs. We note that a move to the use of an international CAPM would be a substantial one – there are a number of alternative models to chose from and other inputs would be affected (such as the market risk premium, 'gamma' and possibly also the risk free rate of return).[7]

Our recommendations on methodological issues arising from the studies noted above are as follows:

- Adjustment for unrepresentative outliers should be undertaken, but with most weight given to the results of approaches that are recognised in the literature;
- Observations on security returns drawn from the period of the technology bubble should be eliminated from consideration (we set out our definition of the technology bubble below);
- The maximum amount of data available should be reviewed, together with more recent data based on 5 years of monthly observations;
- Regard should be given to beta estimates for portfolios of firms comprising the relevant benchmark industry or (almost equivalently) to central estimates of betas from the set of comparable entities;
- Some regard should be paid to beta estimates for foreign firms, but this should be treated with caution;
- The Blume adjustment should not be applied, although we present sensitivities showing the effect of the Blume adjustment; and
- Beta estimates should be undertaken only against the relevant home market, rather than against a 'world index' such as the MSCI.

Specific methodological issues

There are a number of methodological choices that need to be made to derive a beta estimate, and accordingly we set out in detail the methodologies applied in the present study. The most important of the methodological choices that we have made are summarised below.

Technique for adjusting for outliers

In this study, in order to address potential bias due to 'data outliers' three statistical techniques have been used to estimate beta:

[7] In addition, the question of whether it is feasible to assume that capital markets are integrated remains given observed puzzling phenomena (such as the observation that most investors hold the majority of their investments in domestic firms). Moreover, it is not clear that the error from applying a domestic CAPM should result in a materially different estimate to what would be derived under an international CAPM, if both were applied in a consistent manner.

- *Ordinary Least Squares Regression (OLS)* – which is the standard technique applied in beta estimation and makes no adjustment for the effects of outliers. OLS estimation involves finding a 'line of best' fit that minimises the square of the distance of any observation from that line – the fact that the square of the distance is minimised means that outliers can be given a substantial weight.

- *Re-weighted Least Squares Regression (Re-OLS)* – which is a methodology that results in less weight being applied to outliers, with the weight dependent on the extent to which an observation is adjudged to be an outlier, and in extreme outliers being excluded.[8]

- *Least Absolute Variation (LAV)* – which is an alternative to OLS that finds a 'line of best fit' that minimises the absolute distance value of any observation from that line. As the absolute distance is minimised – rather than the square of the distance – this means that outliers are accorded much less weight than under OLS.

We also present the results of using the outlier technique used by Gray and Officer. Their technique involved simply removing an observation that was more than a certain distance from what the regression equation would have predicted for that observation. The 'distance' was expressed in terms of a multiple of the standard error of the beta estimate – with the estimates reported for different cut-off multiples (namely, a distance of one standard error, 1.5 times the standard error and twice the standard error of the predicted value). Of these outliers definitions, however, we consider that the 'twice the standard error' definition to be the most appropriate, and the 'one standard error' definition to include many more observations than necessary as outliers.

Selection of the group of comparable entities

To derive our set of comparable entities, we commenced with securities drawn from the energy transmission and distribution section of the UBS Utilities Index for Australia, the US and UK. However, in the Australian case, given the small number of observations and our view that data from the Australian market is the most relevant, we widened the sample to include the 'integrated' utilities, AGL and Alinta, and utilities that have recently been taken over or merged (GasNet and AGL).

A total of 19 securities have been considered across Australia (9), the UK (1) and the US (10), although four of the Australian firms have not been in operation for a sufficient period to permit a beta to be estimated when using monthly returns.[9] Although monthly returns are the standard most frequently employed in the finance literature, we have obtained returns data at the weekly (5 years) and daily (2 years) level and presented beta estimates for all firms using weekly and daily data over a shorter period, although we caution about the extent of weight that can be placed upon these estimates.

[8] Less weight is applied to observations that are between 1.8 and 2.7 standard errors from the predicted value and are removed if they are beyond 2.7 standard errors of the predicted value.

[9] The firms and DUET, Hastings Diversified Utilities Fund, SP AusNet and Spark.

Creation of portfolios

Following Gray and Officer, betas estimates are also provided for two portfolios. The first portfolio reflects the average returns across all firms in the set of comparable entities in the given time interval (monthly in the case of Table 1), which is equivalent to an equally-weighted portfolio of these securities. This is referred to as the *average portfolio*. The second portfolio reflects the median return that would have been delivered by any of the securities in the set of comparable entities in the given time interval. This is referred to as the *median portfolio*.

Unrepresentative period

With respect to the 'technology bubble', we have defined this as beginning in July 1998, and ending in December 2001. Although it could be argued that the technology bubble period ended around six months earlier (when dot-com securities fell substantially on the US and other world markets), this definition is more likely to be clear of technology bubble influences, and also excludes the temporary disruption to markets caused by the events of September 11, 2001.

Treatment of leverage

All of the beta estimates presented in this report have been adjusted to be consistent with an assumed level of gearing of 60 per cent debt-to-assets. In addition, we have:

- Assumed a debt beta of zero; and
- Used the simplest of levering/de-levering formulae, namely:

  $$\beta_a = \beta_e \frac{E}{V}$$

  where β_a is the asset beta (being the beta for a security that has no gearing), β_e is the equity beta and E/V is the share of equity in the financing structure (i.e. 40 per cent).

The gearing levels for the securities generally have been calculated as the ratio of the market value of the equity divided by the book value of (net) debt, both averaged over the period during which the equity beta was estimated. The exception to this was for the Australian trusts or funds, which own a share of entities that themselves are geared. We have relied upon reports of equity analysts to estimate the level of gearing for the ultimate activity for these entities.

Reporting of statistical precision

One of the most problematic issues when estimating betas is the generally poor degree of statistical precision of the estimates. We consider it important to understand the degree of statistical precision of estimates in order to understand the weight that should be applied to different estimates or outcomes, as well as the confidence that can be had that certain outcomes could be ruled-in or ruled-out.

Accordingly, for all beta estimates we also present the 95per cent confidence interval for that beta estimate. The 95 per cent confidence interval tells us that, if an independent random sample of market observations was generated a large number of times, the true value would lie within that range 95 per cent of the time. A wide interval therefore indicates that the beta estimate is less precise (and that we have less confidence in being able to rule-in or rule-out any outcome), and vice versa for a narrow confidence interval.

The 95 per cent confidence interval is a widely used standard of statistical significance in econometrics; however it does not have any particular standing in regulatory matters. This report uses a 95 per cent confidence interval simply as a convenient means of describing the width of the probability distribution around the mean estimate of the beta coefficient. Alternatively, we could have reported a 60 per cent, 75 per cent or 99 per cent confidence interval in order to convey a similar message.

Given that virtually all of our beta estimates are below the value of 1.00 that has been used by the Commission in its recent energy distribution reviews, we would envisage that the upper end of the confidence interval may be of more interest than the lower end. Given this, and the fact that we have presented a large number of beta estimates, at times we report only the upper end of the confidence interval when discussing results in the text. However, the fact that we have reported only the upper limit should not be taken as implying that more or less weight should be given to the upper end of the confidence interval than the lower end – as discussed earlier, these matters are beyond the scope of this report.

Summary of main findings

Australian data

Our primary focus has been to analyse the available Australian data, and we report only equity betas (for the assumed level of gearing of 60 per cent debt-to-assets), which are the ultimate issue of concern for regulators.

Table 1 summarises the results obtained for the full sample of monthly data. The maximum number of observations was 145, and the number of observations available for each of the securities ranged from 14 observations (for Spark and SP AusNet) to 142 observations (for AGL).[10] As the portfolio returns are based upon the returns achieved by the firms in the set of comparable entities in any return interval, the maximum number of observations (145) are available to estimate the portfolio betas.

[10] AGL was removed from the set of comparable entities after its asset-swap with Alinta.

The average portfolio beta estimate lies between 0.59 and 0.71 depending on the estimation methodology; however there is a wide confidence interval around this level. The OLS and Re-OLS estimates have a 95 per cent confidence interval that has a lower bound of 0.3 to 0.4 and an upper bound of 0.8 – 0.9, with the 95 per cent confidence interval around the LAV estimates wider again, with a confidence interval spanning 0.2 to 1.2. We note that, while the portfolios comprise an equal weight of the securities that are in the set of comparable entities at a point in time,[11] since AGL has been listed since the beginning of the time period and hence is included in the set of comparable entities for the longest period, it is weighted most heavily. AGL and Envestra together account for approximately half of the observations over the whole period.

Thus, it will also be noted in Table 1 that for the OLS and re-OLS methodologies the average beta estimates of the first five securities with longer trading histories are around 10 points lower (at 0.54 and 0.51 respectively) than for the whole portfolio estimates.[12] The difference is much smaller for the LAV methodology. This reflects the higher beta for AGL over the period and its much large weight in the portfolio estimates.

Table 1

AUSTRALIAN ENERGY RELATED SECURITIES: FULL MONTHLY BETA ESTIMATES (1991-1998 AND 2002-2007)

Stock	N	OLS			Re-weighted OLS			LAV		
		L	M	H	L	M	H	L	M	H
AGL	142	0.43	**0.82**	1.21	0.35	**0.69**	1.03	0.21	**0.93**	1.64
ALN	61	-0.06	**0.91**	1.89	0.10	**0.98**	1.86	-0.49	**0.65**	1.78
ENV	71	-0.07	**0.13**	0.32	-0.04	**0.13**	0.29	-0.25	**-0.01**	0.23
APA	61	-0.11	**0.45**	1.01	0.00	**0.31**	0.62	0.30	**0.91**	1.52
GAS	59	0.02	**0.38**	0.75	0.00	**0.31**	0.62	-0.02	**0.34**	0.70
DUE	30	0.00	**0.29**	0.57	0.00	**0.28**	0.56	-0.18	**0.25**	0.67
SPN	14	-0.61	**0.20**	1.01	-0.61	**0.20**	1.01	-1.63	**-0.48**	0.67
SKI	14	-1.27	**-0.21**	0.85	-1.27	**-0.21**	0.85	-1.38	**0.08**	1.55
HDF	26	-0.19	**0.57**	1.33	-0.13	**0.59**	1.32	-0.17	**0.73**	1.17
Average first 5			**0.54**			**0.51**			**0.56**	
Portfolio Average	145	0.34	**0.63**	0.92	0.34	**0.59**	0.83	0.24	**0.71**	1.17
Portfolio Median	145	0.37	**0.65**	0.93	0.34	**0.61**	0.85	0.18	**0.63**	1.08

Note: L denotes lower 95%CI, M denotes mean estimate and H denotes upper 95%CI, N denotes number of monthly observations.

[11] That is, the average monthly return for the portfolio is calculated as an average of that month's returns for the individual portfolio members. The returns calculated in this way were regressed against the market returns for the same months. The median return was calculated as the median return achieved by the portfolio members in that month.

[12] Note that the standard errors (and therefore the confidence intervals) of the top 5 securities cannot be averaged, and this is the reason that portfolio beta estimation has been undertaken.

Tables 2 and 3 show, as a sensitivity, the effect of applying the two elements of the Gray and Officer methodology in sequence, namely:

- First, to exclude observations as outliers that are more than a certain distance from the predicted value (with the critical distances being multiples of 1, 1.5 and 2 of the standard error of the predicted value); and
- Secondly, to then also apply the Blume adjustment.

Table 2

AUSTRALIAN ENERGY RELATED SECURITIES: FULL DATA MONTHLY BETA ESTIMATES FOR ENERGY RELATED SECURITIES EXCLUDING THE TECHNOLOGY BUBBLE, USING GRAY & OFFICER METHODOLOGY WITHOUT BLUME ADJUSTMENT (1991-1998 AND 2002-2007)

Stock	OLS:2SE			OLS:1.5SE			OLS:1SE		
	L	M	H	L	M	H	L	M	H
AGL	0.50	**0.66**	0.99	0.38	**0.69**	1.00	0.71	**0.99**	1.28
ALN	0.60	**1.00**	1.80	-0.12	**0.59**	1.29	0.19	**0.76**	1.33
ENV	0.03	**0.11**	0.28	-0.05	**0.09**	0.24	-0.02	**0.10**	0.22
APA	0.22	**0.47**	0.97	0.06	**0.53**	0.99	0.42	**0.78**	1.15
GAS	0.19	**0.33**	0.62	-0.06	**0.20**	0.46	0.08	**0.28**	0.49
DUE	0.10	**0.22**	0.47	-0.08	**0.13**	0.34	0.04	**0.21**	0.38
SPN	-0.21	**0.20**	1.01	-0.59	**0.15**	0.89	-0.96	**-0.33**	0.31
SKI	-0.74	**-0.21**	0.85	-0.99	**-0.18**	0.63	-1.96	**-0.71**	0.54
HDF	0.29	**0.63**	1.32	0.01	**0.63**	1.24	0.21	**0.63**	1.05
Average first 5		**0.52**			**0.42**			**0.58**	
Portfolio Average	0.49	**0.61**	0.85	0.31	**0.53**	0.75	0.43	**0.62**	0.81
Portfolio Median	0.51	**0.63**	0.87	0.39	**0.60**	0.81	0.46	**0.64**	0.82

Note: L denotes lower 95%CI, M denotes mean estimate and H denotes upper 95%CI, N denotes number of monthly observations.

Table 3

AUSTRALIAN ENERGY RELATED SECURITIES: FULL DATA MONTHLY BETA ESTIMATES EXCLUDING THE TECHNOLOGY BUBBLE USING GRAY & OFFICER METHODOLOGY INCLUDING BLUME ADJUSTMENT (1991-1998 AND 2002-2007)

Stock	OLS:2SE			OLS:1.5SE			OLS:1SE		
	L	M	H	L	M	H	L	M	H
AGL	0.87	**1.04**	1.37	0.74	**1.05**	1.36	0.97	**1.26**	1.55
ALN	0.89	**1.29**	2.09	0.31	**1.01**	1.71	0.56	**1.13**	1.70
ENV	0.23	**0.31**	0.48	0.15	**0.30**	0.45	0.18	**0.30**	0.42
APA	0.47	**0.73**	1.23	0.30	**0.76**	1.23	0.57	**0.94**	1.30
GAS	0.38	**0.52**	0.81	0.17	**0.43**	0.70	0.29	**0.49**	0.69
DUE	0.22	**0.35**	0.60	0.07	**0.28**	0.49	0.16	**0.33**	0.50
SPN	0.09	**0.49**	1.31	-0.28	**0.46**	1.20	-0.49	**0.14**	0.78
SKI	-0.35	**0.18**	1.24	-0.61	**0.20**	1.01	-1.40	**-0.16**	1.09
HDF	0.51	**0.85**	1.54	0.23	**0.85**	1.47	0.43	**0.85**	1.27
Average first 5		**0.78**			**0.71**			**0.82**	
Portfolio Average	0.78	**0.90**	1.14	0.63	**0.85**	1.07	0.72	**0.91**	1.10
Portfolio Median	0.80	**0.92**	1.15	0.69	**0.90**	1.11	0.74	**0.92**	1.10

Note: L denotes lower 95%CI, M denotes mean estimate and H denotes upper 95%CI, N denotes number of monthly observations.

From the above, it can be concluded that the choice of method for dealing with outliers has had little effect on the beta estimates obtained, with striking similarity between in the results. However, the application of the Blume adjustment has resulted in a material increase in the all of the beta estimates, with the portfolio estimates rising to approximately 0.90 and with an upper limit to the 95 per cent confidence of 1.10 to 1.15.

Hence, whether or not the Blume adjustment is applied is material to the interpretation of the market evidence on betas. That said, we note that our beta estimates are much lower than those report by Gray and Officer, with none of our central estimates being above unity. Moreover, the change in the outlier exclusion criterion had much less effect on our estimates than that reported by Gray and Officer.

Table 4 provides a summary of results based on the past 5 years of data since the conclusion of the technology bubble (which we have defined as ending December 2001). For the average portfolio returns, at 0.30, the mean beta estimate is 33 points lower than the estimate based on all available data. Similarly, the beta estimates obtained using the other methods and for the median portfolio are also much lower than those observed when using only the more recent period of data. The main reason for this is the significantly lower beta estimate observed for AGL in the more recent time period, as well as a reduction in the weight assigned to AGL (and greater weight assigned to the Envestra beta).

It is also noticeable that in the last five year period the standard error of the beta estimates (which translates into the width of the confidence limits) are also considerably smaller than for the whole period of data. Again, this is likely to be due to the relative dominance of the whole period results by AGL (i.e. a single security) whereas, in the period since the conclusion of the technology bubble, average and median returns of the portfolio have been influenced by many more securities (and hence there is more diversification within the portfolio). Thus, the upper limit of the 95 per cent confidence interval is 0.5 to 0.6 for the OLS and Re-OLS methods, and 0.5 to 0.8 for the LAV method.

Table 4

AUSTRALIAN ENERGY RELATED SECURITIES: MONTHLY BETA ESTIMATES SINCE THE END OF THE TECHNOLOGY BUBBLE (2002-2007)

Stock	N	OLS			Re-weighted OLS			LAV		
		L	M	H	L	M	H	L	M	H
AGL	58	-0.10	**0.56**	1.22	-0.39	**0.18**	0.75	-0.48	**0.48**	1.43
ALN	61	-0.16	**0.81**	1.78	-0.01	**0.87**	1.75	-0.57	**0.57**	1.71
ENV	61	-0.16	**0.03**	0.23	-0.21	**-0.02**	0.17	-0.33	**-0.04**	0.24
APA	61	-0.01	**0.44**	1.00	-0.10	**0.42**	0.95	0.29	**0.90**	1.50
GAS	59	-0.01	**0.36**	0.73	-0.01	**0.29**	0.60	-0.04	**0.32**	0.68
DUE	29	0.00	**0.29**	0.57	0.00	**0.28**	0.56	-0.18	**0.25**	0.67
SPN	13	-0.61	**0.20**	1.01	-0.61	**0.20**	1.01	-1.63	**-0.48**	0.67
SKI	13	-1.27	**-0.21**	0.85	-1.27	**-0.21**	0.85	-1.38	**0.08**	1.55
HDF	25	-0.19	**0.57**	1.33	-0.13	**0.59**	1.32	-0.17	**0.73**	1.62
Mean first 5			**0.44**			**0.35**			**0.44**	
Portfolio Average	61	0.03	**0.30**	0.56	-0.05	**0.19**	0.44	-0.13	**0.31**	0.75
Portfolio Median	61	0.10	**0.36**	0.61	0.02	**0.24**	0.47	-0.14	**0.20**	0.53

Note: L denotes lower 95%CI, M denotes mean estimate and H denotes upper 95%CI, N denotes number of monthly observations.

We also observe that those securities with beta estimates above those of the portfolio averages (namely Alinta and Australian Pipeline Trust) are either those that have been active in acquisition and merger activity or have substantial non-regulated activities (namely AGL and Alinta, which are classed within the UBS Utilities Index as 'integrated' model utilities rather than as pure 'transmission and distribution' businesses). In contrast, those securities with below average beta estimates (i.e. Envestra and GasNet) have not been very active in acquisitions of mergers in the period since the end of the technology stock bubble and also have a relatively high percentage of their operations being regulated activities.

Table 5 below shows the results obtained by including only the group of 'first 5' securities for the maximum period that all were listed since the end of the technology bubble (i.e. January 2002 to October 2006). This panel allows us to estimate betas for a portfolio that has had no change in composition since the end of the technology bubble, and hence removes the possible effects of compositional changes. We find that the mean beta estimates are very similar to the results obtained by using all data for all securities since the end of the technology bubble. OLS produces the highest mean estimate of 0.42 (upper 95 per cent confidence interval of 0.74), and Re-OLS produces the lowest mean of 0.18 (upper 95 per cent confidence interval of 0.44).

