EVALUATION OF THE ACCC'S PROPOSED APPROACH TO STATISTICAL ESTIMATION OF EQUITY BETAS FOR TNSPS

A Report for TransGrid

Prepared by NERA

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1 INTRODUCTION

TransGrid, on behalf of other transmission network owners, has asked NERA to comment on the Australian Competition and Consumer Commission's (ACCC's) preferred position on estimating the equity beta for Transmission Network Service Providers (TNSPs) as outlined in its recent *Review of the Draft Statement of Regulatory Principles Discussion Paper*. TransGrid has asked NERA's view on the relative merits of the ACCC's preferred approach in the context of the regulatory framework and good regulatory practice. TransGrid has also asked NERA to assess the practical difficulties in codifying the 'ACCC's preferred position' in order to ensure that a common understanding exists of how this position would be implemented.

The remainder of this report is set out as below. We attempt to keep the first three sections as factual as possible with the last section providing a summary of NERA's assessment of the merits of the ACCC's approach.

- Section 2 outlines the ACCC's preferred approach and examines the statistical procedures used in arriving at the empirical estimates reported in the ACCC's discussion paper;

- Section 3 examines the difficulties that would be encountered if the ACCC's preferred approach were to be implemented. This section also addresses the difficulties that would exist in codifying the approach in a manner that provides an adequate level of certainty as to what the ACCC's preferred approach would mean in practice;

- Section 4, examines the a priori view expressed by the ACCC that the equity beta for TNSPs should be less than one;

- Section 5 provides a summary of NERA's views on the relative merits of pursuing the ACCC's preferred approach; and

- Attachments A and B provide further support for arguments advanced in the body of the report.

2 THE ACCC's PREFERED POSITION

2.1 The ACCC's Preferred Position at a Conceptual Level

The ACCC outlines a range of issues relating to determining the appropriate equity beta for TNSPs in section 8.7 of its Discussion Paper. In that section the ACCC states that its current approach of providing an equity beta of 1 is, in its view, likely to be conservative and that there are good reasons to believe that the true equity beta for TNSPs is below 1. In this regard the ACCC notes that:

> *"An β_e of less than one intuitively seems more appropriate for regulated electricity networks in Australia given the level of market risk which they face. These firms are regulated entities guaranteed a revenue stream and the demand for its essential services is inelastic."* Page 76.

In support of this position the ACCC references a report from the Allens Consulting Group that:

> *"… suggested an βe for Australian gas transmission companies of just below 0.7 based exclusively on market evidence, with the corresponding figures for the US, UK and Canada all below 0.2.52 The report advised that caution should be taken with the data from overseas, as equity returns were compared with markets outside Australia, subject to different tax and regulatory regimes. The paper's results provide supporting evidence for the notion that the βe for Australian utilities is overstated at a value of one."* Page 76

The ACCC then goes on to perform its own statistical analysis using estimates of the beta values for 'comparable' Australian companies. This analysis appears to support the view that the equity beta for regulated businesses is likely to be lower than 1. However, the ACCC notes that their sample of comparable businesses is small and that, in this context, it may be appropriate 'build in' a confidence interval based on the sample data.

> *"According to Davis, the size of the comparator firms trading in the Australian market does not seem sufficient to currently justify its use as the sole input for beta estimation. It is however a relevant source of information about beta values which should not be ignored. To the extent that sample market data indicate a substantial reduction from the typically assumed βe of one, the Commission is conscious that a transitional/cautious approach may be required such that the Commission take a conservative view to adopting a market based proxy βe.*
>
> *"One approach is to construct a statistical upper confidence interval based on the sample data. Table 5.2 provides an example of calculating a t-student distribution for upper 95% and 99 % confidence betas."* Page 78.

This is essentially the ACCC's preferred position as confirmed by the ACCC in its concluding statement:

> *"The Commission's initial view is to move towards benchmarking an equity beta from current market evidence and incorporating an upper confidence interval."* Page 81

The ACCC does not directly discuss detailed implementation of this preferred position presumably with a view that later rounds of consultation would address such issues (eg, the process for determining comparable firms etc). We address these issues in Section 3 of this report. However, the ACCC does provide some insight into its thinking on these issues in the empirical work it provides to illustrate how its approach may work. This empirical work is summarised in table 5.2 of the Discussion Paper which is reproduced in full below.