Table 5

AUSTRALIAN ENERGY RELATED SECURITIES: MONTHLY BETA ESTIMATES SINCE THE END OF THE TECHNOLOGY BUBBLE (JANUARY 2002-OCTOBER 2006)

Stock	N	OLS			Re-weighted OLS			LAV		
		L	M	H	L	M	H	L	M	H
AGL	58	0.03	**0.67**	1.31	-0.29	**0.26**	0.81	-0.44	**0.50**	1.45
ALN	58	-0.59	**0.30**	1.20	-0.45	**0.34**	1.13	-0.86	**0.03**	0.92
ENV	58	-0.05	**0.18**	0.41	-0.31	**-0.09**	0.13	-0.49	**-0.13**	0.23
APA	58	-0.06	**0.51**	1.07	0.04	**0.53**	1.02	0.41	**0.88**	1.34
GAS	58	-0.07	**0.29**	0.66	-0.08	**0.20**	0.49	-0.05	**0.30**	0.66
Average			**0.39**			**0.25**			**0.33**	
Portfolio Average	58	0.00	**0.33**	0.67	-0.11	**0.18**	0.48	-0.18	**0.20**	0.57
Portfolio Median	58	0.10	**0.42**	0.74	-0.05	**0.20**	0.45	-0.07	**0.27**	0.61

Note: L denotes lower 95%CI, M denotes mean estimate and H denotes upper 95%CI, N denotes number of monthly observations.

Table 6 repeats the analysis above, as a sensitivity, showing the effect of using the Gray and Officer 'outliers' methodology. It is noted that the portfolio mean beta estimates are quite stable at 0.23 to 0.30 regardless of whether observations are removed under the 2, 1.5 or 1 multiple of the standard error criteria. It is also noted that both the average portfolio and median portfolio beta estimates are *lower* under the Gray and Officer 'outliers' methodology obtained above using simple OLS. The simple average of the individual beta estimates using the Gray and Officer 'outliers' methodology is also lower than obtained using simple OLS, except when the application of the extreme definition of an outlier is applied (which we consider treats many more observations than necessary as outliers).

Table 6

AUSTRALIAN ENERGY RELATED SECURITIES: GRAY & OFFICER METHODOLOGY EXCLUDING BLUME ADJUSTMENT (JANUARY 2002-OCTOBER 2006)

Stock	OLS:2SE			OLS:1.5SE			OLS:1SE		
	L	M	H	L	M	H	L	M	H
AGL	-0.30	**0.26**	0.81	-0.09	**0.41**	0.91	0.40	**0.82**	1.23
ALN	-0.37	**0.36**	1.09	-0.42	**0.25**	0.93	-0.29	**0.31**	0.91
ENV	-0.41	**-0.20**	0.02	-0.06	**0.14**	0.33	-0.05	**0.11**	0.28
APA	0.04	**0.50**	0.96	0.12	**0.57**	1.03	0.43	**0.76**	1.10
GAS	-0.09	**0.20**	0.48	-0.09	**0.19**	0.46	0.10	**0.30**	0.50
Average		**0.22**			**0.31**			**0.46**	
Portfolio Average	-0.04	**0.23**	0.50	0.00	**0.24**	0.49	0.09	**0.29**	0.49
Portfolio Median	0.02	**0.26**	0.50	0.03	**0.25**	0.48	0.13	**0.30**	0.48

Note: L denotes lower 95%CI, M denotes mean estimate and H denotes upper 95%CI, N denotes number of monthly observations.

In Table 7 we have reported, as a sensitivity, the effect of applying the complete Gray and Officer methodology for the period of observations and firms used in Tables 5 and 6, the change over Table 6 being the application of the Blume adjustment.

We find a material increase in the mean and median portfolio beta estimates to approximately 0.60 and an upper limit to the 95 per cent confidence interval of about 0.8 or 0.90. Again, it is clear that the decision of whether to apply the Blume adjustment is material.

Table 7

AUSTRALIAN ENERGY RELATED SECURITIES: GRAY & OFFICER METHODOLOGY INCLUDING BLUME ADJUSTMENT (JANUARY 2002-OCTOBER 2006)

Stock	OLS:2SE			OLS:1.5SE			OLS:1SE		
	L	M	H	L	M	H	L	M	H
AGL	0.24	**0.79**	1.35	0.39	**0.89**	1.39	0.93	**1.17**	1.40
ALN	-0.26	**0.47**	1.20	-0.28	**0.40**	1.08	0.07	**0.44**	0.80
ENV	0.26	**0.47**	0.68	0.50	**0.69**	0.89	0.44	**0.68**	0.92
APA	0.27	**0.74**	1.20	0.33	**0.79**	1.25	0.64	**0.92**	1.19
GAS	0.14	**0.43**	0.71	0.15	**0.42**	0.69	0.26	**0.50**	0.73
Average		**0.58**			**0.64**			**0.74**	
Portfolio Average	0.31	**0.58**	0.85	0.35	**0.59**	0.84	0.46	**0.62**	0.79
Portfolio Median	0.36	**0.60**	0.84	0.37	**0.60**	0.82	0.49	**0.63**	0.77

Note: L denotes lower 95%CI, M denotes mean estimate and H denotes upper 95%CI, N denotes number of monthly observations.

International data

The international data results using our longest period are summarised in Table 8. Here we find that with monthly data a beta estimate of 0.65 (with upper 95 per cent confidence interval of 1.10) is obtained using OLS for the sole UK company, National Grid. Using re-weighted OLS the National Grid mean estimate reduces to 0.40 and using LAV to 0.28. The upper end of the 95 per cent confidence interval for the outlier-adjusted beta estimate is in a range of 0.76 to 0.91.

Table 8

UK AND US GAS T&D BUSINESSES: SUMMARY OF MONTHLY PORTFOLIO DATA EXCLUDING THE TECHNOLOGY BUBBLE

Sample:	N	-95% CI	Mean Estimate	95% CI
UK (National Grid):				
OLS	92	0.20	0.65	1.10
Re-OLS	92	0.03	0.40	0.76
LAV	92	-0.34	0.28	0.91
US Average Portfolio Returns:				
OLS	149	0.44	0.60	0.76
Re-OLS	149	0.21	0.50	0.63
LAV	149	0.32	0.49	0.65
US Median Portfolio Returns:				
OLS	149	0.38	0.54	0.71
Re-OLS	149	0.33	0.48	0.62
LAV	149	0.28	0.44	0.61
US Average:				
OLS	149		0.54	
OLS re-weighted	149		0.50	
LAV	149		0.50	

The US monthly data show that OLS estimates for the portfolios are marginally lower than the beta for the UK firm, but that the outlier adjusted beta estimates are generally higher by 10 to 20 points. The confidence intervals for the US portfolio beta estimates are generally very narrow (much more so than for the Australian firms over the same period), with none of the portfolios of methods delivering an upper 95 per cent confidence interval limit beyond 0.76. This greater precision in beta estimates reflects the larger number of listed entities in the US (and the fact that all of those in our sample have been in existence over the whole period). The beta estimates for the portfolios are slightly higher than the Australian estimates for the same period. In general, we also find that the application of outlier-resistant methodologies has lowered the central estimate. This is similar to the Australian experience.

Table 9 shows the results for the period after the end of the technology bubble. The UK results for National Grid show that beta estimates have lowered compared with using the entire period. However, as this relates to only one security, it is difficult to draw any inferences from this observation. On the one hand the more recent period shows beta estimates that are slightly higher for the US firms, but the confidence intervals for these estimates have widened considerably. Over the whole period, the upper end of the 95 per cent confidence interval was between 0.61 and 0.76, whereas during the most recent period that range has increased to between 0.81 and 1.02.

Table 9

UK AND US GAS T&D BUSINESSES: SUMMARY OF MONTHLY PORTFOLIO DATA SINCE THE END OF THE TECHNOLOGY BUBBLE (2002-2007)

Sample (N=61):	-95% CI	Mean Estimate	95% CI
UK (National Grid):			
OLS	0.02	0.36	0.70
Re-OLS	-0.15	0.17	0.48
LAV	-0.45	0.14	0.73
US Average Portfolio Returns:			
OLS	0.49	0.76	1.02
Re-OLS	0.40	0.65	0.89
LAV	0.34	0.67	1.00
US Median Portfolio Returns:			
OLS	0.38	0.63	0.88
Re-OLS	0.37	0.60	0.83
LAV	0.26	0.53	0.81
US average:			
OLS		0.58	
OLS re-weighted		0.47	
LAV		0.55	

Weekly and daily estimates

In addition to the standard monthly beta estimates, we also calculated beta estimates based on shorter periods of weekly and daily data.[13] We caution against placing excessive weight on these estimates (particularly those using daily data) given the potential for estimates using short return intervals to be subject to certain biases.

[13] Our terms of reference required betas based upon weekly and daily observations to be reported.

The Australian weekly data mean portfolio estimates shown in Table 10 are marginally higher than the monthly estimates for the same period. Due to a larger number of observations, the confidence intervals are in most cases narrower than for monthly estimates. The exception is Alinta (ALN), but even for this security the confidence interval narrows when the influence of outliers is mitigated through the LAV methodology. It is also noticeable that, in general, the estimates fall when outlier-adjusted methodologies are applied.

Table 10

AUSTRALIAN ENERGY RELATED SECURITIES: WEEKLY BETA ESTIMATES SINCE THE END OF THE TECHNOLOGY BUBBLE (2002-2007)

Stock	N	OLS			Re-weighted OLS			LAV		
		L	M	H	L	M	H	L	M	H
AGL	250	0.40	**0.74**	1.07	0.26	**0.57**	0.87	0.11	**0.53**	0.95
ALN	268	0.74	**1.20**	1.66	0.57	**0.92**	1.28	0.28	**0.69**	1.11
ENV	268	0.09	**0.20**	0.31	0.08	**0.18**	0.28	-0.33	**0.00**	0.33
APA	268	0.14	**0.44**	0.74	0.17	**0.41**	0.66	0.17	**0.44**	0.70
GAS	255	0.16	**0.34**	0.52	0.21	**0.36**	0.51	0.07	**0.25**	0.43
DUE	131	0.03	**0.24**	0.44	0.03	**0.18**	0.32	-0.08	**0.13**	0.35
SPN	61	-0.29	**0.07**	0.43	-0.28	**0.01**	0.30	-0.46	**0.00**	0.46
SKI	61	-0.11	**0.21**	0.53	-0.11	**0.20**	0.52	-0.30	**0.21**	0.71
HDF	113	0.08	**0.44**	0.79	0.02	**0.34**	0.65	0.03	**0.38**	0.73
Average first 5			**0.52**			**0.44**			**0.34**	
Portfolio Average	268	0.24	**0.36**	0.48	0.24	**0.35**	0.46	0.17	**0.32**	0.47
Portfolio Median	268	0.32	**0.44**	0.55	0.30	**0.41**	0.51	0.17	**0.34**	0.52

L denotes lower 95%CI, M denotes mean estimate and H denotes upper 95%CI, N denotes number of monthly observations.

The daily data mean estimates are based on up to 555 days of observations. They are higher than the weekly, or monthly estimates, but the portfolio measures indicate a beta estimate of between 0.60 and 0.70, with a 95 per cent confidence interval of between 0.50 and 0.80. As in the weekly estimates, confidence intervals are narrowed due to a greater number of daily observations. However, as noted above, we would recommend being extremely cautious about placing weight on these estimates given the material potential for biases to affect the estimates.

Table 11

AUSTRALIAN ENERGY RELATED SECURITIES: DAILY BETA ESTIMATES FOR THE LAST TWO YEARS (2005 TO 2007)

Stock	N	OLS			Re-weighted OLS			LAV		
		L	M	H	L	M	H	L	M	H
AGL	461	1.01	**1.27**	1.52	0.90	**1.12**	1.33	0.83	**1.07**	1.31
ALN	555	1.17	**1.48**	1.79	1.03	**1.29**	1.54	0.93	**1.23**	1.53
ENV	555	0.43	**0.53**	0.64	0.34	**0.43**	0.52	0.33	**0.42**	0.51
APA	555	0.68	**0.94**	1.20	0.51	**0.72**	0.92	0.59	**0.78**	0.98
GAS	478	0.18	**0.35**	0.52	0.24	**0.37**	0.50	0.10	**0.16**	0.23
DUE	442	0.23	**0.33**	0.42	0.24	**0.32**	0.40	0.25	**0.36**	0.47
SPN	299	-0.01	**0.13**	0.27	0.00	**0.11**	0.23	-0.48	**0.00**	0.48
SKI	299	0.22	**0.37**	0.53	0.10	**0.24**	0.37	0.05	**0.20**	0.36
HDF	555	0.72	**0.92**	1.11	0.63	**0.79**	0.96	0.61	**0.78**	0.96
Mean first 5			**0.91**			**0.78**			**0.73**	
Portfolio Average	555	0.53	**0.61**	0.69	0.51	**0.58**	0.65	0.49	**0.57**	0.65
Portfolio Median	555	0.61	**0.69**	0.77	0.59	**0.66**	0.74	0.59	**0.69**	0.78

Note: L denotes lower 95%CI, M denotes mean estimate and H denotes upper 95%CI, N denotes number of monthly observations.

Conclusions

The purpose of this report has been to take account of the methodological improvements for estimating betas that have been set out in recent reports and to apply those techniques to advise the Commission regarding the available market evidence on the beta for a regulated Australian gas distributor.

We advise that it is preferable to place most reliance on beta estimates from Australian firms. The beta estimation results reported in this section can be summarised as follows:

- Using monthly data for the whole period (1991-1998 and 2002-2007) we find that the portfolio beta estimates are in the range of 0.59 to 0.71, with upper 95 per cent confidence intervals in the range of 0.83 to 1.17, with both ranges depending on the estimation methodology employed (OLS, re-OLS or LAV).
- Using monthly data for the most recent 5 year period, the range of the portfolio beta estimates is lower at 0.19 to 0.36 with the upper end of the 95 per cent confidence intervals in the range of 0.44 to 0.75, with both ranges depending on the estimation methodology employed (OLS, re-OLS or LAV).
- Applying the Gray and Officer outlier elimination methodology to the portfolio data for the whole period (but not applying the Blume adjustment) leads to materially similar beta estimates to those obtained using our preferred method for addressing outliers, with a range of betas for the portfolio estimates of 0.53 to 0.64 and an upper end of the 95 per cent confidence interval range of between 0.75 and 0.87.

- When the Blume adjustment is applied together with the Gray and Officer outlier methodology (i.e. the full Gray and Officer methodology) the range for the beta estimates for the portfolios is materially higher at 0.85 to 0.92, with the upper end of the 95 per cent confidence interval in the range of 1.07 to 1.14.
    - However, the beta estimates that we obtained using the Gray and Officer method were not nearly as high as those reported by Gray and Officer, with none of our estimates being above unity and with the results much less sensitive to the degree of restrictiveness of the definition of an outlier.
- Portfolios comprising the first 5 securities with monthly data from January 2002 to October 2006 were found to corroborate the results found when using all data (for 9 securities) in the period since the end of the bubble in technology stocks. However, again the application of the Blume adjustment generated materially higher beta estimates.
- There is a wide divergence in beta estimates for individual securities, with those more active in acquisition and merger transactions and/or substantial non-regulated activities (AGL, ALN and APA) tending to have beta estimates above those of the portfolio betas. Those securities with less acquisition and merger activity and engaged more heavily in purely regulated activities (Envestra and GasNet) had below average mean beta estimates.
- Beta estimates using weekly observations over the last 5 years produces portfolio estimates that are slightly higher than with monthly observations (0.32 to 0.44), however the upper 95% confidence intervals are lower (0.46 to 0.55) owing to the much larger number of observations. Beta estimates using daily observations over a much shorter period (approximately two years) are higher still. However, we caution against placing substantial weight on weekly and, in particular, daily beta estimates, given the potential for bias in these estimates.

International data

The estimates based on international data are summarised as follows:

- For the UK, whole period monthly observations for National Grid plc (the only appropriate comparator) show a beta estimate range of 0.28 to 0.65, with a range for the corresponding upper end of the 95 per cent confidence interval of 0.76 to 1.10 depending on the methodology employed. In the more recent period since the end of the technology bubble, the range of beta estimates across the different methods has fallen to approximately half the previous level (0.14 to 0.36) and the upper end of the 95 per cent confidence interval has fallen to a range of 0.48 to 0.73 across the range of methods. We note, however, that as we have only obtained a beta estimate for one UK firm, it is difficult to place any material weight on beta estimates from this market.
- For the US the data the portfolio beta estimates for the whole period are in the range of 0.53 to 0.64 across the methods, with a corresponding range for the upper limit of the 95 per cent confidence interval of 0.61 to 0.76. In contrast to the Australian and UK experience, the latest 5 year period has seen an increase in the US mean estimates to a range of 0.53 to 0.76, and an increase in the corresponding range for the upper limit to the 95 per cent confidence interval of 0.81 to 1.12 across the methods.

As noted above, we consider it preferable to place the greatest reliance on Australian data, albeit with regard also had to beta estimates for overseas firms (i.e. US firms). This would argue for placing the greatest weight on the beta estimates for Australian firms measured over the longest period. However, a problem with the full period data is the relatively heavy weighting of two securities (AGL and Envestra). Accordingly, reliance should also be placed upon beta estimates for the period since the end of the technology stock bubble given the greater number of firms that were in existence during this period. For US firms, we would recommend placing the greatest weight on the results using data over the whole period. In all cases, whether or not the Blume adjustment is applied has a material effect on how the data are interpreted, and our view is that this adjustment should not be applied.

Although we have set out our own views on some methodological issues that were required in order to be able to compute beta estimates, and have displayed the results of a number of alternative empirical approaches, we have not specified the weighting that we believe should be applied in deriving an appropriate regulatory beta for gas distribution. It should also be stressed that we have not set out in detail the other qualitative and regulatory considerations that we believe are important in deriving a beta for regulatory purposes. In keeping with our brief, we have reported a range of domestic and international empirical estimates of beta for a benchmark gas distribution business, based on a number of alternative methodologies, which will form an input to the ESC's consideration of the matter.

Chapter 1

Introduction and Overview

1.1 The Brief

The Essential Services Commission of Victoria (ESC) has engaged the Allen Consulting Group (ACG) to provide data analysis relating to the estimation of equity beta for gas distribution businesses. This task is to be an input to the ESC's consideration of an appropriate beta to apply in its cost of capital estimate for its Final Decision on the *Gas Distribution Price Review, 2008-12*.

Specifically, our brief requires us to review and critique proposals for improving the precision of beta estimation presented in a number of recent studies into the matte. We are also required to assemble and review the available empirical evidence on equity betas of gas and other energy transmission and distribution businesses. Such evidence includes share price data on these businesses located in Australia, the UK and US. Our brief requires us to subject this evidence to statistical analysis and to consider the impact of various methodological choices including:

- The effect of applying the Blume adjustment
- Various methodologies to account for outliers
- Length of estimation period
- Estimation interval (e.g. months vs. weeks)
- Exclusion of unrepresentative events such as the technology bubble

The brief also required us to measure the level of gearing of the Australian stock market over time to assess whether there has been a change in the asset beta of the Australian market since the previous gas industry price review.

As part of the brief, we have not been asked to advise the Commission on the most appropriate equity beta to use for a regulated gas distributor. Hence, we do not address matters such as whether stability and predictability may be promoted by requiring a hurdle to be satisfied before the beta is changed from the previous level,[14] or the economic costs and risks of under and over investment in assets and under and over utilisation of assets.[15] Rather, these are matters for the Commission to consider, along with others, informed by the empirical analysis presented herein. We note that in several previous advices, our view has been sought on how such matters should influence the beta that is adopted for regulatory purposes,[16] and accordingly the conclusions presented in this report may differ to those expressed under a more expansive scope of work.

[14] C.f. National Electricity Rules, clause 6A.6.2(j)(4).

[15] C.f. Expert Panel on Energy Access Pricing (2006), Report to the Ministerial Council on Energy, April, p.117.

[16] See for example: ACG (2002) *Final Report: Empirical Evidence on Proxy Beta Values for regulated Gas transmission Activities*, report for ACCC; ACG (2004), *Queensland Distribution Network Service Providers – Cost of Capital Study*, report for QCA.

1.2 Overview of the Report

The study is organised as follows:

- In Chapter 2 we review some recent studies that have investigated data and methodological issues in the estimation of equity beta for regulated energy distribution businesses.
- Chapter 3 outlines the main methodological issues associated with beta estimation, including additional issues that are raised in the regulatory context.
- Chapter 4 describes the data for each market as well as the data compilation methodology.
- Chapters 5 summarise the proxy beta data analysis outputs for the Australian, United Kingdom and United States samples respectively.

Chapter 2

Review of methodological issues in recent studies

2.1 Introduction

We are required to review some key studies of proxy betas for energy distribution businesses that have appeared during the last few years in Australia and the United Kingdom. In the Australian context the studies by Gray and Officer and Gray, Hall, Bowman, Brailsford, Faff and Officer (Gray *et al*.) have proposed that there are approaches that can provide more robust estimates of beta than those supplied by commercial beta estimate providers. In September 2006, Smithers & Co Ltd published a report that was provided to Ofgem in the UK.[17] The report considered a number of issues associated with estimating the cost of capital, including the estimation of beta. In this chapter we consider the methodological issues that have been raised by these and other studies. A general concern of these studies is the problem of high standard errors, which widens the confidence limits around beta estimates. Much of the discussion has therefore centred around how to reduce these confidence limits.

The discussion below presents our views on each of the major methodological issues raised, and makes recommendations on how they should be addressed in estimating betas from market data.

2.2 Dealing with large confidence intervals

Gray and Officer cited Bowman and Bush's suggestion that a way of determining which beta estimates are valid is to accept only those beta estimates that have an R^2 statistic of more than 10 per cent.[18] In other words, where 90 per cent of the variation in returns is caused by firm specific diversifiable risk factors rather than the market return, the equity beta (systematic risk) estimate would be deemed to be 'too unreliable to be of any use'.

We note that, unlike is normally the case in econometrics, theory predicts that there will be a substantial portion of the risk associated with a particular security that cannot be explained by movements in the returns to the well-diversified portfolio of assets (i.e. the explanatory variable when estimating betas). This is because there is generally a large part of the risk of any asset that reflects by events that arte unique to the asset in question and that can be diversified away by holding the asset as part of a portfolio. Indeed, in a regression equation that is used to estimate a beta, the R^2 value merely indicates the proportion of the asset's risk that is classified as systematic risk, as the AGSM Risk Measurement Service has noted:

> A high value of R-squared (close to unity) simply implies that much of the risk of this equity is due to market risk: and a low value of R-squared (close to zero) implies that much of the total risk is specific risk. In particular note that R-squared should not, in this finance context, necessarily be interpreted as a measure of the reliability of the regression equation.

[17] Smithers & Co (1 September, 2006), *Report on the Cost of Capital*, provided to Ofgem by Stephen Wright, Robin Mason, Steve Stachell, Kenjiro Hori and Meltem Baskaya.

[18] Bowman, R.J. and S.R. Bush (2004), "A Test of the Usefulness of Comparable Company Analysis", Department of Accounting and Finance, University of Auckland.

Indeed, Table 2.1 below shows that, if Bowman and Bush's criterion was applied to the AGSM beta estimates – a widely used source of beta estimates – almost 75 per cent of the sample of firms (i.e. ASX listed securities) would be eliminated from consideration.

Table 2.1

R-SQUARED OF ASX MEMBER COMPANIES (BETA ESTIMATION)

Range of R^2	No. of companies	Cumulative No.	% Cumulative
>= 90%	2	2	0.1%
>=80% and < 90%	1	3	0.2%
>=50% and < 60%	2	5	0.3%
>=40% and < 50%	9	14	1.0%
>=30% and < 40%	20	34	2.4%
>=20% and < 30%	66	110	7.6%
>=10% and < 20%	263	373	25.8%
>=0% and < 10%	1,071	1,444	100.0%

Source: AGSM Risk Measurement Service, Beta Estimates. September 2006.

Brailsford, Faff and Oliver displayed the R^2 of a sample of 14 securities, and made no further comment than to note that the values ranged from a low of 2.7 per cent to a high of 56.5 per cent. However, they did note that 'the researcher might also be concerned with the statistical significance of the estimate', for example, whether the estimate is statistically different from 'zero, unity or an industry average'.

Our view is that the Bowman and Bush cut-off rule is arbitrary, and does not focus on what is of most importance, namely the statistical precision of the beta estimate. While the R^2 for a regression and the standard error of the beta estimate are related, for a given R^2 value, the standard error will reduce (and hence statistical precision will increase) as a larger sample size is employed. Any beta estimate should be considered alongside information on the statistical precision of the beta estimate, and for this purpose we have reported confidence intervals for the beta estimates.

Moreover, we do not think that an arbitrary cut-off of betas based on standard errors should be employed either. Rather, if an estimate of a beta coefficient has a wider confidence interval, then that information should be taken into account when interpreting and assigning weight to different estimates or outcomes, as well as the confidence that can be had that certain outcomes could be ruled-in or ruled-out. An investigation should also be undertaken as to whether it may be possible to improve the precision of estimates, for example, by adopting a method to address the effect of outliers, or using a longer data set.

Accordingly, for all beta estimates we also present the 95 per cent confidence interval for that beta estimate. The 95 per cent confidence interval tells us that, if an independent random sample of market observations was generated a large number of times, the true value would lie within that range 95 per cent of the time. A wide interval therefore indicates that the beta estimate is less precise (and that we have less confidence in being able to rule-in or rule-out any outcome), and vice versa for a narrow confidence interval.

The 95 per cent confidence interval is a widely used standard of statistical significance in econometrics; however it does not have any particular standing in regulatory matters. This report uses a 95 per cent confidence interval simply a convenient means of describing the width of the probability distribution around the mean estimate of the beta coefficient. Alternatively, we could have reported a 60 per cent, 75 per cent or 99 per cent confidence interval in order to convey a similar message.

Given that virtually all of our beta estimates are below the value of 1.00 that has been used by the Commission in its recent energy distribution reviews, we would envisage that the upper end of the confidence interval may be of more interest than the lower end. Given this, and the fact that we have presented a large number of beta estimates, at times we report only the upper end of the confidence interval when discussing results in the text. However, the fact that we have reported only the upper limit should not be taken as implying that more or less weight should be given to the upper end of the confidence interval than the lower end – as discussed earlier, these matters are beyond the scope of this report.

2.3 Removal of outliers

Gray and Officer noted that in beta estimation, wide confidence intervals could arise due to the influence of 'extreme outlier data points', which are not reflective of conditions likely to reoccur in the future. The likelihood of outliers having a significant influence on estimates is compounded by the fact that most commercial data providers use a relatively small number of observations (e.g. 48 monthly observations in the case of the AGSM service). They asserted that if only two observations were changed, AGL's Ordinary Least Squares (OLS) beta estimate in the AGSM service (re-geared to 60 per cent debt-to-assets) would rise from -0.04 to 0.98, while that of Envestra would have increased from 0.22 to 0.41. The actual method that Gray and Officer employed was to remove observations completely if they were adjudged to be an outlier. An observation was defined as an outlier if it was more than a certain distance from the value that would be predicted by the regression equation, with distance defined as a multiple of the standard error of that predicted value (the multiples applied were 2x, 1.5x or 1x the standard error of the predicted value).

The problem of outliers affecting beta estimates has been discussed in the financial economics literature in the past. Brailsford, Faff and Oliver noted that the use of continuously compounded returns will reduce the effect of outliers as the series is more likely to follow a normal distribution.[19] They also noted that there are formal procedures such as Cook's Distance that can be used to identify outliers, as did Gray and Officer. Smithers & Co. didn't formally adjust for outliers, but the Kalman Filter approach they applied has the effect of smoothing beta estimates and widening confidence limits.

In principle, adjustments and techniques to deal with outliers, if approached in an objective manner, can be useful in obtaining more rigorous estimates of beta risk. However, if too many 'outliers' are identified and completely excluded, the remaining data may no longer represent the expected future risk profile. Adjusting for outliers also leaves open the scope for beta estimates to be manipulated, given the sensitivity that beta estimates may have to a small number of observations.

While the principle of adjustment for outliers is found in the finance literature, we note that there are alternative methods for defining and treating outliers that have more support in that literature than merely excluding observations as outliers according to some type of rule, as undertaken by Gray and Officer. For example, Martin and Simin's approach is to remove outliers only if they are more than 2.7 standard errors from the predicted value, and to weight other outliers according to the extent to which they are classified as an outlier (i.e. their distance from the predicted value).[20] An alternative approach is not to use the standard 'ordinary least squares' technique for estimating betas, but to use an alternative technique that is less susceptible to being affected by outliers. Moreover, if outliers are to be excluded according to a simple rule, we consider it inappropriate to define an observation that is only one standard error from the predicted value as an outlier, noting that this could imply excluding 32 per cent of observations, on average. Rather, the most restrictive definition of an outlier employed by Gray and Office – namely, for an observation to be excluded only if it is more than two standard errors from the predicted value, implying that about five per cent of observations would be excluded on average – is the more appropriate criterion for exclusion.

However, we agree with Gray and Officer that an adjustment for outliers has the potential to provide additional useful information about beta estimates. In the following chapter we discuss the Martin and Simin 'Re-weighted Least Squares' approach and other potential approaches for dealing with outliers in greater detail.

2.4 Removal of unrepresentative market events

Another difficulty that has been discussed in recent beta studies relates to the impact of unrepresentative events. Gray and Officer submitted that the use of historical data on betas to forecast a forward-looking cost of capital effectively assumes that conditions in the past would be repeated in the future. They considered that beta estimation undertaken in 2004 would be heavily affected by the impact of the technology bubble that had concluded only 2 years earlier and hence included in the dataset, and that the resulting estimates could not be relied upon unless similar conditions could be expected to be repeated in the future.

[19] Brailsford, Faff and Oliver, (1997) *Volume 1, Research Design Issues in the Estimation of Beta*, McGraw Hill Series in Advanced Finance.

[20] R Douglas Martin and Timothy T Simin (Sept/Oct 2003), *Outlier-Resistant Estimates of Beta*, Financial Analysts Journal.

We agree that data that has been affected by a unique market could generate biased estimates of the expected beta and should not be relied on to estimate beta for regulatory purposes. We have recommended in the previous advice on this issue that data that has been affected by the period of the technology bubble (1998 to 2001) should be eliminated from consideration.

We note that Smithers & Co. didn't formally adjust their estimates for the impact of the technology bubble. However, the most recent beta estimates of Smithers & Co are free or largely free of technology bubble effects, having used a period that largely post-dated the technology period. As in Australian and US data, the UK data showed a marked reduction in the beta estimates for utilities through the technology bubble period, and a rising average beta since the end of the bubble period. However, another effect that was not adjusted for in the Smithers & Co data was the changing capital structures.

In summary, we agree with Gray and Officer's approach, which eliminates data that are likely to have been contaminated by the effects of the technology bubble. The conclusion of the bubble period over five years ago now allows the estimation of betas using data over a five year period (or longer if the security data pre-dates the commencement of the technology stock bubble). A US study examining this issue has also concluded that since the end of the technology bubble, betas are now 'back to normal'.[21] Hence, we recommend excluding data on security returns that are drawn from the period represented by the technology 'bubble'.

2.5 Estimating using a longer series of data

Another potential solution to the problem of wide standard errors is the estimation of betas based on a longer series of data.

We note that the question regarding the optimal time period for measuring betas normally invites a trade-off. On the one hand, having additional observations will improve the precision of estimates; however, there is a risk that over longer periods the nature of the company's operations will have changed, and so dated observations may not represent its expected future activities. Thus, Brailsford, Faff and Oliver, in a major review of beta methodological issues, concluded that 'five years of data is often used as a rule of thumb', since 'this choice generally satisfies both requirements'.[22]

However, for regulated businesses, we do not consider the risk that company activities have changed to be as relevant. In particular, the purpose is to estimate the systematic risk for a particular set of activities that are not likely to change materially over time, and for which the systematic risk is also not likely to change materially over time. Accordingly, in principle at least, we recommend having regard to the longest set of data available.

[21] Annema, Andre and Marc H. Goedhart (Summer 2006), "Betas: Back to normal", *The McKinsey Quarterly*.

[22] Brailsford, Faff and Oliver (1997), p.16.

That said, however, a practical problem in the context of the Australian energy distribution industry is the fact that only AGL has more than 7 years of observations if the period of the technology bubble is excluded from consideration. Accordingly, using a longer period of data will just imply placing more weight on the beta estimate for AGL relative to the estimates of other firms, and may also raise the standard error (reduce the precision) of the resulting beta estimates. On balance, we recommend estimation of betas using the maximum data available, excluding the technology 'bubble', as well as estimations based on the 'rule of thumb' of five years of data.

We note, however, that the activities of the firms that are in the set of comparable entities are likely to change over time, and so their true betas may also be expected to change. However, this does not mean that a shorter, more recent period of observations should be used to estimate the firm's beta. Rather, if the firm's activities have changed materially, it should be examined whether the firm remains sufficiently comparable to a regulated gas distributor to remain in the set of comparable entities. To reiterate, the characteristics of the target – i.e. a benchmark regulated gas distributor – would not have changed.

2.6 Application of the Blume adjustment

The Blume adjustment applies a weighted average formula to the 'raw' (observed) beta estimate that has the effect of drawing betas up to unity if the raw beta is below unity, and down to unity if the raw beta is above unity.[23] While the justification for the Blume adjustment comes from the observed empirical regularity that betas do tend to move towards one over time, several reasons have been posited as to why this may be the case, including that :

- betas are estimated with error, so that at least part of the observed regression towards one is merely the unwinding of an error, and – at least when considered on average across all securities – this unwinding should be towards one; and
- management may undertake initiatives to cause the true beta of the firm to tend towards one over time, such as by changing the gearing structure or changing the scope of activities, either through organic growth or acquisitions or divestitures.[24]

[23] Specifically, the formula is $\beta_{adj} = (\beta_{raw} \times 0.67) + (1 \times 0.33)$, where 1 is the value of the market beta. The adjustment was first suggested in: Blume, M. (1971), "On the assessment of risk", *Journal of Finance*, 26, pp.1-10.

[24] For example see Sheutrim, G., (1998), *Systematic Risk Characteristics of Corporate Equity*, Research Discussion Paper 9802, Reserve Bank of Australia, Sydney.

In May 2005, Gray *et al* prepared a report for the Energy Networks Association that tested different methods for estimating or adjusting equity betas.[25] The test undertaken was to determine the extent to which the beta estimate obtained to was able to explain future equity returns (that is, to forecast the next quarter's stock return based on a CAPM-based 'market model' that included an equity beta variously defined). They postulated that "the [beta estimation] method which produces forecast stock returns closest to actual stock returns is superior'. They employed the AGSM's CRIF database relating to Australian listed companies over the period 1989 to 2003, which provided very large sample sizes of up to almost 40,000 observations. One of the conclusions reached by Gray *et al* was that 'mechanical beta estimates, without appropriate adjustments, perform very poorly when used in the CAPM to estimate the cost of equity capital'.[26] One of the methods that was found to improve the performance of betas to a statistically significant degree was to apply the Blume adjustment.

We do not consider the tests performed by Gray *et al* to be particularly convincing, however, for a number of reasons.

- First, their tests were based upon the performance of an equity beta estimate for individual firms, and not for a beta that was estimated for a well-chosen set of comparable entities. As noted below, having regard to the average beta from the set of comparable entities or, almost equivalently, a portfolio estimate, is an alternative method for addressing the error in individual beta estimates.
- Secondly, the results achieved do not provide much support for the use of the Blume adjustment, even when dealing with individual betas. While the Blume adjustment was found to improve the forecasting of future equity returns to a statistically significant amount, it only did so 52.7 per cent of the time – which is barely more than a random result and is not economically significant.
- Thirdly, as the sample included all ASX listed stocks, it would have comprised beta estimates of the many smaller, thinly traded companies, whose beta estimates are not reliable. The inclusion of small stocks in the sample set would be expected to have increased materially the degree of mean reversion that was measured.

It is our view that the use of the Blume adjustment is not appropriate given the use of a set of comparable entities to estimate the beta for a regulated gas distributor and given that the objective is to derive a beta for a benchmark regulated firm rather than an actual firm. In particular:

- Focussing on the central estimates of betas for a set of comparable entities, or the beta for a portfolio comprised of those entities, is an alternative means of eliminating the error observed in individual beta estimates. Moreover, the effect would be that individual betas would be regressed towards the mean of the group of carefully selected comparable entities rather than the mean for the overall market.
  - One source of error that may remain is if all firms in the set of comparable entities are subject to the same error (for example, arising from an event

[25] Stephen Gray, Jason Hall, Jerry Bowman, Tim Brailsford, Robert Faff and Bob Officer (May, 2005), *The performance of alternative techniques for estimating equity betas of Australian firms*, Report prepared for the Energy Networks Association.

[26] Gray et.al. (May, 2005), p.1.

that affected that industry only). However, this is less likely to be a material concern where longer time periods of observations are used, and where techniques are used to deal with outlier events.

- There is no case in principle for assuming that the beta of a regulated gas distributor should regress towards the market average due to management actions. A benchmark regulated utility is assumed to only undertake the regulated activities and have a constant level of gearing. Hence, the levers that management have to alter a firm's beta (i.e. change scope of operations or gearing) are unavailable.

We note that it has been pointed out in the finance literature that applying the Blume adjustment can cause (rather than remedy) bias,[27] particularly when being applied to industries where a beta of below or above unity is expected. Given that the majority of our beta estimates are below unity, and that this pattern is repeated in the US, such a bias may well be result from the application of the Blume adjustment.

Accordingly, we recommend that the Blume adjustment not be applied.

2.7 Computing portfolio betas

As noted, one of Gray and Officer's methodological choices was to report beta estimates for a portfolio formed from the set of comparable entities. Gray and Officer reported two portfolio-related beta estimates. The first portfolio reflects the average returns across all firms in the set of comparable entities in the given time interval, which is equivalent to an equally-weighted portfolio of those securities. This was referred to by the authors as the *average portfolio*. The second portfolio reflects the median return that would have been delivered by any of the securities in the set of comparable entities in the given time interval. This was referred to by the authors as the *median portfolio*.

We agree with Gray and Officer that it is useful to compute industry portfolio betas, noting that such betas have a higher degree of precision that those for individual beta estimates, in much the same way that averaging betas across a group of comparable entities improves precision. Moreover, when betas are estimates for a portfolio of firms, it is a straightforward task to compute the standard errors (and hence confidence interval) of the industry beta. In our view, however, most weight should be placed upon the average portfolio measure, although we note that the use of median returns as the measure of the portfolio return is yet another means of dealing with outliers (as it eliminates the potential skewing of results caused by unusual events with one security).

[27] Lally, M (1998), "An Examination of Blume and Vasicek Betas", *The Financial Review*, vol. 33, p.189.

2.8 Including foreign comparable firms

While considering it would be 'improper to pay no attention at all to the foreign comparables', Gray and Officer believed it is not possible to 'directly use as an estimate of a domestic company's beta, the beta of a comparable company from another market or economy.'[28] ACG concurs with this view. However, it is difficult to envisage mechanical adjustments (apart from market leverage adjustments), and the order of magnitude of any such adjustments would necessarily be crude. We therefore recommend that although foreign evidence should be reviewed, this should be undertaken with caution.