Table 1: ACCC Discussion Paper, Table 5.2 Upper 95 % and 99 % confidence betas

		June 02 AGSM data	Sept 02 AGSM data	Dec 02 AGSM data
Core Sample	Re-levered average β_e	0.30	0.17	0.19
	Standard deviation	0.1103	0.0583	0.0890
	Number in sample	5	5	5
	95 % $t_{(\alpha/2)}$	2.776	2.776	2.776
	95 % confidence β_e	**0.44**	**0.24**	**0.30**
	99 % $t_{(\alpha/2)}$	4.604	4.604	4.604
	99 % confidence β_e	**0.53**	**0.29**	**0.37**
Combined Sample (core and additional firms)	Re-levered average β_e	0.51	0.36	0.33
	Standard deviation	0.4140	0.3078	0.2548
	Number in sample	9	9	9
	95 % $t_{(\alpha/2)}$	2.306	2.306	2.306
	95 % confidence β_e	**0.83**	**0.60**	**0.53**
	99 % $t_{(\alpha/2)}$	3.355	3.355	3.355
	99 % confidence β_e	**0.97**	**0.70**	**0.61**

The ACCC's 'core sample' consists of 5 firms with significant regulated revenues (Australian Pipeline Trust, Envestra, Alinta Gas, Australian Gas Light and UnitedEnergy) while the 'combined sample' includes additional firms that are considered to be 'less comparable' but still 'comparable' (Transurban, Macquarie Infrastructure, Auckland International Airport, Hills Motorway Group).

The ACCC considers that this analysis supports their view that the appropriate equity beta for TNSPs is less than 1 because not only are the mean estimates of the equity beta below 0.52 in all periods and for both groups but so are the 99% confidence equity beta estimates below 1 for both samples and in both periods.

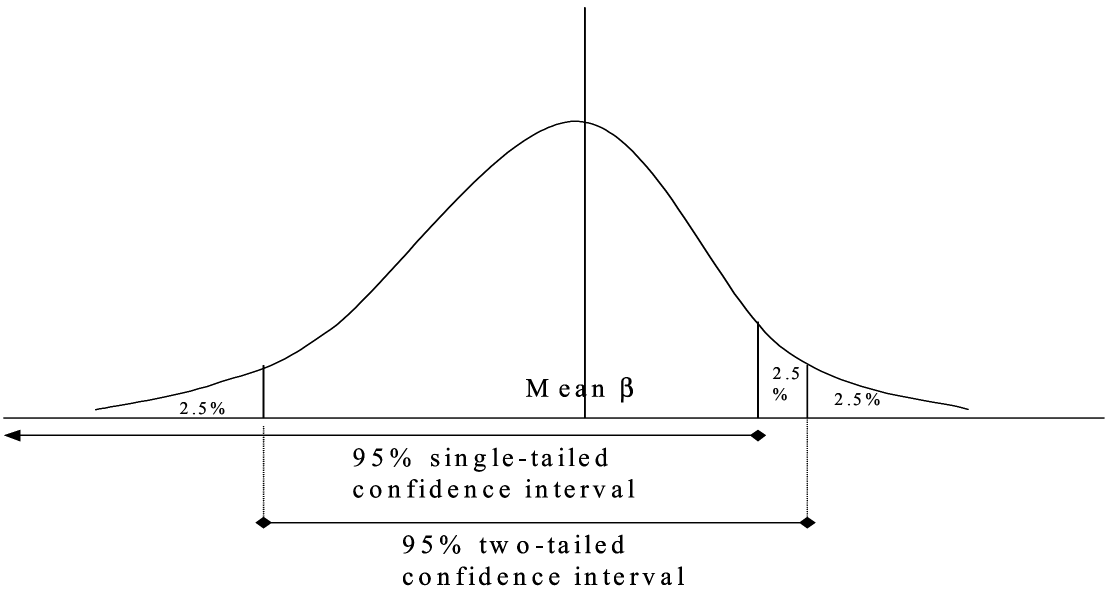
2.2 The ACCC's Practical Estimation of an Upper Bound βe

There appears to be two statistical errors in the ACCC's calculation of the upper bound estimate of the βe under different confidence levels. The first of these arises from the fact that the ACCC has used a two-tailed confidence interval to establish a single-tailed upper bound probability. Calculating a one-tailed upper bound estimate tends to reduce the upper bound on the βe relative to the ACCC's estimates. The second error arises from the fact that the ACCC has reported an upper bound estimate of the *population mean for comparable firms* rather than the upper bound estimate of the βe for *an individual firm* (such as an individual TNSP). Calculating an upper bound estimate for TNSP's βe tends to increase the βe above the ACCC estimates.