2.9 Beta estimates against the 'World' index

Another study that we undertook to review is the Smithers & Co study prepared for Ofgem, the energy regulator in the UK. Smithers & Co used daily data to estimate betas with rolling OLS regressions and also applied the Kalman Filter technique, which assumes that there is drift in beta. A disadvantage of the Kalman Filter approach is that standard errors (SE) are widened relative to OLS. When betas were calculated against the Morgan Stanley Capital Investments (MSCI) world index, it was found that beta estimates reduced in size.

Table 2.2

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

Source: Smithers & Co (1 September, 2006), p.8 Note: 'CAPM beta' refers to raw equity beta, i.e. not re-geared to a specific gearing level.

[28] Gray and Officer (2005), p.29.

It appeared that the beta of the businesses examined longitudinally had fallen over time. They speculated that one reason for this may be that the risk level of the UK market had risen. Smithers & Co undertook a longitudinal estimate of the beta of the UK market relative to the world market (defined as the MSCI index) and found that this had increased over time, attributing this to greater global operations of UK-listed companies. When they estimated the betas of individual securities in their sample against the world market, the estimates were lower than when estimated against the UK market. It was felt that a way to circumvent the problem of beta instability caused by movements of the UK market relative to the MSCI is to assume that world capital markets are integrated, and measure beta against the MSCI.

Smithers & Co undertook a separate study of movements in gearing among their sample of nine securities and found that it had been rising over the period. At the same time, the observed equity beta had been falling, and this led them to conclude that asset betas had also been falling over time as gearing increased. They noted these observations to be contrary to the pure Modigliani-Miller theorem. It was surmised that a possible reason for this is that the regulator has *caused* asset betas to decline as gearing levels increased.

An examination of the activities of the group of 9 securities shows that only National Grid plc could be considered a close comparator for a benchmark gas distribution business. Table 2.4 shows that Smithers & Co. found National Grid's mean beta estimate to range from 0.55 to 0.63 against the UK market and 0.36 against the world market. The other businesses in the Smithers & Co sample are not close comparators. For example, Scottish & Southern and Viridian are engaged in electricity generation and retailing activities. At the other end of the spectrum, Smithers & Co included water distribution businesses. In the analysis undertaken by Smithers & Co. the important differences in the basic risk characteristics of companies in its sample receive scant attention.

An important oversight in the Smithers & Co. study is that it does not provide for each of the sample companies an estimate of what the regeared (to 55% or 60%) equity beta would have been cross-sectionally at each point in time. It would seem that a combination of increased gearing in the sample and falling equity betas would result in an even more dramatic fall in re-geared beta. For example, National Grid's central equity beta estimate has been gradually falling since 2000, while its gearing has increased from around 30% to around 50% over the last decade.

We do not consider that it would be straightforward or even appropriate to use a beta estimate measured against a world share market index (such as the MSCI) when setting a regulatory cost of capital (which, for Australian firms, is likely to result in lower beta estimates).[29] If a beta that is measured against a world share market index is to be used, then a different version of the CAPM would be required, given that the version in common use for Australian regulators assumes segmented capital markets and hence domestic-oriented inputs. We note that a move to the use of an international CAPM would be a substantial one – there are a number of alternative models to choose from and other inputs would be affected (such as the market risk premium, 'gamma' and possibly also the risk free rate of return).[30] Hence, we recommend that beta be estimated by regressions only against the returns of domestic capital markets.

2.10 Gray and Officer's empirical results

Gray and Officer presented estimates of equity betas for Australian firms using the techniques that have been discussed in this chapter. They selected a group of companies described as 'close comparables', which were AGL, Alinta, Australian Pipeline Trust, and Envestra. The specific methodological choices made were to:

- report betas for portfolios of the comparable entities, with both an average portfolio and median portfolio used;
- exclude the period of the 'technology bubble';
- excluded outliers based on removal of observations that were more than a multiple of 2, 1.5 and 1 standard errors from the predicted value; and
- applied the Blume adjustment to the raw beta estimates, before adjusting for gearing.

The results reported by Gray and Officer are reported in Table 2.3.

[29] This likelihood is based upon our own previous work and work of others, such as Ragunathan, Faff and Brooks (1999), "Australian Industry Beta Risk, the Choice of Market Index and Business Cycles", *Applied Financial Economics*.

[30] In addition, the question of whether it is feasible to assume that capital markets are integrated remains given observed puzzling phenomena (such as the observation that most investors hold the majority of their investments in domestic firms). Moreover, it is not clear that the error from applying a domestic CAPM should result in a materially different estimate to what would be derived under an international CAPM, if both were applied in a consistent manner.

Table 2.3

GRAY AND OFFICER'S EMPIRICAL RESULTS: RE-LEVERED OLS PORTFOLIO BETA ESTIMATES AFTER REMOVAL OF TECHNOLOGY BUBBLE AND OUTLIERS AND BLUME ADJUSTED

Outlier Removal Criteria (Standard Errors)	2.0	1.5	1.0
	Beta (R^2)	Beta (R^2)	Beta (R^2)
3.5 years: 7/2001-12/2004			
Mean Portfolio	0.96 (0.27)	1.04 (0.31)	1.18 (0.45)
Median Portfolio	1.02 (0.34)	1.07 (0.45)	1.27 (0.52)
4 years: 1/1998-6/1998 7/2001-12/2004			
Mean Portfolio	0.97 (0.18)	0.96 (0.23)	1.22 (0.40)
Median Portfolio	1.07 (0.22)	1.02 (0.29)	1.26 (0.46)
5 years: 1/1997-6/1998 7/2001-12/2004			
Mean Portfolio	1.01 (0.25)	1.07 (0.31)	1.26 (0.54)
Median Portfolio	1.03 (0.26)	1.10 (0.36)	1.37 (0.58)

Source: Gray and Officer (17 April 2005)

It is clear from the table that their beta estimates for both portfolios were at or slightly above one for the most restrictive definition of outliers, and generally increased as more observations were excluded as outliers. It was concluded by the authors that once the effects of the technology bubble and statistical outliers was removed, 'beta estimates return to long-term levels, at or above one (assuming 60% gearing).'[31]

We have replicated the Gray and Officer method below with the more recent data used in this study in order to test the robustness of their results, as well as the relative contributions of their method for dealing with outliers and their use of the Blume adjustment.

2.11 Conclusion

We have examined several studies that have reviewed beta estimation methodology and estimated beta empirically for energy distribution activities in Australia and the United Kingdom. From this analysis it emerges that beta estimation for a benchmark gas distribution business is difficult given the multitude of confounding factors. This is manifested in the observance of high standard errors and consequently wide confidence limits around the central estimate.

Having reviewed a number of studies in this area, ACG's general recommendations on methodological issues for estimating beta are as follows:

- Estimates with high standard errors should not be discarded per se, although the precision of the estimates is relevant when interpreting those estimates, and whether techniques for reducing improving precision should be investigated;

[31] Gray and Officer (2005), p.39.

- Adjustment for unrepresentative outliers should be undertaken, but with most reliance placed upon approaches that are recognised in the literature;
- Data drawn from the period of the technology bubble should be eliminated from consideration as it is likely to be unrepresentative of the future;
- Regard should be had to portfolios constructed from the set of comparable entities;
- The maximum amount of data available should be reviewed, together with more recent data based on the approximately 5 years of monthly observations available since the conclusion of the technology bubble;
- The Blume adjustment should not be applied as it is not relevant in the context of Australia's regulatory framework;
- Some regard should be given to beta estimates for foreign firms; and
- Beta estimates should be undertaken against the relevant home market, rather than against a 'world index' such as the MSCI.

Chapter 3

Specific methodological choices

3.1 Introduction

There are numerous methodological approaches that may be applied in generating beta estimates. In this chapter we describe the methodology that has been applied in the present report in some detail. In an earlier ACG report for the ACCC on proxy beta estimation for regulated gas transmission activities, we included a detailed discussion of methodological issues, and we will draw on that discussion as required.[32]

3.2 Beta estimation – methodological choices

In estimating beta there are numerous methodological choices that must be made, and it is important in any study that these choices are set out clearly. Our choices on the most important methodological issues are discussed in turn below.

Empirical specification of the CAPM and Beta

We define a model of the form:

$$R_{it} = \alpha + \beta R_{Mt} + \varepsilon_{it}$$

Where R_{it} is the return on the asset i for period t, α and β (Beta) are parameters to be determined and R_{Mt} is the rate of return for the portfolio of the entire market.

Discrete vs continuous returns

Discrete returns are calculated as the return in a given period from the change in the stock price plus dividend, relative to the initial stock price. Continuously compounded returns are calculated as the natural logarithm of one plus the discrete return. Some advantages of continuous returns are that they can be aggregated over different periods of time and are more likely to be normally distributed and therefore less likely to be subject to outliers.[33] We undertook a sensitivity test and found that for OLS, the discrete returns data provided beta estimates up to 2 points higher than using continuous returns, which was not considered material. Since the use of continuous returns is commonly applied, we have adopted this approach and define returns as:

$$R_{it} = \ln\left((P_t + D_t)/P_{t-1}\right)$$

Where R_{it} is the return on the asset i for period t, P_t is the price of the asset in period t, and D_t is the dividend payed in period t.

[32] The Allen Consulting Group (July, 2002), *Empirical Evidence on Proxy Beta Values for Regulated Gas Transmission Activities*, Final Report for the Australian Competition and Consumer Commission.

[33] Brailsford, Faff and Officer (1997), p.8.

Market index

The market index should be calculated consistently with the returns calculated for securities. Theoretically the market index should comprise all risky assets available to investors. In general, researchers proxy all assets with the assets contained in a broad based stock market index. Within the Australian regulatory context, which assumes a segregated domestic capital market, the domestic market in each case is appropriate. Hence, we have applied a broad stock market accumulation index for each of three markets:

- Australia: The All Ordinaries Accumulation Index
- United Kingdom: The FTSE All Share Accumulation Index
- United States: Standard & Poor's 500 Total Return Index

Each of these is a value-weighted index, which is preferred because it is more consistent with the true market portfolio defined in the theory of the CAPM.

Return period

In the literature on beta estimation the most common return period interval is monthly, although weekly and daily estimates have been discussed at times.[34] Wright, Mason and Miles have shown that betas are likely to be more stable with weekly and daily data as there are more observations.[35] However, Gray and Officer showed that for a given number of observations, applying weekly data creates greater instability in beta estimates than longer-term monthly data. In addition, shorter time periods are more susceptible to bias caused where the security is traded more or less often than the market average (non-synchronous trading, or 'thin and thick' trading), as discussed below. The standard approach used in beta analysis is the use of monthly returns over a period of 60 months or more, and we recommend adherence to this convention.

However, we were also asked to present estimates of betas using shorter return periods, particularly in relation to the recently listed companies for the comparator companies in the Australian market. Accordingly, we have reported betas using the following data (to the extent available) starting from July 1991 up to February 2007.

- Monthly returns data for up to 15 years
- Weekly returns data for 5 years
- Daily returns data for 2 years

The returns data was calculated based on Bloomberg closing prices and Bloomberg dividend data. However, as noted elsewhere, we recommend that, if betas estimated using weekly and daily observations are considered, that material weight not be applied to these estimates given the potential for bias in those estimates.

[34] See Wright, Mason and Miles (13 February, 2003), p.

[35] Using the example of British Telecom, Wright, Mason and Miles showed that when 60 months of monthly observations are used, as a new month is added and an old month discarded in a rolling estimation process, there is greater scope for fluctuations than with higher frequency data such as weekly or daily data.

Thin and thick trading

'Thin trading' is one of the problems encountered in beta estimation, particularly for smaller stocks where trading may be infrequent. This problem is compounded when more frequent return periods (such as weekly or daily) are used, since there may be no trades at all between these periods. In general, thin trading tends to bias downward the estimate of beta, as there will be a disproportionate number of observations for the stock with zero observations when there are positive or negative observations for market returns. This in turn will bias upwards the beta of frequently (thickly) traded stocks.

To counteract the effect of thin trading, ordinary least squares regression has typically been extended by the introduction of lagged and leading market returns. One such technique is the Scholes-Williams (S-W) beta, which is applied by a number of commercial beta providers, including the AGSM.[36] The AGSM beta measurement service also provides an LM statistic that it recommends should be employed to distinguish those stocks where thin trading is likely to be a problem.[37] The cut-off LM statistic recommended is 0.05, with values below this indicating that the S-W beta could be applied. Within the utilities industry group the AGSM has published the LM statistics shown in Table 3.1 below during the last three years based on four years of monthly observations. At the level of monthly returns, not one of the utilities industry group shown would have warranted application of the S-W beta under the AGSM's threshold.

Table 3.1

POTENTIAL FOR THIN TRADING BIAS: 'LM' STATISTIC FOR SELECTED UTILITIES

	December 2004	December 2005	September 2006
Australian Gas Light	0.457	0.597	0.729
Alinta Limited	0.479	0.331	0.792
Australian Pipeline Trust	0.655	0.248	0.879
DUET Group			0.422
Envestra Limited	0.608	0.639	0.098
Hastings Diversified			0.876
GasNet	0.088	0.081	0.836

Source: AGSM Risk Measurement Service, Beta Estimates.

The utility stocks in the sample examined in the current report tend to be frequently traded. Hence, we have not applied procedures to correct for thin trading bias.[38]

[36] Scholes, M. and J. Williams (1977), 'Estimating betas from non-synchronous data', *Journal of Financial Economics*, Vol. 5, pp. 309-327.

[37] The AGSM's Centre for Research in Finance "Risk Measurement Service" document (at p.14) defines the LM statistic as: 'This is the 'p-value' of a test for the effects of thin trading. If this number is small (say less than 0.50), then it is likely that thin-trading has affected the parameter estimates in a way which may be compensated for by using the Scholes-Williams technique.'

[38] Any procedure for correcting for thin trading – such as the Scholes-Williams technique – requires additional parameters to be estimated, and hence leads to a material reduction in the precision of beta estimates. Accordingly, such techniques should be applied only where problems of non-synchronous trading are considered sufficiently material.

However, we note that the LM test presented above applies only to betas that are estimates using monthly returns. The potential for thin or thick trading is much more significant when using returns that are measured over shorter periods (such as weekly and daily observations), which explains why the use of monthly returns is the norm in beta estimation. Accordingly, we recommend that, if weekly and daily observations are considered, that material weight not be applied to these estimates.

Return window

As noted in section 2.5, we consider it appropriate in principle to have regard to the longest period of observations available when estimating betas for a regulated utility, given that there is less reason to consider that the beta of the benchmark firm would change over time. However, we also noted that, in practical terms in Australia, this means placing increasing weight on observations for AGL, given that it is the only firm that has more than 7 years of observations if the period of the technology bubble is excluded from consideration. Accordingly, we consider that weight should also be applied to betas estimated over just the period since the end of the technology stock bubble, given the additional firms in the set of comparable entities during that period.

Accordingly, to provide a range of estimates, we have reported beta estimates for returns measured over the following periods:

- As many months of monthly data as possible up to January 2007 excluding the period of the technology bubble (up to 149 months)
- As many months as possible of monthly data up to January 2007 since the conclusion of the technology bubble (up to 61 months)
- Up to 268 weeks of weekly data since the end of the technology bubble to January 2007
- Up to 555 days of daily data to January 2007

We note again that, while we have reported results using weekly and daily data, we caution against placing material weight on these estimates.

Adjustment for leverage

It is the equity beta forecast that is of primary concern in both regulatory and non-regulatory applications of the CAPM. The equity beta will be affected by its financial leverage or gearing. In order to obtain the appropriately re-levered equity beta, it is necessary to first de-lever to obtain the un-geared or asset beta. It is important that the de-levering and re-levering are undertaken in a consistent fashion.

This aspect is discussed in some detail in ACG's previous report for the ACCC, where it is concluded that the appropriate adjustment formula depends on the following factors:

- Whether the debt policy is active (debt is maintained at a constant proportion of the market value of assets) or passive (debt is maintained at a constant level);
- The marginal tax advantages of debt (reflecting both company tax considerations, and the relative personal taxation of debt and equity); and

- Whether or not debt is risky (or materially risky), the implication of which is whether or not debt providers share some of the beta risk associated with the project.

We concluded that it may not be inappropriate to assume a near zero tax term in the levering/de-levering equation for all markets.[39] Since the re-levering equation applied by the ESC is the Brealey and Myers with a debt beta of zero, we have adopted this approach, namely:

$$\beta_a = \beta_e \frac{E}{V}$$

where β_a is the asset beta (being the beta for a security that has no gearing), β_e is the equity beta and E/V is the share of equity in the financing structure (i.e. 40 per cent).

Another aspect of gearing that requires a methodological choice is the definition of the gearing level that is assumed in the in the levering/de-levering. We have calculated the average level of gearing over the return window period that is used to estimate the raw beta. Gearing is defined as the book value of debt divided by the sum of the market value of equity and the book value of debt. Since equity values are available daily but debt values are constrained to reporting dates, we have interpolated the debt levels in intervening periods and calculated interpolated gearing levels.

In order to make inferences from the results of the regression we adjusted the coefficient estimates – the estimates of β – to account for the gearing relationship. We define the average level of observed gearing G, as:

$$\overline{G} = \frac{\overline{D}}{\left(\overline{D} + \overline{E}\right)}$$

Where D is the book value of net debt and E is the market value of equity. Applying the re-levering equation of Brealey and Myers with an assumed debt beta of zero and a regulatory gearing level of 60%, it can be shown that the re-levering factor that should be applied to the raw beta estimates is:

$$\omega = \frac{\left(1 - \overline{G}\right)}{\left(1 - 0.60\right)}$$

[39] ACG (July, 2002), p.27.

For purposes of inference (i.e. computing confidence intervals) we assume that ω is constant and we can then estimate the standard error for the re-levered $\hat{\beta}_r$ using the relationship that the variance of a constant times a random variable is the constant squared times the variance of the random variable thus for any estimate of β we find $\hat{\beta} \sim (\beta, \sigma^2_{\hat{\beta}})$ then $\hat{\beta}_r \sim (\omega\beta, \omega^2\sigma^2_{\hat{\beta}})$. This assumes that the average gearing $\overline{G}$ is independent of the estimated value of β. This assumption should not be considered an important one however, in a small experiment it was discovered that the value of $\overline{G}$ changes so little even in monthly data that the assumption that it is constant will not have much impact, and that it is not correlated with the estimate of β.[40]

The technology bubble

Many of commentators have maintained that the 'bubble' in technology stocks experienced in the late 1990s substantially reduced the measured betas for US utility firms over the period, and which is not considered a reliable guide to the future. As noted in a US study of this phenomenon:[41]

> Sharp recent declines in telecom, media and technology valuations suggest that the past three to five years were truly extraordinary… But in assessing future values for betas, most practitioners look to the equity returns of the recent past – and the most recent three to five-year averages and correlations of returns to shareholders are of course quite extreme. By excluding the bubble years entirely, it is possible to calculate betas that are more consistent with the long-term historical results and indicate more accurately the relative risk borne by companies in other sectors. In the absence of such a correction, data drawn from the bubble years may generate artificially low betas for the next couple of years.

In Australia, while the share market as a whole did not experience the 'boom and bust' of the US market, the fortunes of the new economy and old economy sectors over the period differed substantially. Over the period from about mid 1998, the telecommunications sector (the proxy for the 'new economy') experienced substantial growth in share prices and then an equally substantial decline. At the same time, the utilities sector moved largely counter to the telecommunications sector and counter to the market as a whole – particularly during the subsequent decline in the telecommunications sector. A more normal relationship occurred after about the end of 2001. The effect of utility stocks moving contrary to the general movements in the share market over an extended period would have been to depress artificially beta estimates that use data from this period.

Accordingly, beta estimates for utility companies that employ data for this period are expected to be biased (and most likely, downward biased). Estimates of betas to the current time using five years of observations would only now be free of the effects of this potential bias, although estimates that span a longer period would remain influenced. While a potential solution is to exclude the technology 'bubble' and only use observations for the period that predated it, and this can be done for US and UK sample companies, this is not a satisfactory option in Australia since:

- Modern utility regulation did not commence in Australia much before the commencement of the technology boom, and so it is questionable whether information from the previous period was relevant.

[40] In a bootstrap analysis in which 1000 estimates of both $\overline{G}$ and $\hat{\beta}$ were computed from the same samples it was found that the monthly least squares estimator of β for AGL and the gearing factor ω have a correlation of less than .05.

[41] Annema A. and M. Goedhart, 2003, 'Current Research – A Better Beta', *McKinsey Quarterly*, No.1, p.8. The authors classified the abnormal period for the US market as between January 1998 and December 2001.

- Very few companies with regulated energy activities were listed in 1998 and are still listed now – Envestra listed in August 1997 and, prior to that, AGL was the only one of the firms that have been subject to modern utility regulation that was in existence.

For each sample company in each market we define the technology bubble period as 1 July 1998 to 31 December 2001. This definition has the advantage of also excluding another unusual market event, the 11 September, 2001 terrorist attack and its impact.

Blume adjustment

We note that while the ESC had regard to 'Blume adjusted' betas in a 2000 decision on electricity distribution activities, the Commission criticised the adjustment, and had regard to it together with unadjusted betas. In the gas access arrangements concluded in 2002, and electricity access arrangements concluded in 2006 the ESC had regard only to raw (60 per cent gearing adjusted) betas.

In the discussion of Gray and Officer's approach in Chapter 2 above, and also in our earlier study of gas transmission and distribution betas for the ACCC, we have concluded that it is inappropriate to apply the Blume adjustment when estimating the beta for regulated businesses in a situation where betas are estimated a set of comparable entities.

Portfolio analysis

As discussed in Chapter 2, we support Gray and Officer's calculation of betas for a portfolio comprised of the set of comparable entities.

However, a problem associated with the portfolio analysis approach is that the results are sensitive to changes in the composition of the portfolio over time. Thus, significant changes in apparent returns, or beta estimates, can be caused by old members exiting and new members entering the portfolio. For this reason, any examination of the results of a portfolio should be considered together with an understanding of the portfolio composition. We have provided in Table 3.2 the portfolio weights that are implied in this study to calculate portfolio re-geared equity betas.

Table 3.2

PORTFOLIO WEIGHTS

From:			Jun 91	Oct 97	Jan 02	Aug 04	Dec 04	Dec 05	Nov 06	Dec 06	Jan 07
To:			Aug 97	Jun 98	Jul 04	Nov 04	Nov 05	Oct 06	Nov 06	Dec 06	Jan 07
Security:	Weights (%):										
	Full	Post 2001									
AGL	29.9	15.1	AGL	AGL	AGL	AGL	AGL	AGL			
Envestra	14.8	15.9		ENV	ENV	ENV	ENV	ENV	ENV	ENV	ENV
Alinta	12.7	15.9			ALN	ALN	ALN	ALN	ALN	ALN	ALN
APT	12.7	15.9			APA	APA	APA	APA	APA	APA	APA
GasNet	12.3	15.4			GAS	GAS	GAS	GAS	GAS		
DUET	6.3	7.8				DUE	DUE	DUE	DUE	DUE	DUE
Hastings	5.4	6.8					HDF	HDF	HDF	HDF	HDF
SPN	2.9	3.6						SPN	SPN	SPN	SPN
Spark	2.9	3.6						SKI	SKI	SKI	SKI
Whole period weights (%)			100	50	20	17	14	11	13	14	14

For beta estimates estimated with all of the monthly data, AGL is responsible for approximately one third of the outcome, while observations for the relatively new entrant, Spark Infrastructure are responsible for only 2.9 per cent of the total outcome. For individual periods defined above, the equal (period) contributions of each of the members of the Australian portfolio are given in the bottom row. For example, during the period from December 2005 to October 2006, there were 9 members of the portfolio, with each contributing 11 per cent to the overall outcome. For the period from June 1991 to August 1997, AGL accounted for 100 per cent of all of the portfolio observations.

3.3 Techniques to account for unusual events – outliers

The traditional method used to estimate equity beta is least squares, or OLS (ordinary least squares) regression, which minimises the sum of the squared errors. Using this method we attempt to find the estimate of β that will minimise the sum of the squared errors when applied to the data for the equity returns and the market returns. The regression equation is of the form specified in section 3.2 above. The least squares estimator has the property that it is unbiased and has the least variance of all other estimators if the properties of the errors in the model have the appropriate characteristics. The appropriate characteristics are that the errors are identically and independently distributed. Unfortunately, we cannot observe the values of ϵ_t. Thus we need to make assumptions as to the nature of the errors by examining the estimates of the errors as formed by the residuals $\hat{\epsilon}_t$ (here we drop the *i* subscript) where:

$$\hat{\varepsilon}_t = R_t - \hat{\alpha} - \hat{\beta} R_{Mt}$$

and the $\hat{\alpha}$ and $\hat{\beta}$ are estimates of the parameters of the model. The most important characteristic of $\hat{\varepsilon}_t$ is whether the distribution of this error appears to be generated by a distribution that has a large number of extreme values or not. Concern that outliers will influence the estimated beta has led to the consideration of a number of robust regression techniques.

The least squares solution for the estimate of the β in $R_{it} = \alpha + \beta R_{Mt} + \varepsilon_{it}$ is defined as the value of an estimate of α and β that minimizes the sum of the squared error which is defined as:

$$\underset{\text{min w.r.t } \alpha \text{ and } \beta}{SSE} = \sum_{t=1}^{T} \left(R_{it} - \hat{\alpha} + \hat{\beta} R_{Mt} \right)^2$$

This criterion for a solution is a very powerful one in that the estimates can be found from the application of simple calculus and via the central limit theorem the distribution of the parameter estimates $\hat{\alpha}$ and $\hat{\beta}$ become normally distributed as the sample size grows if the distribution of the errors is identically and independently distributed with a finite variance and expected value. This property allows the formation of probability statements concerning the values of the estimated parameters.

However, this assumption may not hold or the sample size may be of insufficient size for these properties to hold. One way to ensure that we have sufficient observations is to remove (or adjust) those observations that may be from another distribution so that the errors in the sample we observe are from one that allows the parameters to be normally distributed with a smaller sample.

Robust regression techniques

A number of robust methods have been proposed in the statistics literature and a number of authors in the financial economics literature have used these methods for estimation of β. In this study we will use two of the most widely applied robust techniques.

Re-weighted Ordinary Least Squares

First, we employ a re-weighted least squares approach proposed by Martin and Simin (2003) in the *Financial Analysts Journal*.[42] This technique has been proposed to ensure that the properties of the least squares estimator are appropriate. This is achieved through the removal of observations that have been deemed to be "outliers" or values that have been generated by another process that we are not interested in modelling. In order to account for these unusual observations we may employ a method based on weighting the sum of the squared errors:

$$\underset{\text{min w.r.t } \alpha \text{ and } \beta}{WSSE} = \sum_{t=1}^{T} w_t \left(R_{it} - \tilde{\alpha} + \tilde{\beta} R_{Mt} \right)^2$$

[42] Martin, R. Douglas and Timothy T. Simin, (2003),"Outlier-Resistant Estimates of Beta", *Financial Analysis Journal*, Sept/Oct, 56-69.

Where the sum of squared error is now minimised with respect to the estimates however not all errors are weighted the same. Note that if the $w_t = 1$ for all observations we would obtain the least squares solution as the appropriate value. However, in this case we have that some observations that have $w_t < 1$ and for extreme outliers we set $w_t = 0$. In this way we can use the least squares regression methods but with a consideration for the possibility of extreme values.

The proposal by Martin and Simin (2003) is to use the residuals from a preliminary regression. The residuals from this regression are the estimated errors defined as:

$$\hat{\varepsilon}_t = R_{it} - \hat{\alpha} + \hat{\beta} R_{Mt}$$

The errors are assumed to be distributed with an expected value of zero and a variance of σ_ε^2. Thus we can form a statistic that is distributed as: $\hat{\phi}_t = \frac{\hat{\varepsilon}_t}{\hat{\sigma}_\varepsilon} \sim (0,1)$ with a mean of zero and a variance equal to 1. If we want to make a probability statement about this value we can use the normal distribution which would indicate that any value of $\left|\hat{\phi}_t\right|$ that is greater than 2 is quite unlikely. They then define a weighting function based on the value of $\left|\hat{\phi}_t\right|$ defined as $w_t = f\left(\left|\hat{\phi}_t\right|\right)$. According to this weighting function value of $\left|\hat{\phi}_t\right| > 2.7$ implies that the $w_t = 0$ and those values where $\left|\hat{\phi}_t\right| < 1.8$ have weights equal to one.

This implies that outliers to the initial regression are excluded from the analysis in the second step regression. Where these cut-off values come from is not made explicit. One could imagine picking a number of other values.

In effect, this approach has some resemblance to the approach applied by Gray and Officer (2005), which applied exclusion criteria of 2 (1.5 and 1) standard errors. However, there are two differences. First, Martin and Simin do not exclude observations unless S.E. exceeds 2.7 (compared with 2 and below for Gray and Officer). Secondly, for S.E.s of between 1.8 and 2.7, Martin and Simin allocate a weight that falls from unity to zero.

Least Absolute Values (LAV)

The alternative robust regression method employed in this study is the Least Absolute Values (LAV).[43] This method has been mentioned by a number of authors as a widely available robust regression method.

This method employs an alternative estimation procedure in which the objective is to determine the values of the parameters that minimize the sum of the absolute value of the errors:

$$\underset{\text{min w.r.t } \alpha \text{ and } \beta}{SAE} = \sum_{t=1}^{T} \left| R_{it} - \breve{\alpha} + \breve{\beta} R_{Mt} \right|$$

[43] This method is also referred to as Least Absolute Deviation (LAD) or Minimum Absolute Deviation (MAD) or the Percentile Regression among other titles.

This criterion for estimation is less prone to be influenced by extreme values than the least squares approach because the size of the error has a linear impact on the objective function as opposed to a squared effect when we perform least squares regression.

However, the optimal parameter values that minimise *SAE* are not found from the solution to a set of linear equations as with least squares but require the use of a linear programming algorithm in an iterative cycle of solutions, which may not converge in every situation. In the applications in this study we use the Madsen and Nielsen algorithm.[44] The estimation of the standard error of these estimates is also dependent on an approximation method. In the analysis performed here we use the McKean-Schrader approximation.[45]

3.4 Conclusion

The methodological choices considered above are set out in summary in Table 3.3. As can be seen from the number of choices made, there are alternative presentations of beta estimates that we will not present. However, we believe that the methodological choices made are consistent with best practice in the financial economics literature, and the requirements of the ESC given existing assumptions such as re-levering to a gearing level of 60 per cent.

[44] Madsen, K. and H. B. Nielsen, (1993), "Finite Smoothing Algorithm for Linear L_1 Estimation", *SIAM Journal on Optimization*, 3, 223-235.

[45] McKean, J. W. and R. M. Schrader, (1987), "Least Absolute Errors Analysis of Variance", in *Statistical Data Analysis – Based on L_1 Norm and Related Methods*, ed. Y. Dodge, Amsterdam: North Holland, 297-305.

Table 3.3

SUMMARY OF METHODOLOGICAL APPROACH

Methological issue	Consequence / problem	Methodological choice made
Discrete vs continuous returns	Continuous returns preferred theoretically and reduce effect of outliers	Continuous returns
Market index	Index should be reflective of investment alternatives applicable to investors	Broad home market accumulation indexes for Australia, UK and US
Return period	Monthly observations used most widely and minimises the risk of non-synchronous trading bias	Monthly, with beta estimates from weekly and daily data reported as well
Thin and thick trading	Thin trading under- estimates beta & thick trading over-estimates	No correction applied for monthly estimates (unlikely to be material). Caution against relying on weekly and daily return betas.
Serial correlation	Higher frequency returns more likely to be serially correlated, making SE misleading	Newey West SE procedure applied to weekly and daily estimates if evidence of serial correlation
Return window	Prefer maximising observations, subject to obtaining a spread of firms.	Up to 149 months of monthly data Up to 268 weeks of weekly data Up to 555 days of daily data
Accommodating leverage	Equity beta is dependent on level of gearing	De-lever and lever to 60% consistent with regulatory target. Average gearing over period of estimation
Re-leveraging formula	Formula depends on views about the impact of taxation and active vs passive debt management	Brealey & Myers formula with debt beta of zero
Unusual events (outliers)	Unusual outliers result in potential upward or downward distortion of the true beta estimate	Apply Re-weighted Least Squares (re-OLS) and Least Absolute values (LAV) techniques
Technology bubble	Technology bubble cause caused tech stocks to be upwardly biased and utilities to be downward biased	Exclude observations from the affected period: 1/7/1998 to 31/12/2001
Mean reversion of betas	Adjustment for observed tendency of mean reversion of betas	Estimate betas for a set of comparable entities. Reject Blume adjustment as inappropriate.
Interpretation of portfolio SE	Cannot interpret the SE of an average of individual betas for a portfolio	Construct a returns index of the portfolio an regress against the relevant market, showing portfolio composition

Chapter 4

Data description

4.1 Introduction

In this chapter we describe the data sample, and the process by which it was derived. We begin with the UBS utilities index, which includes a broad population of listed energy related businesses around the world. We then choose the Australian, US and UK energy related businesses due to broad similarities in their legal, financial, market and regulatory frameworks. From that group:

- For Australia we eliminate businesses that do not have a relatively significant component of regulated energy distribution or transmission; and
- For the US and UK we retain only those businesses that are almost exclusively gas distribution and transmission business and have not been involved in significant recent merger or acquisition transactions.

It would be preferable to impose the stricter selection criteria to Australian business, however in that case most of the potential sample would not be selected.

4.2 Choice of comparators

The choice of appropriate comparators is a critical part of the analysis, and it is therefore essential that the criteria used to choose the proxy group have been well defined. In our previous study for the ACCC, which was concerned with deriving betas for regulated gas transmission companies, we established a hierarchy for the consideration of proxy comparator data, as follows:[46]

- Regulated gas transmission;
- Regulated gas distribution;
- Regulated energy transmission/distribution; and
- Regulated transmission/distribution network activities for the other essential services (namely water and sewerage services).

In the current study we are concerned with estimates of betas for gas distribution businesses, and we would therefore switch the first two bullets in the hierarchy. In the Australian context there are often too few close comparators, and the question arises as to whether international proxies should be considered. International proxies should ideally be for countries with similar markets and legal systems.

[46] ACG (July 2002), *Empirical Evidence on Proxy Beta Values for regulated Gas Transmission Activities*, Final report to the Australian Competition and Consumer Commission.

4.3 UBS utilities index

We have relied on the current UBS Utilities Index as an objective starting point for deriving a sample of proxy companies for gas distribution. We selected Australia, the UK and US as three markets with comparable economic, market and legal systems.[47] Within these countries we considered the classification of businesses engaged in the supply of energy. As shown in Table 4.1 below, these categories are: transmission and distribution; integrated regulated, integrated; and generation.

Table 4.1

UBS UTILITIES INDEX – AUSTRALIAN ENERGY RELATED

Transmission & Distribution	Integrated Regulated	Integrated	Generation
APT group		Alinta Energy	BB Wind Partners
DUET		AGL Energy	EDL
Envestra		Origin Energy	
HDUF			
Spark			
SP Ausnet			

Source: UBS

In Table 4.1, the companies in the generation category are not suitable comparators for a benchmark gas distribution business, since their operations are almost exclusively energy generation or retail. However, the integrated firms need to be examined more closely, given that both AGL and Alinta do, or have, undertaken significant regulated activities (which contrast with Origin). The group of 6 listed entities in the first column of Table 4.1 includes a number of securities that have either not been listed for very long, or are holding vehicles for a number of investments that are not wholly owned. We note that GasNet is no longer in the UBS index given its recent purchase by Australian Pipeline Trust.

Table 4.2

UBS UTILITIES INDEX – UK ENERGY RELATED

Transmission & Distribution	Integrated Regulated	Integrated	Generation
National Grid	Scottish Power	Centrica	British Energy
		Scottish & Southern Energy	Drax Group
		United Utilities	International Power

Source: UBS

[47] Reference UBS Index

Table 4.3

UBS UTILITIES INDEX - ENERGY RELATED

Transmission & Distribution	Integrated Regulated	Integrated	Generation
Gas T&D only:	Ameren Corp	American Elec. Power	AES Corp
AGL Resources	ALLETE Inc	Constellation Energy	Dynergy Inc
Atmos Energy	Avista Corp	CMS Energy	Mirant Corp
Cascade Natural Gas	Allegheny Energy	Dominion Resources	NRG Energy
Kinder Morgan	Black Hills	DTE Energy Co	Ormat Technologies
Kinder Morgan Mgmt	CLECO Corp	Duke Energy	Reliant Energy
Laclede	DPL Inc	Energen Corp	
NICOR	Empire District Electric	Edison Intl	
Northwest Natural Gas	El Paso Electric	El Paso Corp	
Peoples Energy	FirstEnergy Corp	Entergy Corp	
Piedmont Natural Gas	Great Plains Energy	Exelon Corp	
South Jersey Industries	Hawaiian Electric	FPL Group	
Southwest gas	IDACORP Inc	Keyspan Energy	
Valero GP Holdings	Aquila Inc	Alliant Energy	
WGL Holdings	MGE Energy	MDU resources	
Electricity & Gas T&D:	Northwestern Corp	National Fuel Gas	
CH Energy Group	OGE Energy	ONEOK Inc	
CenterPoint Energy	Otter Tail Corp	Public Serv. Ent.	
Consolidated Edison	PG&E Corp	Portland General Electric	
Energy East	Progress Energy Inc	Sempra Energy	
NiSource Inc	PNM Resources	Questar Corp	
NJ Resources	Pinnacle West Capital	Southern Union	
NSTAR	PPL Corp	TXU Corp	
Northeast Utilities	Puget Energy	UGI Corp	
Electricity T&D only:	SCANA Corp	Williams Cos.	
Duquesne Light Hlds	Southern Co	Xcel Energy Inc	
Sierra Pacific	TECO Energy		
UIL Holding Corp	Unisource Energy		
Pepco Holdings	Vectren Corp		
	Wisconsin Energy		
	WPS Resources		
	Westar Energy		

Source: UBS and ACG

Table 4.2 shows that the only energy related business in the UK that fits the description of gas transmission and distribution is National Grid plc. Given the difficulties of making international comparisons of beta estimates, we consider that stricter selection criteria should be applied to overseas firms. In the case of the US, the large number of listed entities means that a reasonable sample size is obtained if only the gas transmission or distribution businesses are considered. The next three sections describe the final samples.

4.4 Australia

Of the firms that are currently or have recently been listed on the Australian stock exchange, the 9 businesses listed in Table 4.4 could be characterised as sufficiently comparable entities for regulated energy infrastructure, although there are caveats as set out below.