2.2.1 Calculating one-tailed confidence for the upper bound

In calculating the relevant 95% upper bound estimates of βe the ACCC assumes that the relevant statistic is distributed according to a student-t distribution. The ACCC then adopts the 'critical value of t' such that the probability that the true value of is either above the upper bound or below an analogous lower bound is only 5%. However, in setting a 95% confidence upper bound we are interested in establishing the value of the statistic where there is only a 5% probability that the true value is above that level. Consistent with this definition of an upper bound the ACCC's 95% confidence β_e is, in reality, a 97.5% confidence upper bound. This is because there is only a 2.5% probability that the statistic's true value is above this level. (Of course, there is also a 2.5% probability that the true value of βe is below an analogous lower bound.)

This can be explained graphically. **Graph 1**



The ACCC's estimate of the 95% confidence upper bound on βe involves setting a value that ensures that there is only a 2.5% probability that the true value of βe is outside a range around the sample mean estimate. The 'correct' 95% confidence upper bound on βe involves setting a value for the statistic that ensures there is only a 5% probability that the true value is above this level. Consequently, the correct 95% confidence upper bound is less than the ACCC estimate.

In terms of the actual calculations, the ACCC's "core" and "combined" samples have degrees of freedom of 4 and 8 respectively. Using this information to determine the critical t values and the associated upper bound estimates we have the following correct equations for the upper bound:

confidence upper bound βe	=	Sample mean βe + $t_{(\alpha)}$ *Standard deviation of statistic	(1)
95% confidence upper bound βe for core sample	=	Sample mean βe + 2.132*Standard deviation of statistic	(2)
95% confidence upper bound βe for combined sample	=	Sample mean βe + 1.860*Standard deviation of statistic	(3)

By contrast, instead of using critical t values of 2.132 and 1.860, the ACCC has used critical t values of 2.776 and 2.306 (see Table 5.2 of the discussion paper reproduced above).

2.2.2 Calculating the upper bound for TNSPs

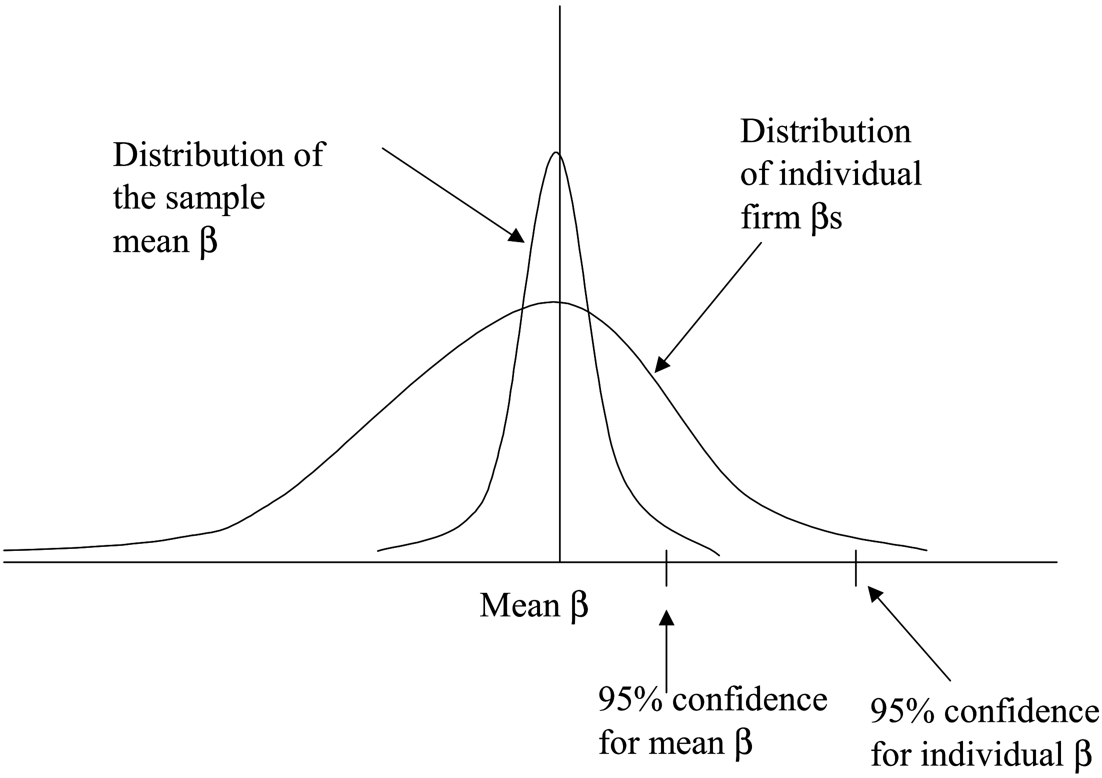
A further error in the calculations in Table 5.2 of the discussion paper is that rather than calculating the upper bound estimate for *an individual TNSP's equity beta*, they have calculated the upper bound estimate for *the mean of the population of all comparables*. That is, when the ACCC states a 95% confidence upper bound estimate of the equity beta what it is really saying is that it is 95% confident that *the mean of all comparable firms' equity beta* is below that level.