Table 4.4

FINAL SAMPLE DETERMINATION: AUSTRALIA

Transmission & Distribution – currently listed	Included – not currently listed	Excluded
1. APT Group		
2. DUET		
3. Envestra		
4. HDUF		
5. SP AusNet		
6. Spark		
7. Alinta		
	8. AGL (prior to restructure)	
	9. GasNet (prior to acquisition)	
		United Energy (listed in tech bubble period)

Source: UBS and ACG

There are, however, potential problems with the quality of the data associated with these 9 businesses, which are as follows:

1. Envestra – Listed in August 1997, it has been subject to rumours of takeover offers at times, but otherwise has been relatively stable over recent years;

2. Australia Pipeline Trust – APT was listed in June 2000, and has undertaken a series of acquisitions in recent years (including Murraylink, the GasNet system in Victoria and the Allgas gas distribution network in Queensland), as well as being subject to rumours of potential takeover offers;

3. DUET – Listed in August 2004, DUET does not have a long history of operation. Moreover, the betas for investment trusts are more difficult to interpret, given that they are generally geared entities that have an equity interest in the ultimate firm – and hence two levels of gearing need to be accounted for;[48]

4. Hastings Diversified Utilities Fund – Listed in December 2004, and so does not have a long history of operation. Like DUET, the betas for investment trusts may be difficult to interpret, given that they are generally geared entities that have an equity interest in the ultimate firm – and hence two levels of gearing need to be accounted for;

5. SPAusnet – SP AusNet listed in December 2005, and so has an even shorter price history. Cheung Kong Infrastructure (CKI) retains ownership of 51 per cent of the underlying assets and has a 10 per cent stake in the listed entity.

6. Spark – Spark listed in December 2005, two days after SP AusNet, and so has a relatively short price history. Since it owns parts of businesses, its ultimate 'see through' gearing needs to be considered. Spark has a wider investment mandate than SPAusNet, as it is able to pursue merger and acquisition opportunities globally.

7. Alinta – Listed at October 2000, Alinta has been involved in a series of mergers or takeovers since its listing, and at times has had substantial activities outside of regulated infrastructure;

Recently delisted firms for which beta estimates can be derived include:

8. AGL – Delisted in October 2006 due to its restructure, its share price was affected by merger speculation for a long period prior to it being delisted. In addition, AGL contained a significant component of non-regulated activities; and

9. GasNet – Listed in December 2001 and delisted in November 2006, GasNet was not highly active in mergers or acquisitions, although its share price was affected by merger speculation for a period prior to it being delisted.

The tenth company, United Energy, was delisted in July 2003. It has not been included in the sample as it had little trading history outside of the period affected by the technology 'bubble'.

4.5 The United Kingdom

The sample of UK energy related businesses is shown in Table 4.5 below. In this table it was our view that National Grid plc is the only company that is a close comparator for a benchmark regulated gas distribution business. All other potential comparators, including those that were examined by Smithers & Co. (e.g. water utilities Kelda and Severn & Trent) have been excluded.

[48] While two levels of gearing need to be accounted for, investment analysts calculate 'see through' gearing levels for these securities, and we have relied on these as shown in Appendix Table C.2.

Table 4.5

FINAL SAMPLE DETERMINATION: UNITED KINGDOM

Transmission & Distribution	Excluded	Reason for exclusion
10. National Grid		
	Scottish Power	Significant generation
	Scottish & Southern	Significant generation
	Viridian	Significant generation
	Centrica	Retail and generation business
	IPR	Independent power generation
	United Utilities	Water utility plus operations management
	Kelda	Water utility
	Severn & Trent	Water utility

Source: UBS and ACG

4.6 The United States

The derivation of the final sample of US comparator companies is shown in Table 4.6. Nine companies have been included, and five companies have been excluded, generally on the grounds that they have been subject to recent merger or acquisition activity or management buy-outs. Kinder Morgan Management was excluded on the grounds that it is not a pure gas distribution business, but rather a management business. In addition, we have excluded Valero GP Holdings on the grounds that it was listed only in 2006, and therefore does not have a significant price and dividend history.

Table 4.6

FINAL SAMPLE DETERMINATION: UNITED STATES

Transmission & Distribution	Excluded	Reason for exclusion
11. AGL Resources		
12. Atmos Energy		
13. Laclede		
14. NICOR		
15. Northwest Natural Gas		
16. Piedmont Natural Gas		
17. South Jersey Industries		
18. Southwest Gas		
19. WGL Holdings		
	Cascade Natural Gas	Merger underway
	Kinder Morgan	Management buy-out
	Kinder Morgan Management	Management company
	Peoples Energy	Has been acquired
	Valero GP Holdings	Listed in 2006

Source: UBS and ACG

Chapter 5

Proxy beta estimates

5.1 Introduction

In this chapter we summarise the results that have been obtained by applying the methodology described in the previous two chapters to the available data base. The chapter is divided into three sections, which discuss the Australian, UK and US results respectively. By far the greatest attention is given to the Australian results, which are considered as portfolios and individually.

5.2 Monthly Australian data – whole period

Empirical estimates of the 60 per cent geared beta based on monthly data are set out in Table 5.1 below. In the table, we have applied the maximum monthly data available for the 9 comparator securities. The data excludes the technology bubble period, and is effectively weighted in the manner set out in Table 3.2 above, i.e. AGL has the greatest influence (29.9 per cent), with Envestra behind it (at 14.8 per cent) and so on.

Table 5.1

AUSTRALIAN ENERGY RELATED SECURITIES: FULL MONTHLY BETA ESTIMATES FOR ENERGY RELATED SECURITIES EXCLUDING THE TECHNOLOGY BUBBLE (1991-1998 AND 2002-2007)

Stock	N	OLS			Re-weighted OLS			LAV		
		L	M	H	L	M	H	L	M	H
AGL	142	0.43	**0.82**	1.21	0.35	**0.69**	1.03	0.21	**0.93**	1.64
ALN	61	-0.06	**0.91**	1.89	0.10	**0.98**	1.86	-0.49	**0.65**	1.78
ENV	71	-0.07	**0.13**	0.32	-0.04	**0.13**	0.29	-0.25	**-0.01**	0.23
APA	61	-0.11	**0.45**	1.01	0.00	**0.31**	0.62	0.30	**0.91**	1.52
GAS	59	0.02	**0.38**	0.75	0.00	**0.31**	0.62	-0.02	**0.34**	0.70
DUE	30	0.00	**0.29**	0.57	0.00	**0.28**	0.56	-0.18	**0.25**	0.67
SPN	14	-0.61	**0.20**	1.01	-0.61	**0.20**	1.01	-1.63	**-0.48**	0.67
SKI	14	-1.27	**-0.21**	0.85	-1.27	**-0.21**	0.85	-1.38	**0.08**	1.55
HDF	26	-0.19	**0.57**	1.33	-0.13	**0.59**	1.32	-0.17	**0.73**	1.17
Average first 5			**0.54**			**0.51**			**0.56**	
Portfolio Average	145	0.34	**0.63**	0.92	0.34	**0.59**	0.83	0.24	**0.71**	1.17
Portfolio Median	145	0.37	**0.65**	0.93	0.34	**0.61**	0.85	0.18	**0.63**	1.08

Note: L denotes lower 95%CI, M denotes mean estimate and H denotes upper 95%CI, N denotes number of monthly observations

Average Portfolio

The average portfolio beta estimates range from 0.59 (re-OLS) to 0.71 (LAV), with the OLS estimate lying in between at 0.63. The 95 per cent confidence intervals in the OLS and re-weighted OLS portfolios suggest that it would be highly unlikely (1 in 20 chance) that the portfolio beta would be as high as 0.83 or as low as 0.34. The LAV confidence intervals are somewhat wider, suggesting a 1 in 20 chance for the beta to be as high as 1.17, or as low as 0.24.

Median Portfolio

The median portfolio beta estimates are slightly higher than the mean for the OLS and re-weighted OLS approaches, and considerably lower in the case of LAV estimates. They range from 0.61 (re-weighted OLS) to 0.65 (OLS), with the LAV estimates lying in between at 0.63. For the median returns portfolio the 95 per cent confidence interval for the re-weighted OLS portfolio suggests that it would be highly unlikely (1 in 20 chance) that the beta would be as high as 0.85 or as low as 0.34. The LAV confidence intervals are again somewhat wider, suggesting a 1 in 20 chance for the beta to be as high as 1.08, or as low as 0.18.

Individual securities beta estimates based on full monthly data

AGL (AGL)

The estimates for AGL are based on 142 months of observations, or equivalent to almost 12 years. An advantage of considering such a long monthly sequence is that it introduces more observations and a greater variety of market conditions against which beta is measured. This would have the effect of narrowing confidence intervals. The mean beta estimate ranges from 0.69 (re-weighted OLS) to 0.93 (LAV), with an OLS estimate of 0.69 in between. The 95 per cent confidence intervals also range widely from a low of 0.21 (LAV) to a high of 1.64 (LAV).

Alinta (ALN)

The mean beta estimates for Alinta (ALN) are higher than for AGL under the OLS and re-weighted OLS methodologies (at around 0.95), but lower (at 0.65) for the LAV methodology. We have already noted that in the past five years, and particularly during 2006, Alinta was heavily engaged in merger and acquisition activity, which could have had the effect of increasing confidence intervals, which are relatively wide. Under the OLS approach these confidence intervals range from -0.06 to 1.89, and using LAV, from-0.49 to 1.78.

Australian Pipeline Trust (APA)

The Australian Pipeline Trust has also been acquisitive during the last five years, and particularly during 2006. However, the mean beta estimates are considerably lower using the two OLS techniques (0.43 and 0.31), but relatively closer to Alinta using the LAV technique (0.91). Again, the 95 per cent confidence intervals are relatively wide under the LAV technique, but not as wide as for AGL or Alinta. Under the re-weighted OLS technique the confidence interval is much narrower.

Envestra (ENV)

Envestra has not been very active in acquisitions, and has almost 10 years of monthly trading history available. Compared with the previous businesses (AGL, ALN and APA), it has had a higher percentage of its operations under regulatory oversight, and is the closest Australian comparator to a benchmark gas distribution and transmission business. The mean estimates for the OLS and re-weighted OLS techniques are identical at 0.13, with the 95 per cent confidence intervals ranging from close to zero to close to 0.32. This indicates that it would be very unlikely for the geared beta to be zero, and unlikely for beta to be as high as 0.32. The LAV technique provides a geared beta estimate of approximately zero for Envestra, with a 95 per cent confidence interval range of -0.25 to +0.23.

GasNet

Approximately 80 per cent of GasNet's earnings before interest and taxation was based on regulated gas transmission and distribution activities prior to its acquisition by Australian Pipeline Trust. There is a reasonable degree of consistency in the beta estimates using monthly data, with a geared central estimate of 0.34 to 0.38 using LAV and OLS and a lower estimate of 0.31 using re-weighted OLS. Similarly, the 95 per cent confidence interval ranges are from -0.02 to 0.75.

Average of First Five

The estimates based on an average of the first five securities for which there is a longer span of monthly data yield results that are different from the portfolio results. The beta estimate for the average of the first 5 is uniformly lower than the the portfolios (the mean estimate average ranging from 0.51 to 0.56 depending on methodology), with this difference ranging from 5 to 15 points.

5.3 Australian data since the end of the technology bubble

Table 5.2 summarises beta estimates based on the past 5 years of data since the end of the technology bubble (defined as occurring at December 2001). The average portfolio mean beta estimate using OLS is 0.30, which is approximately 33 points lower than the estimate based on all available data. The main reason for this is the significantly lower beta estimate observed for AGL in the more recent time period and the reduction in the weight applied to AGL. In the last five year period the standard error of the portfolio beta estimate is much narrower than for the whole period of data, which is also likely to be due to AGL's dominance of the whole period results compared to the greater degree of diversification (due to the larger number of companies) in the shorter period estimates.

Table 5.2

AUSTRALIAN ENERGY RELATED SECURITIES: MONTHLY BETA ESTIMATES SINCE THE END OF THE TECHNOLOGY BUBBLE (2002 TO 2007)

Stock	N	OLS			Re-weighted OLS			LAV		
		L	M	H	L	M	H	L	M	H
AGL	58	-0.10	**0.56**	1.22	-0.39	**0.18**	0.75	-0.48	**0.48**	1.43
ALN	61	-0.16	**0.81**	1.78	-0.01	**0.87**	1.75	-0.57	**0.57**	1.71
ENV	61	-0.16	**0.03**	0.23	-0.21	**-0.02**	0.17	-0.33	**-0.04**	0.24
APA	61	-0.01	**0.44**	1.00	-0.10	**0.42**	0.95	0.29	**0.90**	1.50
GAS	59	-0.01	**0.36**	0.73	-0.01	**0.29**	0.60	-0.04	**0.32**	0.68
DUE	29	0.00	**0.29**	0.57	0.00	**0.28**	0.56	-0.18	**0.25**	0.67
SPN	13	-0.61	**0.20**	1.01	-0.61	**0.20**	1.01	-1.63	**-0.48**	0.67
SKI	13	-1.27	**-0.21**	0.85	-1.27	**-0.21**	0.85	-1.38	**0.08**	1.55
HDF	25	-0.19	**0.57**	1.33	-0.13	**0.59**	1.32	-0.17	**0.73**	1.62
Mean first 5			**0.44**			**0.35**			**0.44**	
Portfolio Average	61	0.03	**0.30**	0.56	-0.05	**0.19**	0.44	-0.13	**0.31**	0.75
Portfolio Median	61	0.10	**0.36**	0.61	0.02	**0.24**	0.47	-0.14	**0.20**	0.53

Source: ACG estimates based on Bloomberg data Note: L denotes lower 95%CI, M denotes mean estimate and H denotes upper 95%CI, N denotes number of monthly observations.

The differential observed for the re-OLS methodology is consistent in that the average portfolio beta estimate is considerably lower at 0.19 (compared with 0.30 for OLS) and the median portfolio estimate of 0.24 is also considerably lower than the 0.36 estimate using OLS. For the LAV methodology, the median beta estimate of 0.20 is lower than for the portfolio average (0.30). The upper end of the 95 per cent confidence interval for the average portfolio estimates are in the range of 0.44 to 0.75 depending on the methodology.

At approximately 0.35 to 0.44, the average of the beta estimates of the first 5 securities for the last five years are generally higher than the portfolio beta estimates. The beta estimates for individual securities indicate that some are well below the average of their peers, while others are well above the average. We observe that the securities with beta estimates above their peers (Alinta, Australian Pipeline Trust and AGL) are also ones that have undertaken mergers or acquisitions or that have substantial non-regulated activities. The securities with below average beta estimates (i.e. Envestra and GasNet) have not been very active in mergers or acquisitions and have a relatively high percentage of their operations are regulated.

5.4 Application of Gray and Officer outlier methodology

In this section we provide, as a sensitivity, the results obtained using the methodologies employed by Gray and Officer. The two differences in method that Gray and Officer employed were to:

- Exclude outliers based on removal of observations that were more than a multiple of 2, 1.5 and 1 standard errors from the predicted value, rather than using the approaches we discussed in section 3.3; and
- Apply the Blume adjustment to the raw beta estimates, before adjusting for gearing.

In order to separate the effects of these two differences of approach, we have reported beta estimates applying these changes in sequence, that is, first applying the different treatment of outliers and then applying the adjustment.

Whole period data set

Table 5.3 shows the beta estimates that are obtained by applying the Gray and Officer outlier methodology to the 'whole period' data (excluding the technology bubble) used in the present study, but not including the Blume adjustment. We find that the range of beta estimates is quite similar to the range of results found when applying the re-weighted OLS and LAV methodologies to the same data. If anything, the beta estimates obtained using LAV are higher than the Gray and Officer methodology estimates and the re-OLS estimates. For the individual security estimates also, the ranges obtained using the Gray & Officer outliers methodology (without the Blume adjustment) are generally lower than the estimates using re-OLS or LAV.

Table 5.3

AUSTRALIAN ENERGY RELATED SECURITIES: FULL DATA MONTHLY BETA ESTIMATES FOR ENERGY RELATED SECURITIES EXCLUDING THE TECHNOLOGY BUBBLE, USING GRAY & OFFICER METHODOLOGY WITHOUT BLUME ADJUSTMENT (1991-1998 AND 2002-2007)

Stock	OLS:2SE			OLS:1.5SE			OLS:1SE		
	L	M	H	L	M	H	L	M	H
AGL	0.50	**0.66**	0.99	0.38	**0.69**	1.00	0.71	**0.99**	1.28
ALN	0.60	**1.00**	1.80	-0.12	**0.59**	1.29	0.19	**0.76**	1.33
ENV	0.03	**0.11**	0.28	-0.05	**0.09**	0.24	-0.02	**0.10**	0.22
APA	0.22	**0.47**	0.97	0.06	**0.53**	0.99	0.42	**0.78**	1.15
GAS	0.19	**0.33**	0.62	-0.06	**0.20**	0.46	0.08	**0.28**	0.49
DUE	0.10	**0.22**	0.47	-0.08	**0.13**	0.34	0.04	**0.21**	0.38
SPN	-0.21	**0.20**	1.01	-0.59	**0.15**	0.89	-0.96	**-0.33**	0.31
SKI	-0.74	**-0.21**	0.85	-0.99	**-0.18**	0.63	-1.96	**-0.71**	0.54
HDF	0.29	**0.63**	1.32	0.01	**0.63**	1.24	0.21	**0.63**	1.05
Average first 5		**0.52**			**0.42**			**0.58**	
Portfolio Average	0.49	**0.61**	0.85	0.31	**0.53**	0.75	0.43	**0.62**	0.81
Portfolio Median	0.51	**0.63**	0.87	0.39	**0.60**	0.81	0.46	**0.64**	0.82

Source: ACG estimates based on Bloomberg data Note: L denotes lower 95%CI, M denotes mean estimate and H denotes upper 95%CI, N denotes number of monthly observations.

Table 5.4 shows the results obtained when applying the full Gray and Officer methodology to the whole period data (excluding the technology bubble) and including the application of the Blume adjustment. The mean portfolio estimates are conisderably higher than without the Blume adjustment (Table 5.3). Another point to note is that Gray and Officer's practice of deleting observations narrows the confidence intervals compared with the application of the re-OLS or LAV methodologies.

Table 5.4

AUSTRALIAN ENERGY RELATED SECURITIES: FULL DATA MONTHLY BETA ESTIMATES EXCLUDING THE TECHNOLOGY BUBBLE USING GRAY & OFFICER METHODOLOGY INCLUDING BLUME ADJUSTMENT (1991-1998 AND 2005-2007)

Stock	OLS:2SE			OLS:1.5SE			OLS:1SE		
	L	M	H	L	M	H	L	M	H
AGL	0.87	**1.04**	1.37	0.74	**1.05**	1.36	0.97	**1.26**	1.55
ALN	0.89	**1.29**	2.09	0.31	**1.01**	1.71	0.56	**1.13**	1.70
ENV	0.23	**0.31**	0.48	0.15	**0.30**	0.45	0.18	**0.30**	0.42
APA	0.47	**0.73**	1.23	0.30	**0.76**	1.23	0.57	**0.94**	1.30
GAS	0.38	**0.52**	0.81	0.17	**0.43**	0.70	0.29	**0.49**	0.69
DUE	0.22	**0.35**	0.60	0.07	**0.28**	0.49	0.16	**0.33**	0.50
SPN	0.09	**0.49**	1.31	-0.28	**0.46**	1.20	-0.49	**0.14**	0.78
SKI	-0.35	**0.18**	1.24	-0.61	**0.20**	1.01	-1.40	**-0.16**	1.09
HDF	0.51	**0.85**	1.54	0.23	**0.85**	1.47	0.43	**0.85**	1.27
Average first 5		**0.78**			**0.71**			**0.82**	
Portfolio Average	0.78	**0.90**	1.14	0.63	**0.85**	1.07	0.72	**0.91**	1.10
Portfolio Median	0.80	**0.92**	1.15	0.69	**0.90**	1.11	0.74	**0.92**	1.10

Source: ACG estimates based on Bloomberg data Note: L denotes lower 95%CI, M denotes mean estimate and H denotes upper 95%CI, N denotes number of monthly observations.

Thus it can be concluded that there is little difference between the results ACG has obtained using the re-weighted OLS and LAV methodologies and the Officer and Gray methodology excluding the Blume adjustment, but a material difference arises as a result of Officer and Gray's use of the Blume adjustment. Hence, whether the Blume adjustment should be applied is material to how the empirical evidence on beta estimates should be interpreted.

Uniform portfolio since the end of the technology bubble

In this section we fist repeat the analysis undertaken in section 5.2 for a uniform portfolio consisting of AGL, Alinta, Envestra, Australian Pipeline Trust and GasNet (i.e. the First 5 group), for the period since the end of the technology bubble when all five were listed on the market. This period extended from January 2002 until October 2006, after which GasNet was delisted. We find in 0 that the mean beta estimates are very similar to the results obtained by using all data for all securities since the end of the technology bubble (Table 5.2 above). The highest mean estimate of 0.42 (upper end of the 95 per confidence interval of 0.74) is obtained under OLS, while Re-OLS produces the lowest mean of 0.18 (upper end of the 95 per cent confidence interval of 0.47).

Table 5.5

AUSTRALIAN ENERGY RELATED SECURITIES: MONTHLY BETA ESTIMATES SINCE THE END OF THE TECHNOLOGY BUBBLE (JANUARY 2002-OCTOBER 2006)

Stock	N	OLS			Re-weighted OLS			LAV		
		L	M	H	L	M	H	L	M	H
AGL	58	0.03	**0.67**	1.31	-0.29	**0.26**	0.81	-0.44	**0.50**	1.45
ALN	58	-0.59	**0.30**	1.20	-0.45	**0.34**	1.13	-0.86	**0.03**	0.92
ENV	58	-0.05	**0.18**	0.41	-0.31	**-0.09**	0.13	-0.49	**-0.13**	0.23
APA	58	-0.06	**0.51**	1.07	0.04	**0.53**	1.02	0.41	**0.88**	1.34
GAS	58	-0.07	**0.29**	0.66	-0.08	**0.20**	0.49	-0.05	**0.30**	0.66
Average			**0.39**			**0.25**			**0.33**	
Portfolio Average	58	0.00	**0.33**	0.67	-0.11	**0.18**	0.48	-0.18	**0.20**	0.57
Portfolio Median	58	0.10	**0.42**	0.74	-0.05	**0.20**	0.45	-0.07	**0.27**	0.61

Note: L denotes lower 95%CI, M denotes mean estimate and H denotes upper 95%CI, N denotes number of monthly observations.

Table 5.6 repeats the analysis above using the Gray and Officer 'outliers' methodology. The portfolio mean beta estimates are quite stable at 0.23 to 0.30 regardless of whether observations are removed under the 2, 1.5 or 1 SE criteria, with an upper end to the 95 per cent confidence interval of about 0.50.

Table 5.6

AUSTRALIAN ENERGY RELATED SECURITIES: GRAY & OFFICER METHODOLOGY EXCLUDING BLUME ADJUSTMENT (JANUARY 2002-OCTOBER 2006)

Stock	OLS:2SE			OLS:1.5SE			OLS:1SE		
	L	M	H	L	M	H	L	M	H
AGL	-0.30	**0.26**	0.81	-0.09	**0.41**	0.91	0.40	**0.82**	1.23
ALN	-0.37	**0.36**	1.09	-0.42	**0.25**	0.93	-0.29	**0.31**	0.91
ENV	-0.41	**-0.20**	0.02	-0.06	**0.14**	0.33	-0.05	**0.11**	0.28
APA	0.04	**0.50**	0.96	0.12	**0.57**	1.03	0.43	**0.76**	1.10
GAS	-0.09	**0.20**	0.48	-0.09	**0.19**	0.46	0.10	**0.30**	0.50
Average		**0.22**			**0.31**			**0.46**	
Portfolio Average	-0.04	**0.23**	0.50	0.00	**0.24**	0.49	0.09	**0.29**	0.49
Portfolio Median	0.02	**0.26**	0.50	0.03	**0.25**	0.48	0.13	**0.30**	0.48

Note: L denotes lower 95%CI, M denotes mean estimate and H denotes upper 95%CI, N denotes number of monthly observations.

In Table 5.7 we have applied the complete Gray and Officer methodology (including the Blume adjustment). The findings indicate a material increase in the mean portfolio beta estimates to approximately 0.60, and a corresponding upper limit to the 95 per cent confidence interval of 077 to 0.85.

Table 5.7

AUSTRALIAN ENERGY RELATED SECURITIES: GRAY & OFFICER METHODOLOGY INCLUDING BLUME ADJUSTMENT (JANUARY 2002-OCTOBER 2006)

Stock	OLS:2SE			OLS:1.5SE			OLS:1SE		
	L	M	H	L	M	H	L	M	H
AGL	0.24	**0.79**	1.35	0.39	**0.89**	1.39	0.93	**1.17**	1.40
ALN	-0.26	**0.47**	1.20	-0.28	**0.40**	1.08	0.07	**0.44**	0.80
ENV	0.26	**0.47**	0.68	0.50	**0.69**	0.89	0.44	**0.68**	0.92
APA	0.27	**0.74**	1.20	0.33	**0.79**	1.25	0.64	**0.92**	1.19
GAS	0.14	**0.43**	0.71	0.15	**0.42**	0.69	0.26	**0.50**	0.73
Average		**0.58**			**0.64**			**0.74**	
Portfolio Average	0.31	**0.58**	0.85	0.35	**0.59**	0.84	0.46	**0.62**	0.79
Portfolio Median	0.36	**0.60**	0.84	0.37	**0.60**	0.82	0.49	**0.63**	0.77

Source: ACG estimates based on Bloomberg data Note: L denotes lower 95%CI, M denotes mean estimate and H denotes upper 95%CI, N denotes number of monthly observations.

5.5 Australian weekly and daily data estimates

In this section we review evidence relating Australian weekly and daily data. We caution against placing excessive weight on these estimates (particularly those using daily data) given the potential for estimates using short term return intervals to be subject to certain biases.

The average portfolio mean estimates shown in Table 5.8 indicate betas are similar to the monthly estimates for the same period (mostly below 0.50). Owing to a larger number of observations, the confidence intervals generally narrower than for the monthly estimates. Alinta (ALN) is an exception, but its confidence interval narrows when the influence of outliers is mitigated through application of the LAV methodology. The difference between the OLS and LAV estimates is greatest for the average of the first 5 securities compared with the portfolio measures. It is noticeable that, in general, the mean beta estimates are slightly lower when outlier-adjusted methodologies are applied.

Table 5.8

AUSTRALIAN ENERGY RELATED SECURITIES: BETA ESTIMATES SINCE THE END OF THE TECHNOLOGY BUBBLE (2002 TO 2007) USING WEEKLY OBSERVATIONS

Stock	N	OLS			Re-weighted OLS			LAV		
		L	M	H	L	M	H	L	M	H
AGL	250	0.40	**0.74**	1.07	0.26	**0.57**	0.87	0.11	**0.53**	0.95
ALN	268	0.74	**1.20**	1.66	0.57	**0.92**	1.28	0.28	**0.69**	1.11
ENV	268	0.09	**0.20**	0.31	0.08	**0.18**	0.28	-0.33	**0.00**	0.33
APA	268	0.14	**0.44**	0.74	0.17	**0.41**	0.66	0.17	**0.44**	0.70
GAS	255	0.16	**0.34**	0.52	0.21	**0.36**	0.51	0.07	**0.25**	0.43
DUE	131	0.03	**0.24**	0.44	0.03	**0.18**	0.32	-0.08	**0.13**	0.35
SPN	61	-0.29	**0.07**	0.43	-0.28	**0.01**	0.30	-0.46	**0.00**	0.46
SKI	61	-0.11	**0.21**	0.53	-0.11	**0.20**	0.52	-0.30	**0.21**	0.71
HDF	113	0.08	**0.44**	0.79	0.02	**0.34**	0.65	0.03	**0.38**	0.73
Average first 5			**0.52**			**0.44**			**0.34**	
Portfolio Average	268	0.24	**0.36**	0.48	0.24	**0.35**	0.46	0.17	**0.32**	0.47
Portfolio Median	268	0.32	**0.44**	0.55	0.30	**0.41**	0.51	0.17	**0.34**	0.52

Source: ACG estimates based on Bloomberg data Note: L denotes lower 95%CI, M denotes mean estimate and H denotes upper 95%CI, N denotes number of monthly observations.

Relative to the monthly results, the use of just over 5 years of weekly data (268 weeks) reduces the mean beta estimates for AGL and Alinta, but has a smaller impact on the other securities. Using weekly data, none of the four more recently listed securities (DUE, SPN, SKI, HDF) has an upper 95 per cent confidence interval higher than 0.79. However, even less reliance should be placed on these estimates, as they are all based on less than 4 years of data.

The daily data mean beta estimates shown in Table 5.9 rely on up to 555 days of observations. The estimated betas are higher than the weekly, or monthly estimates, but the portfolio measures indicate a mean beta of less than 0.70, and an upper 95 per cent confidence interval of between 0.50 and 0.80. As for the weekly estimates, confidence intervals are narrower than for monthly estimates due to a much greater number of daily observations. The mean estimate is higher for the average of the first 5 securities at 0.91 for OLS and 0.73 for LAV. The two exceptions are AGL and Alinta, which have mean estimates above unity under all estimation methodologies.

Using daily data, HDF (Hastings Diversified Fund) has an upper 95 per cent confidence interval near unity, while for the other three recently listed securities the upper 95 per cent confidence interval is generally below 0.50. Despite the number of observations, these results should be viewed with extreme caution owing to the relatively short periods of data. However, as noted above, we would recommend being extremely cautious about placing weight on these estimates given the material potential for biases to affect the estimates.

Table 5.9

AUSTRALIAN ENERGY RELATED SECURITIES: BETA ESTIMATES FOR THE LAST TWO YEARS (2005 TO 2007) USING DAILY OBSERVATIONS

Stock	N	OLS			Re-weighted OLS			LAV		
		L	M	H	L	M	H	L	M	H
AGL	461	1.01	**1.27**	1.52	0.90	**1.12**	1.33	0.83	**1.07**	1.31
ALN	555	1.17	**1.48**	1.79	1.03	**1.29**	1.54	0.93	**1.23**	1.53
ENV	555	0.43	**0.53**	0.64	0.34	**0.43**	0.52	0.33	**0.42**	0.51
APA	555	0.68	**0.94**	1.20	0.51	**0.72**	0.92	0.59	**0.78**	0.98
GAS	478	0.18	**0.35**	0.52	0.24	**0.37**	0.50	0.10	**0.16**	0.23
DUE	442	0.23	**0.33**	0.42	0.24	**0.32**	0.40	0.25	**0.36**	0.47
SPN	299	-0.01	**0.13**	0.27	0.00	**0.11**	0.23	-0.48	**0.00**	0.48
SKI	299	0.22	**0.37**	0.53	0.10	**0.24**	0.37	0.05	**0.20**	0.36
HDF	555	0.72	**0.92**	1.11	0.63	**0.79**	0.96	0.61	**0.78**	0.96
Mean first 5			**0.91**			**0.78**			**0.73**	
Portfolio Average	555	0.53	**0.61**	0.69	0.51	**0.58**	0.65	0.49	**0.57**	0.65
Portfolio Median	555	0.61	**0.69**	0.77	0.59	**0.66**	0.74	0.59	**0.69**	0.78

Source: ACG estimates based on Bloomberg data Note: L denotes lower 95%CI, M denotes mean estimate and H denotes upper 95%CI, N denotes number of monthly observations.

5.6 UK data

National Grid plc is the only British company that is a suitable comparator for a benchmark gas transmission and distribution business. The beta estimates for National Grid are displayed in Table 5.10 below. Using monthly data the mean beta estimate for National Grid ranges from 0.28 with LAV, to 0.65 with OLS. Corresponding to these mean estimates, the upper 95 per cent confidence interval is highest under OLS (1.10) and lowest under the LAV methodology (0.91).

Table 5.10

UK (NATIONAL GRID PLC): SUMMARY OF MONTHLY PORTFOLIO DATA EXCLUDING THE TECHNOLOGY BUBBLE (1996-1998 AND 2002-2005)

Sample (N=92):	-95% CI	Mean Estimate	95% CI
UK (National Grid):			
OLS	0.20	0.65	1.10
Re-OLS	0.03	0.40	0.76
LAV	-0.34	0.28	0.91

Source: ACG estimates based on Bloomberg data

Beta estimates for National Grid for the period since the end of the technology bubble are shown in Table 5.11 below. It can be seen that the mean estimates of beta are significantly lower in the more recent period compared with the whole period. The highest mean estimate is 0.36 with OLS and the lowest is 0.14 applying LAV. This is consistent with the conclusions about the UK regulated energy utility sector drawn by the Smithers & Co. report undertaken for Ofgem. It is also consistent with the earlier findings of the present study with respect to the Australian data.

Table 5.11

UK (NATIONAL GRID PLC): SUMMARY OF MONTHLY PORTFOLIO DATA SINCE THE END OF THE TECHNOLOGY BUBBLE (2002-2005)

Sample (N=61):	-95% CI	Mean Estimate	95% CI
UK (National Grid):			
OLS	0.02	0.36	0.70
Re-OLS	-0.15	0.17	0.48
LAV	-0.45	0.14	0.73

Source: ACG estimates based on Bloomberg data

5.7 US data

The monthly data beta estimates using the whole period average and median portfolio returns data for US gas transmission and distribution companies are shown in Table 5.12. The confidence intervals for the US portfolio beta estimates are generally very narrow (much more so than for the Australian firms over the same period), with none of the portfolios of methods delivering an upper 95 per cent confidence interval limit beyond 0.76. This greater precision in beta estimates reflects the larger number of listed entities in the US (and the fact that all of those in our sample have been in existence over the whole period).

The monthly data median estimate applying OLS is 0.60, with an upper 95 per cent confidence interval of 0.76. Attenuating the influence of outliers, the mean estimate falls to approximately 0.50, with an upper 95 per cent confidence interval of 0.65. The mean estimates for the median portfolio are lower than for the average portfolio by approximately 5 points. The upper 95 per cent confidence interval ranges from 0.28 to 0.76 depending on methodology. The average beta of all securities is very close to the range of estimates obtained using the portfolios and the mean beta estimate ranges from 0.46 to 0.55.

Table 5.12

US GAS T&D SECURITIES: FULL DATA MONTHLY BETA ESTIMATES FOR EXCLUDING THE TECHNOLOGY BUBBLE (1990-1998 AND 2002-2007)

Stock	N	OLS			Re-weighted OLS			LAV		
		L	M	H	L	M	H	L	M	H
ATO	149	0.06	**0.49**	0.93	0.09	**0.43**	0.78	0.06	**0.38**	0.70
LG	149	0.12	**0.44**	0.75	0.22	**0.50**	0.78	-0.03	**0.43**	0.90
NWN	149	0.02	**0.34**	0.66	0.11	**0.39**	0.67	-0.11	**0.38**	0.88
WGL	149	0.34	**0.66**	0.98	0.39	**0.67**	0.94	0.38	**0.68**	0.97
ATG	149	0.323	**0.63**	0.93	0.34	**0.62**	0.90	0.26	**0.54**	0.82
GAS	149	0.70	**1.21**	1.73	0.34	**0.73**	1.12	0.15	**0.75**	1.36
PNY	149	0.23	**0.64**	1.06	0.31	**0.65**	0.99	0.02	**0.50**	0.99
SJI	149	0.07	**0.35**	0.64	0.16	**0.41**	0.66	-0.02	**0.36**	0.73
SWX	149	-0.12	**0.11**	0.35	-0.05	**0.14**	0.33	-0.15	**0.09**	0.33
Average	149		**0.55**			**0.50**			**0.46**	
Portfolio Average	149	0.44	**0.60**	0.76	0.37	**0.50**	0.63	0.32	**0.49**	0.65
Portfolio Median	149	0.38	**0.54**	0.71	0.33	**0.48**	0.62	0.28	**0.44**	0.61

Source: ACG estimates based on Bloomberg data Note: L denotes lower 95%CI, M denotes mean estimate and H denotes upper 95%CI, N denotes number of monthly observations.

Table 5.13 displays the US data results for the most recent 5 year period since the end of the technology bubble period. The data indicate a higher level of portfolio betas (ranging from 0.53 to 0.76). However, the average of all securities is relatively similar (ranging from 0.47 to 0.58). The main difference is that in the most recent period, the confidence interval has widened. The upper 95 per cent confidence interval in the most recent period ranges from 0.83 (re-OLS, portfolio median) to 1.12 (LAV portfolio median). The US company that stands out from the others is Nicor (GAS), whose beta (and CI range) has increased significantly in the more recent period.

Table 5.13

US GAS T&D SECURITIES: MONTHLY BETA ESTIMATES SINCE THE END OF THE TECHNOLOGY BUBBLE (2002-2007)

Stock	N	OLS			Re-weighted OLS			LAV		
		L	M	H	L	M	H	L	M	H
ATO	61	0.24	**0.56**	0.88	0.21	**0.52**	0.83	-0.01	**0.43**	0.87
LG	61	0.24	**0.63**	1.02	0.22	**0.58**	0.95	0.04	**0.62**	1.20
NWN	61	-0.26	**0.18**	0.62	0.01	**0.37**	0.74	-0.21	**0.39**	0.99
WGL	61	0.04	**0.42**	0.80	0.06	**0.4**	0.75	-0.01	**0.61**	1.23
ATG	61	0.19	**0.52**	0.86	0.23	**0.52**	0.81	0.20	**0.52**	0.85
GAS	61	0.72	**1.70**	2.68	0.09	**0.72**	1.36	0.05	**0.98**	1.92
PNY	61	0.09	**0.54**	0.99	0.03	**0.46**	0.88	-0.12	**0.49**	1.10
SJI	61	0.05	**0.44**	0.83	0.25	**0.61**	0.97	0.12	**0.75**	1.38
SWX	61	-0.02	**0.25**	0.53	-0.18	**0.07**	0.31	-0.15	**0.19**	0.54
Average	61		**0.58**			**0.47**			**0.55**	
Portfolio Average	61	0.49	**0.76**	0.88	0.40	**0.65**	0.89	0.34	**0.67**	0.81
Portfolio Median	61	0.38	**0.63**	1.02	0.37	**0.60**	0.83	0.26	**0.53**	1.12

Source: ACG estimates based on Bloomberg data Note: L denotes lower 95%CI, M denotes mean estimate and H denotes upper 95%CI, N denotes number of monthly observations.

5.8 Summary

We advise that it is preferable to place most reliance on beta estimates from Australian firms. The beta estimation results for Australian firms reported in this chapter can be summarised as follows:

- Using monthly data for the whole period (1991-1998 and 2002-2007) we find that the portfolio beta estimates are in the range of 0.59 to 0.71, with upper 95 per cent confidence intervals in the range of 0.83 to 1.17, with both ranges depending on the estimation methodology employed (OLS, re-OLS or LAV).
- Using monthly data for the most recent 5 year period, the range of the portfolio beta estimates is lower at 0.19 to 0.36 with the upper end of the 95 per cent confidence intervals in the range of 0.44 to 0.75, with both ranges depending on the estimation methodology employed (OLS, re-OLS or LAV).
- Applying the Gray and Officer outlier elimination methodology to the portfolio data for the whole period (but not applying the Blume adjustment) leads to materially similar beta estimates to those obtained using our preferred method for addressing outliers, with a range of betas for the portfolio estimates of 0.53 to 0.64 and an upper end of the 95 per cent confidence interval range of between 0.75 and 0.87.
- When the Blume adjustment is applied together with the Gray and Officer outlier methodology (i.e. the full Gray and Officer methodology) the range for the beta estimates for the portfolios is materially higher at 0.85 to 0.92, with the upper end of the 95 per cent confidence interval in the range of 1.07 to 1.14.
  - However, the beta estimates that we obtained using the Gray and Officer method were not nearly as high as those reported by Gray and Officer, with

none of our estimates being above unity and with the results much less sensitive to the degree of restrictiveness of the definition of an outlier.