The impact of this is illustrated graphically below. Assume that a sample of comparable firms' equity betas are estimated and that a sample mean is calculated. The 'wide' distribution in the graphic below is a depiction of the probabilistic distribution of equity betas for *comparable firms* not in the sample. The most likely value for any such firm's equity beta is the sample mean. However, the expectation is that some equity betas of firms not in the sample are higher than the sample mean while other equity betas are lower.

The 'thinner' distribution is the distribution of the possible values for the *population mean*[1] given the sample mean that has been observed. This distribution is 'thinner' because we can be more certain that the sample mean is a good approximation for the *population mean* equity beta than we can be that the sample mean is a good approximation of *any individual firm's* equity beta.

1 That is, the mean of all comparable (in and out of the sample) firms' equity betas.

Graph 2



Algebraically, we can see the difference between the 95% confidence upper bound for the population mean and for the βe of an individual firm by examining the formula for the standard deviation for the sample mean versus the standard deviation of the difference between an individual firm's βe and the sample mean.

Standard deviation of the sample mean βe	=	$\frac{\sigma}{\sqrt{n}}$
Standard deviation for the difference between an individual firm's βe and the sample mean βe	=	$\sigma\sqrt{1+\frac{1}{n}}$

σ is is the cross sectional standard deviation of beta values in the population and n is the size of the sample used to calculate the sample mean.

Substituting these values into equation 1 and replacing σ by its sample estimate S gives:

95% confidence upper bound βe for *population mean βe*	=	Sample mean βe + $t_{(\alpha)} * \frac{S}{\sqrt{n}}$	(1′)
95% confidence upper bound βe for *TNSP βe*	=	Sample mean βe + $t_{(\alpha)} * S\sqrt{\frac{n+1}{n}}$	(1′′)

The ACCC uses the standard deviation of the sample mean (ie, equation 1′) to calculate the upper bound βe rather than equation 1′′. Clearly, the 95% upper bound for the population mean βe collapses to the sample mean as the sample size grows large, but the upper bound for an individual firm's βe approaches the sample mean βe plus 1.860*S as the sample size grows large. This is an unsurprising result because, as the sample size approaches infinity, the sample and the population become the same thing. Consequently, we know the population mean is equal to the sample mean with 100% certainty (ie, the confidence interval for the population mean is zero). On the other hand, the cross-sectional standard deviation of the sample becomes the standard deviation of the population – which must be used to estimate the confidence level for any individual observation from within that population (such as the confidence interval associated with a TNSP's equity beta).

So far in this section we have established that the ACCC's Table 5.2 establishes the upper bound standard deviation for the population mean but we have not directly addressed why we regard this as an 'error'. In order to explain this we note that it is necessary to answer the question why the ACCC is calculating an upper bound? We are only aware of one answer to this question which can be put as follows:

> *"The calculation of an upper bound is necessary because the negative consequences of underestimating a TNSP's equity beta are more severe than the negative consequences of overestimating a TNSP's equity beta."*

If this were not the case then it would be inappropriate to set the regulatory beta at anything other than the sample mean (ie, there would be no reason for erring on one side of the mean than for erring on the other). Accepting this explanation, it follows axiomatically that the appropriate upper bound is the upper bound associated with *a single firm* not with the *value of the population mean of all firms*. As already discussed, as the sample size grows the ACCC's calculations gives an equity beta that approaches a probability of roughly 50% that the value calculated is below any single firm's true equity beta.

2.2.3 The impact of correcting errors in calculation of the upper bound

The analysis in the discussion paper appears to have led the ACCC to believe that its preferred approach would result in an equity beta that is, on average, below 1. Table 5.3 in the discussion paper illustrates the potential impact of equity beta values of 0.70, 0.80 and 0.9 on ElectraNet allowable revenues. It is relatively easy to see how the ACCC may have come to the conclusion that its preferred approach would reduce the equity beta below 1. In table 5.2 of the discussion paper all upper bound equity beta's are below 1 – even at the 99% confidence interval.