- Portfolios comprising the first 5 securities with monthly data from January 2002 to October 2006 were found to corroborate the results found when using all data (for 9 securities) in the period since the end of the bubble in technology stocks. However, again the application of the Blume adjustment generated materially higher beta estimates.

- There is a wide divergence in beta estimates for individual securities, with those more active in acquisition and merger transactions and/or substantial non-regulated activities (AGL, ALN and APA) tending to have beta estimates above those of the portfolio betas. Those securities with less acquisition and merger activity and engaged more heavily in purely regulated activities (Envestra and GasNet) had below average mean beta estimates.

- Beta estimates using weekly observations over the last 5 years produces portfolio estimates that are slightly higher than with monthly observations (0.32 to 0.44), however the upper 95% confidence intervals are lower (0.46 to 0.55) owing to the much larger number of observations. Beta estimates using daily observations over a much shorter period (approximately two years) are higher still. However, we caution against placing substantial weight on weekly and, in particular, daily beta estimates, given the potential for bias in these estimates.

International data

The estimates based on international data are summarised as follows:

- For the UK, whole period monthly observations for National Grid plc (the only appropriate comparator) show a beta estimate range of 0.28 to 0.65, with a range for the corresponding upper end of the 95 per cent confidence interval of 0.76 to 1.10 depending on the methodology employed. In the more recent period since the end of the technology bubble, the range of beta estimates across the different methods has fallen to approximately half the previous level (0.14 to 0.36) and the upper end of the 95 per cent confidence interval has fallen to a range of 0.48 to 0.73 across the range of methods. We note, however, that as we have only obtained a beta estimate for one UK firm, it is difficult to place any material weight on beta estimates from this market.

- For the US the data the portfolio beta estimates for the whole period are in the range of 0.53 to 0.64 across the methods, with a corresponding range for the upper limit of the 95 per cent confidence interval of 0.61 to 0.76. In contrast to the Australian and UK experience, the latest 5 year period has seen an increase in the US mean estimates to a range of 0.53 to 0.76, and an increase in the corresponding range for the upper limit to the 95 per cent confidence interval of 0.81 to 1.12 across the methods.

As noted above, we consider it preferable to place the greatest reliance on Australian data, albeit with regard also had to beta estimates for overseas firms (i.e. US firms). This would argue for placing the greatest weight on the beta estimates for Australian firms measured over the longest period. However, a problem with the full period data is the relatively heavy weighting of two securities (AGL and Envestra). Accordingly, reliance should also be placed upon beta estimates for the period since the end of the technology stock bubble given the greater number of firms that were in existence during this period. For US firms, we would recommend placing the greatest weight on the results using data over the whole period. In all cases, whether or not the Blume adjustment is applied has a material effect on how the data are interpreted, and our view is that this adjustment should not be applied.

Appendix A

A.1 Description of sample securities

In this appendix we provide a general description of the sample of securities that have been selected as comparators for a benchmark gas distribution business.

A.2 Australian Gas Light (AGL)

Traditionally Australian Gas Light Company Limited (AGL) sold and distributed gas and electricity various networks along with the operation of natural gas transmission pipelines. In 2000 it spun off the Australian Pipeline Trust (APT) as a stand-alone pipeline operating company. The company also extracted and sold LPG, provided power generation and energy infrastructure, invested in energy and telecommunications businesses and was involved in property rentals.

Table A.1

EBIT ESTIMATES FOR OPERATIONS OF AGL LIMITED: 2004 AND 2005

Activity/business	FY2004	FY2005
Networks:		
Gas networks	23%	24.0%
Electricity networks	9.8%	10.7%
APT	2.0%	2.3%
Actew AGL	7.1%	7.9%
Network management:		
Agility	7.8%	9.2%
Retail related:		
Retail	30.7%	31.6%
Generation	3.0%	3.2%
LPG	2.1%	2.9%
Corporate:	-4.5%	-3.6%
Other Investments:		
NGC	18.1%	10.6%
Chile	0.9%	0.0%
Property	0.1%	0.8%
Telecom	-0.1%	0.4%

Source: CSFB (25 February, 2005) *Australian Gas Light*, CSFB Research, p.5

On 31 October 2005, AGL announced its de-merger proposal under which two separate companies would be formed:

- AGL Energy (ProForma FY05 EBITDA $342 million) would hold the electricity generation and retailing assets, Sydney Gas, LPG, the PNG Gas Project and gas retailing.
- AGL Infrastructure (ProForma FY05 EBITDA $439), which would hold the gas transmission assets (30% of APA) the gas and electricity assets of ActewAGL, the gas distribution assets in Chile (GasValpo) and the contracted electricity generation (Wattle Point Wind Farm).

Alinta/AGL Transaction

The AGL demerger plan was not implemented in the manner envisaged, as Alinta put forward its own proposed merger, which was subsequently modified to a merger/demerger under which Alinta:

- Purchased AGL's network assets
- Purchased 26% of Australian Pipeline Trust
- Sold 33% of its Western Australian retail business to AGL (which became part of AGL Energy)
- Cancelled the 19.9% interest that it owned in AGL

Gearing: In August 2006, UBS estimated that AGL's 5 year average gearing (Net Debt /Enterprise Value) was 26.3%.[49]

A.3 Alinta (ALN and AAN)

Pre-AGL transaction (i.e. pre 26 October, 2006) (ALN)

Alinta Limited listed on 17 October 2000 as the leading gas distributor/retailer in Western Australia (owned 74% of Alinta Gas Networks). The distribution system delivered natural gas to around 60% of WA households through a network of 10,500 km of pipes. The retailing business sold gas to around 485,000 customers. During 2003-2005 Alinta acquired stakes in Multinet (20%) and United Energy Distribution (34%) in Victoria as well as contracts to operate and manege those assets. In April 2004 it acquired the assets of Duke Australia, which included 3 gas pipelines and 4 power stations in New Zealand and Australia. In 2005, Alinta began construction of a co-generation plant with Alcoa.

In October 2005 Alinta spun off the Duke Australia assets into Alinta Infrastructure Holdings (AIH), while it retained the O&M management and investment manager contracts.

The table below displays the breakdown of Alinta's operations in terms of contribution to EBITDA during the financial years 2004 and 2005. Alinta positioned itself as a "growth utility". Given its retailing and generation activities, it was viewed by the market as a blend of an integrated utility like AGL and transmission and distribution (T&D) utilities such as Envestra, Australian Pipeline Trust and GasNet. The UBS Utilities Index classed it among the 'integrated utilities'

[49] Craig Stafford David Leitch and Anthony Rohrlach (29 August, 2006), "Scheme booklet confirms guidance. We expect it to be improved", *The Australian Gas Light Company, UBS Investment Research,* p.8).

Alinta/AGL Transaction

The basic outline of the Alinta/AGL transaction are set out above in the section on AGL.

Table A.2

ALINTA: BREAKDOWN OF EBITDA, FY 2004 AND 2005

	FY2004 $m	%	FY2005 $m	%
Energy retail	50.2	15.8%	61.5	17.9%
Energy wholesale	0.9	0.3%	-12.1	-3.5%
Wesfarmers LPG	30.2	9.5%	31.2	9.1%
Energy distribution	85.4	26.9%	93.1	27.1%
Asset management	43.3	13.6%	63.4	18.4%
Power generation	0	0.0%	-2.8	-0.8%
Energy investments	17.6	5.5%	16.3	4.7%
Duke assets sold to AIH (20% retained by ALN)	105.9	33.3%	115.7	33.6%
Other/eliminations	-15.8		-22.3	
Total	317.7		344.0	

Source: Craig Stafford, Alex Unsworth and Scott Kelly (23 February, 2006), "FY05 result ahead of expectations. Overshadowed by bigger things", *Alinta Limited, UBS Investment Research*, p.2.

Post-AGL transaction (i.e. post 26 October, 2006) (AAN)

Following the AGL transaction, Alinta is engaged in amalgamating operations, and reported its activities as comprising:

Energy markets:

- WA Retail (Alinta owns 67% of AlintaAGL JV)
- Wholesale
- Wesfarmers LPG

Power Generation:

- Alcoa Cogeneration (Alinta owns 67% of AlintaAGL JV)
- Cawse Cogeneration and Wattle Point Wind Farm
- Tamar Valley Power Station

Energy Distribution:

- AlintaGas Networks
- NSW Gas Distribution and Victorian Electricity Distribution

Energy Investments:

- 19.9% stake in AGL up to 26 October 2006
- AIH (taken over after offer announced in November 2006)
- Multinet and United Energy
- Dampier Bunbury natural gas Pipeline
- 50% interest in ActewAGL through AGL transaction
- 26% interest in Australian Pipeline Trust through AGL transaction and 10.25% additionally

Alinta Asset Management (AAM)

- AAM formed in April 2006 following merger of Alinta Network Services (ANS) and National Power Services (NPS)
- October 2006 acquired Agility asset management business through AGL transaction

A.4 Australian Pipeline Trust (APA)

The Australian Pipeline Trust (APA) was spun off from AGL in 2000. As can be seen in the statement of asset holdings set out in Table A.3 below, APA has interests in a portfolio of high pressure gas transmission pipelines in Australia covering four states and two territories which transport natural gas. As at September 2006 the major shareholders in APA were AGL (26% but transferring to Alinta) and Petronas at 13.5%. APA has no external portfolio management. Revenue by pipeline at June 2006 is shown below.

Table A.3

AUSTRALIAN PIPELINE TRUST: REVENUE BY PIPELINE, JUNE 2006

	%	$m revenues
Moomba to Sydney, NSW	28%	79
Central West, NSW (MSP to Dubbo etc.)	2%	5
Total MSP system	30%	83
Roma to Brisbane, Qld	11%	32
Carpentaria (Ballera to Mt Isa)	14%	39
Amadeus, NT (Alice Springs to Darwin)	8%	24
Midwest, WA	0%	1
Parmelia, WA	7%	18
Goldfields, WA (82.2% consolidated)	30%	86
Total Revenue		283
Less pass-through revenue		(89)
Net revenue from pipelines		193

Source: UBS estimates, Alex Unsworth, Anthony Rohrlach and David Leitch (17 August, 2006), *Australian Pipeline Trust*, UBS Investment Research, p.2.

During 2006 APA was a very active participant in the shakeout of the Australian energy sector. Its major acquisitions were:

- Murraylink – In March 2006, APA paid $156.5 million for the Murraylink electricity interconnector between South Australia and Victoria.
- Allgas – In October 2006, APA bought Allgas in South East Queensland for $550 million at 19x regulated 2007 EBITDA and a RAB multiple of 1.74x, which was considered expensive by market observers.
- DirectLink – In December 2006, APA acquired DirectLink, paying a 1.44x RAB multiple and a 15.3x EBITDA multiple, which was also considered to be at the top end of comparable transactions.

Another impact on the APA share price in the last year was the upside growth potential of its 20% option over the PNG pipeline.

Table A.4

AUSTRALIAN PIPELINE TRUST 2007: ASSETS

Asset	Length (kms)	APA ownership (%)
Moomba to Sydney	2,029	100
Central West Pipeline	255	100
Roma to Brisbane Pipeline System (including Peat lateral)	851 (972)	100
Kogan North gas processing facility	-	100
Allgas gas distribution network	2,398	100
Carpentaria Gas Pipeline	840	100
Canning Lateral	98	100
Mt Isa Lateral and Meter Station	6	100
Amadeus Basin to Darwin Pipeline System (including Darwin distribution system)	1,681	96
Mataranka Lateral	11	100
Yimuyn Manjerr Lateral	10	100
Port Hedland to Telfer Lateral	443	97
Nifty Lateral	45	97
Goldfields Gas Transmission Pipeline Laterals	74	100
Midwest Gas Pipeline	353	50
Westlime Lateral	16	100
Mondara gas storage facility	-	100
Parmelia Gas Pipeline	445	100
Murraylink Transmission System	180	100
GasNet Victorian gas network	1,930	97
LNG facility	-	97

Source: Australian Pipeline Trust

APA has also been subject to considerable takeover speculation over the past year or more given the AGL (now Alinta) and Petronas holdings. The AGL demerger proposal was seen as the first threat. Now Alinta is seen as the most likely bidder. APA is currently trading at high multiples and low yields, and it is expected that the price could be re-rated downwards if the threat of an Alinta takeover were to recede.

A.5 Diversified Utility & Energy Trust (DUET)

DUET is a stapled investment fund that has a mandate to invest in energy and utility investments in developed countries. The current spread of operations is shown in the table below. DUET recently took up a 27% interest in the US transmission utility Duquesne Light. AMP and Macquarie Bank are the external investment managers, while Alinta is the operations and maintenance manager. AMP owns 30% of DUET and Macquarie Bank owns 7%.

Table A.5

DUET - DESCRIPTION OF OPERATIONS

Asset	Description	DUET Ownership	When purchased
United Energy Distribution	Electricity distribution in Victoria	66% equity 100% sub-debt	Seed asset
Multinet	Gas distribution	79.9% equity, 100% sub-debt	Seed asset
Alinta Gas Networks	Gas distribution	25.9% equity, 100% sub debt	Seed asset
Dampier-Bunbury Natural Gas Pipeline	Gas transmission	60% (currently 87.6% economic interest reducing as Alinta/Alcoa 20%/20% pay up partly paids), 100% sub debt	October 2004

Source: UBS, Diversified Utility & Energy Trusts, 11 January, 2007 Note: DUET is currently negotiating the purchase of Duquesne Light, a US electric company located in Pennsylvania.

A.6 Envestra

Envestra Limited operates natural gas distribution networks and transmission pipelines in South Australia, Victoria, Queensland, New South Wales and the Northern Territory. The Company's networks distribute gas to households and businesses in Adelaide, Brisbane (north of the Brisbane River), Alice Springs and various regional centres in South Australia and Queensland.

A.7 Hastings Diversified Utilities Fund (HDF)

Hastings Diversified Utilities Fund was listed in December 2004. It is an investment fund that pursues utility infrastructure assets, including gas and electricity transmission/distribution and electricity generation (regulated and unregulated) in OECD countries. HDF is managed by Hastings Fund Management (100% owned by Westpac). The initial assets at listing were the Epic Energy gas transmission pipelines:

- Moomba to Adelaide Pipeline System (MAPS);
- South West Queensland Pipeline (SWQP);
- Pilbara Pipeline System (PPS);

In February 2005, HDF bought 50% of Mid Kent Water, a UK water-only company.

In October 2006, HDF acquired 43% of South East Water in the UK on a 9.1x FY06 EV/EBITDA multiple, and a 1.27x FY06e RAB multiple

Market analysts indicate upside to HDF from the potential North Gas Link project that would link HDF's SWQP and MAPS pipelines and provide new haulage contracts. On the other hand, there is a possibility the UK Commerce Commission could order HDF to divest one of their two water utilities, and OFWAT has indicated that it thinks regulated returns for UK water assets are too high.[50]

A.8 GasNet (GAS)

GasNet owned and operated more than 1,900 kilometres of gas transmission assets in Victoria. Around 80% of GasNet's revenues were regulated by the ACCC. It owned the 450 kilometre Telfer pipeline from Port Hedland to the Telfer gold mine in Western Australia. GasNet also engaged in bidding (together with McConnell Dowell and Adecco) for the Trans-Territory Pipeline in the Northern Territory.

During 2004 GasNet was unsuccessful in its bids for the Epic Rest and Duke assets.

In November 2004 Babcock and Brown took up a 7.6% interest in GasNet, up to that point GasNet had no cornerstone investors. It was relatively unique among its peers as it had no external management of its operations and management. Market sources believed that for some months previously, GasNet shares had been pricing in the probability of a takeover bid.[51] Historically GasNet shares traded at the highest yield among its peers (9.5%), but this fell to 8% after takeover speculation and its own announcement to the market that it would engage in aggressive acquisition.

[50] Anthony Rohrlach, Andrew Woolley and David Leitch (23 February, 2007), *Hastings Diversified Utilities Fund*, UBS Research, p.1.

[51] Alex Unsworth, Craig Stafford and David Fraser (22 November, 2004), *GasNet Australia Trust*, UBS Investment Research, p.2.

A.9 SP AusNet

SP AusNet owns three utility networks in Victoria, 1) electrticity transmission, 2) electricity distribution, and 3) gas distribution. SP AusNet was spun off by Singapore Power, which has retained 51% (and executive staff) and is the investment manger under a base and performance fee arrangement that is capped at 75 basis points. SP AusNet listed on 14 December 2005. It owns:

- one of the three major Victorian gas distribution networks
- one of the five Victorian electricity distribution networks; and,
- the primary Victorian electricity transmission network.

UBS estimates that in the 2007 financial year, regulated revenues will account for 87% of SP AusNet's total revenues.[52] UBS estimated revenue breakdowns by activity are: electricity transmission (43%), electricity distribution (37%), and gas distribution (20%). UBS attributes a 55% 'see through' gearing to the SP AusNet business.

A.10 Spark Infrastructure

Spark Infrastructure was listed in December of 2005 when it was spun off from CKI, and invests in three electricity distribution assets in Victoria and South Australia. The major strategic shareholder is Singapore Power with 9.9% and Deutsche Bank with 9.6%. The key assets are:

- Powercor, an electricity distributor in Victoria
- Citipower, an electricity distributor in Victoria
- ETSA Utilities, an electricity distribution business in South Australia

[52] Alex Unsworth, Craig Stafford and Scott Kelly (31 January, 2006), *SP AusNet*, UBS Research.

Appendix B

Corporate Gearing

Table B.1

CORPORATE GEARING ASSUMPTIONS – FOR LONGEST DATA PERIOD AVAILABLE

Stock	Assumed gearing	Source:
AGL	28.0%	Bloomberg data
ALN	25%	Bloomberg data
ENV	70%	Bloomberg data
APA	50.3%	Bloomberg data
GAS	63.7%	Bloomberg data
DUE	76.2%	UBS
SPN	56.2%	UBS
SKI	61.0%	UBS
HDF	48.0%	UBS
Australian portfolio	40.0%	Bloomberg data
NG	41.7%	Bloomberg data
ATO	41.6%	Bloomberg data
LG	40.5%	Bloomberg data
NWN	40.9%	Bloomberg data
WGL	33.3%	Bloomberg data
ATG	40.5%	Bloomberg data
GAS	30.3%	Bloomberg data
PNY	34.1%	Bloomberg data
SJI	45.6%	Bloomberg data
SWX	70.3%	Bloomberg data
US portfolio	45.7%	Bloomberg data

Source: Bloomberg and UBS

Table B.2

US: MONTHLY BETA ESTIMATES SINCE TECHNOLOGY BUBBLE (2002-2007)

US/UK Stock	Bloomberg Ticker	Australian stock	Bloomberg Ticker
National Grid	NG	AGL	AGL
Atmos Energy	ATO	Alinta	ALN
Laclede Group	LG	Envestra	ENV
North West Natural gas	NWN	Australian Pipeline Trust	APA
WGL Hldgs	WGL	GasNet	GAS
AGL Resources	ATG	DUET	DUE
NICOR Inc	GAS	SP Ausnet	SPN
Piedmont Nat. Gas	PNY	Spark Infrastructure	SKI
South Jersey Ind.	SJI	Hastings Funds Management	HDF
Southwest Gas	SWX		

Source: Bloomberg