However, correcting the upper bounds in the ACCC's Table 5.2 has the net effect of considerably increasing the upper bound estimates of βe. We report below the upper bound estimates for three confidence levels derived from data reported for the ACCC's "combined sample".

Table 2: Correctly estimated upper bounds equity beta based on AGSM data (combined sample)

	June 02	Sept 02	Dec 02	Average
95.0% upper bound	1.33	0.97	0.83	**1.04**
97.5% upper bound	1.52	1.11	0.95	**1.20**
99.0% upper bound	1.78	1.31	1.11	**1.40**

These estimates of the upper bound are clearly significantly in excess of the ACCC estimates of the upper bound outlined in the ACCC's Table 5.2 reproduced above (these averaged 0.65). If a 95% upper bound were calculated the average equity beta upper bound over the three periods used by the ACCC in the Discussion Paper would still be equal to 1.04. If any higher confidence interval were used then the average equity beta would be significantly above 1.00. We also provide a fully amended version of the ACCC's Table 5.2 below.

Table 3: Amended Version of Table 5.2 in the ACCC Discussion Paper to Correct Calculation Errors

		June 02 AGSM data	Sept 02 AGSM data	Dec 02 AGSM data
Core Sample	Re-levered average β_e	0.30	0.17	0.19
	Standard deviation	0.1103	0.0583	0.0890
	Number in sample	5	5	5
	95 % t $_{(\alpha)}$	2.132	2.132	2.132
	95 % confidence β_e	**0.56**	**0.31**	**0.40**
	99 % t $_{(\alpha)}$	3.747	3.747	3.747
	99 % confidence β_e	**0.76**	**0.41**	**0.56**
Combined Sample (core and additional firms)	Re-levered average β_e	0.51	0.36	0.33
	Standard deviation	0.4140	0.3078	0.2548
	Number in sample	9	9	9
	95 % t $_{(\alpha)}$	1.860	1.860	1.860
	95 % confidence β_e	**1.33**	**0.97**	**0.83**
	99 % t $_{(\alpha)}$	2.896	2.896	2.896
	99 % confidence β_e	**1.78**	**1.31**	**1.11**

3 IMPLEMENTATION ISSUES

This section outlines a number of implementation issues that would have to be addressed each time the ACCC's preferred approach could be implemented. The approach to these issues would have to be codified before a common understanding of the ACCC's preferred position could be established and reflected in the SRP. Each of the remaining subsections addresses one of the below issues:

- uncertainty surrounding the CAPM;
- selection of comparables
- sampling periods/intervals and adjustments for thin trading;
- circularity in the analysis as a result of regulatory decisions affecting observed equity beta and *vice versa*; and
- questions concerning the AGSM beta estimates.

3.1 The CAPM Framework

Prior to entering into any statistical procedures designed to estimate the upper bound of CAPM parameters such as βe it is important to recognise that there is a great deal of uncertainty as to whether the CAPM itself is an accurate reflection of what determines investor behaviour. Consequently, it is possible to imagine a situation where there was sufficient data to accurately estimate every CAPM parameter in the recent past, but to still be highly uncertain what the true required WACC was for a TNSP.

That is not to say that we can suggest a better conceptual framework to work within when estimating the required WACC for TNSPs – no such agreed framework exists in the literature on finance theory. However, it should be recognised that the framework that we do have is not perfect for understanding investor behaviour. For example, the CAPM does not recognize the return required from an asset will depend in part on the covariance between that asset's return and future investment opportunities in the economy. The CAPM is a one-period model in which the only risk is that of covariance between the asset's return and the contemporaneous return on other assets—there are no future investment opportunities. Ross, Westerfield and Jaffe (1999) note in their graduate text that :

> *"However, one must never forget that, as with any other model, the CAPM is not revealed truth but, rather, a construct to be empirically tested. The first empirical tests of the CAPM occurred over 20 years ago and were quite supportive. …While a large body of work developed over the following decades, often with varying results, the CAPM was not seriously called into question until recently. Two papers by Fama and French (…) present evidence inconsistent with the model. Their work has received a great deal of*

> *attention, both in academic circles and in the popular press, with newspaper articles displaying headlines such as "Beta Is Dead". These papers make two related points. First they conclude that the relationship between average return and beta is weak over the period from 1941 to 1990 and virtually non-existent from 1963 to 1990. "*[2]

If upper bound estimates of the required WACC are to be derived within a CAPM framework then it would be appropriate to take account of uncertainty surrounding the explanatory power of the CAPM as well as any uncertainty associated with statistical estimates of individual parameters. That is, while we may not have a better theory than the CAPM to work within, we should recognise that we are nonetheless uncertain that the CAPM correctly describes reality.

When we can not be certain as to the factors that do explain differences in required and expected returns, then the catholic response is to assume that the required return on all stocks are equal. Using a beta of 1 in the CAPM yields a required return equal to the expected return on the market. The CAPM with a beta of 1 is simply a way of saying that one expects the same return from this stock as one expects from the typical stock in the economy.

3.2 Selection of Comparables

Sample selection is a critical component of any statistical methodology. This is particularly so in the current context where the ACCC has only identified five businesses in the 'core sample' and, consequently, has relied on 'additional firms' that the ACCC appears to regard as 'less comparable' but still 'comparable'. This raises three main questions:

- how is the distinction between the core and additional firms to be made? For example, is it obvious that AGL with its significant retail and international exposure should be included in the core group but that Transurban should not?

- what criteria is to be used to determine firms that qualify as 'additional but non-core' comparables?

- what criteria is to be used to determine the total sample size (ie, how many firms from the 'additional but non-core' comparables should be included in a combined sample)? If less than all 'additional but non-core' comparables are to be included in the core sample what criteria is to be used to determine which are included and which are excluded?

This problem is intensified when it is recognised that four of the five firms in the ACCC's 'core sample' have significant cross-ownership such that it is arguably inappropriate to

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2 Ross, Westerfield and Jaffe (1999), Fifth edition, *Corporate Finance*, McGraw-Hill, pp 269-270.

regard them as five independent observations. Note that the upper bound on βe is greater than that given in equations (1′) and (1′′) when the sample mean used in creating that upper bound is itself calculated from observations that are not independent. This is due to the fact that the standard deviation of a sample mean calculated from n observations that are not independent is in fact greater than $\frac{\sigma}{\sqrt{n}}$. It can be as large as σ.

In particular, AGL has a minimum equity investment of 30% in APT and UnitedEnergy was a 'foundation shareholder' in AlintaGas. In any event, UnitedEnergy was recently sold (with the sale process significantly affecting variance in its share price over the period estimated by the ACCC) and future observations of UnitedEnergy will not be available. This suggests that, at best, there were only three independent observations within the core sample during the period examined by the ACCC. Moreover, APT's first monthly return was only available in July 2000 and AlintaGas October 2000 - leaving less than the AGSM's recommended four years for observations. On the other hand, in the future a longer time series for GasNet will be available and this firm, as a regulated Australian business, should be able to join the 'core sample'. Nonetheless, this will only provide four observations within the ACCC's core sample.

To see the implications of removing UnitedEnergy and APT from the sample (to ensure all observations are independent) we recalculate the estimates in Table 5.2 of the ACCC's discussion paper with these observations removed from the analysis.

Table 4: Amended Version of Table 5.2 in the ACCC Discussion Paper to Correct Calculation Errors and to Remove Interdependent Observations

		June 02 AGSM data	Sept 02 AGSM data	Dec 02 AGSM data
Core Sample	Re-levered average β_e	0.30	0.16	0.16
	Standard deviation	0.1531	0.06027	0.06245
	Number in sample	3	3	3
	95 % $t_{(\alpha)}$	2.92	2.92	2.92
	95 % confidence β_e	**0.81**	**0.36**	**0.37**
	99 % $t_{(\alpha)}$	6.065	6.065	6.065
	99 % confidence β_e	**1.37**	**0.58**	**0.60**
Combined Sample (core and additional firms)	Re-levered average β_e	0.57	0.41	0.36
	Standard deviation	0.4579	0.3359	0.2835
	Number in sample	9	9	9
	95 % $t_{(\alpha)}$	1.943	1.943	1.943
	95 % confidence β_e	**1.52**	**1.11**	**0.94**
	99 % $t_{(\alpha)}$	6.065	6.065	6.065
	99 % confidence β_e	**2.11**	**1.54**	**1.31**

The impact of removing UnitedEnergy and APT is to significantly increase the upper bound estimates of equity betas.

It is not obvious to us that there is any non-arbitrary answers to the previously outlined three questions. We would be keen to respond to any proposals from the ACCC on how they would envisage the sample selection process proceeding. However, we believe that it would inevitably be a somewhat arbitrary process. This exposes he regulated businesses to significantly higher variability in their allowed rate of return. It is quite possible to foresee the situation where the inclusion of one comparable and not another could halve/double the estimated upper bound equity beta derived from a small sample.

3.3 Thin Trading, Sampling Period and Sampling Interval

3.3.1 Thin trading

If a stock is 'thinly traded' then information that affects the observed returns to other stock may not show up in the observed returns to the thinly traded stock until the following sampling interval. For example, if the sampling interval is monthly returns and a stock is only lightly traded at the end of the month then information that may have affected the market late in the month may not yet be observed in the individual stock's share price. Consequently, running a simple contemporaneous OLS regression will incorrectly attribute a lower beta to that stock as it will not recognise the fact that the information is only reflected in the stock's share price with a lag.

There are standard statistical techniques for dealing with these issues that involve using lagged and leading variables in the relevant regressions (eg, Scholes-Williams beta estimates). However, while such beta estimation procedures have a more accurate expected value (because they remove thin trading bias) the variance associated with this form of statistical procedure, for any given data set, is higher because more parameters, namely the leading and lagged relation as well as the contemporaneous relation, have to be estimated from the same amount of data.

The AGSM deals with this trade-off between the bias in the beta estimate and the standard error of the estimate by reporting both ordinary OLS regressions and Scholes-Williams beta estimates for the same time period. The AGSM then reports a test for whether the Scholes-Williams beta estimate is statistically different to the OLS beta estimate. If it is, the AGSM recommends use of the Scholes-Williams beta estimate. The downside of adopting such an approach is that it introduces a bias into the beta estimates (as Scholes-Williams beta estimates are not universally used). The upside is that the variance of the estimates is dramatically reduced. (We note that the ACCC's consultants the Allen Consulting Group used the AGSM thin trading beta of 0.93 and not the OLS beta of 0.44 in its July 2002 report to the ACCC.[3])

[3] Empirical Evidence on Proxy Beta Values for regulated Gas Transmission Activities.

While this trade-off may be appropriate for the main purposes to which the AGSM data is to be used it is not obvious that it is appropriate for the purpose to which the ACCC proposes to use the data – ie, to set returns for regulated businesses. An alternative approach would be to use Scholes-Williams estimates of the beta universally. In general, one could also consider the possibility of increasing the number of observations by extending the sampling period beyond four years and/or reducing the sampling interval to less than one month.

By way of example of the magnitude of the impacts, NERA has run its own regressions to compare the use of ordinary OLS and Scholes-Williams regressions on the estimated equity betas for the ACCC's core sample. Using the same 4 year sampling period with a monthly sampling interval and using the All Ordinaries as the market portfolio we calculate the following upper bounds.

Table 5: Comparison of OLS with Scholes-Williams Beta Estimates

(up to) 4 years ending	Jun 02	Sep 02	Dec 02	Mar 03	Jun 03	Sep 03
95% upper bound using simple OLS	0.78	0.49	0.46	0.54	0.65	0.58
95% upper bound using thin trading	1.37	2.47	1.04	1.36	1.19	1.11

The Scholes-Williams (thin trading) upper bounds are considerably larger than the OLS estimates. This is largely driven by the higher variance in the estimated sample interacting with the calculation of the upper bound estimate. However, this higher variance should be reduced if a longer time period were used (or, indeed, if APT and AlintaGas had been traded for the full four year periods).

3.3.2 The sampling period and interval

The appropriate sampling period and interval are important issues in their own right (not just in relation to the thin trading issue). Assuming that the beta is constant over the sampling period, the longer the sampling period the greater the number of observations and the greater the accuracy of the estimates. However, if the beta is not constant over the sampling period using longer sample periods may bias the results – although the direction of any bias is unclear unless there is reason to believe the beta has moved in a particular direction.

The optimal length of the sampling interval (eg, monthly versus weekly) is quite complex. While it looks at first blush as if monthly observations mean we have a smaller number of observations available for any given sampling period, monthly observations will largely aggregate weekly results. For example if we estimate the mean continuously compounded return per annum on some stock using weekly observations rather than monthly observations over the same sample period we would obtain the same estimate.[4] But the longer the sampling interval the less pronounced will be any thin trading effects.

The AGSM results are derived using a four-year (or shorter) sampling period and a monthly sampling interval (ie, a maximum of 48 observations). The AGSM appears to have taken the view that a relatively short sampling period (4 years) is an appropriate compromise between the desirability of maximising observations while preventing bias as a result of changing beta values over time.

The AGSM may well have correctly calculated this trade-off taking into account the purpose for which its average customer base wants these values. However, the AGSM's approach is a mass produced product aimed at delivering equity beta estimates for around 1,400 entities. The ACCC requires data on equity betas for a highly specialised purpose and where accuracy is of great importance to the operation of the essential infrastructure industries in Australia. It is by no means obvious that the AGSM data strikes the appropriate balance given the ACCC's intended use of the data.

For example, many users of the AGSM data are interested in calculating the average beta of a large portfolio of investments while the ACCC is interested in calculating the individual betas of a small number of 'comparables'. In a large portfolio inaccuracies tend to 'cancel out' and the overall accuracy of the portfolio's beta estimate will be little affected. This is not the case under the ACCC's preferred approach. Moreover, there may be many reasons why the equity beta of unregulated businesses can change over time (eg, changes in the nature of operations/acquisitions and changed market structures such as the entry of competitors). The reasons why a regulated businesses equity beta may change over time are fewer. Moreover, in the process of selecting comparable companies it would, in theory at least, be possible to determine whether there was any reason to expect its equity beta had changed over the desired sampling period.

3.3.3 Conclusions

The above are important issues in establishing the appropriate statistical procedures to use in the ACCC's preferred position. They also serve to highlight the problems associated with the ACCC simply adopting beta estimates from 'an independent source'.

In the context of something as important as setting regulated returns, if the ACCC were to implement its preferred position it could reasonably be expected to develop an understanding of the statistical procedures that it believes best serves the purpose to which it intends to put the results. The ACCC would then be expected to acquire the relevant raw data and to provide this publicly alongside its statistical analysis for all interested parties to replicate. Relying on published AGSM results without the raw data would lack an

[4] Continuously compounded returns are such that the total return over a given year is equal to the sum of the monthly returns which is equal to the sum of the weekly returns and the sum of the daily returns over that year.

appropriate level of transparency and would run the risk of problems in the AGSM results not being subject to scrutiny by affected parties.

3.4 Circularity and Feedback

The use of statistical procedures to set the equity beta for regulated firms may introduce circularity/feedback into the regulatory process. This will be true where the firms included in the sample used to determine the regulated beta have that regulated beta applied to them.[5] There are three implications of such an approach:

- first, there is an artificial incentive created for regulated businesses in the sample to take on more systemic risk;
- second, the possibility exists that regulatory decisions/announcements will affect the beta that is later observed; and
- a cycle will be established where the equity beta will be high in one period and low in the next and so on through time.

3.4.1 Incentive to take on systemic risk

Under the ACCC's preferred approach it would appear that if regulated businesses take on systemic risk, which increases their observed beta, then they will be fully compensated for this. If this is the case, regulated businesses will have a strong incentive to take on systemic risk. This is because they would effectively be compensated twice for the same risk.

By way of example, imagine a regulated business negotiating the contract for supply of particular inputs into the business. The price they have to pay in that contract will depend on, amongst other things, the systemic risk properties of the contract. If the contract leaves the supplier with the majority of the systemic risk (eg, the contract stipulates the contract price varies with the price of copper on the world market and there is no minimum quantity the regulated business must purchase) the regulated business will have to pay a higher price for the inputs than if the regulated business took on the systemic risk (eg, a fixed price and a fixed quantity contract). In this situation the regulated business would have an incentive to take on the systemic risk because not only would it receive a lower (expected) price on the contract[6] but would also receive a higher compensation for WACC (as its observed equity

[5] In the ACCC's current core sample, the ACCC directly regulates only APT. However, GasNet is an obvious candidate for future inclusion in the core sample as its trading history extends over time. Moreover, if a future energy regulator were to also adopt such a statistical approach then all firms in the core sample would have their equity beta set according to, at least partially, their observed equity beta.

[6] Under incentive regulation it should benefit from this lower price in the form of a lag between when it is achieved and when it is passed to customers.

beta would tend to increase). The same issues would apply to contracting with regulated businesses' customers.

Of course, the most obvious way to increase a company's observed beta would be to trade in financial derivatives. While taking significant trading positions in financial derivatives should render such companies as 'non comparable', this would require the ACCC to understand what these positions were. For example, how would the ACCC determine whether AGL's electricity market hedging position in Australia and New Zealand meant that it no longer qualified as a 'comparable'?

3.4.2 Regulators creating the beta they observe

The possibility would also exist for the timing of regulatory decisions to have an important affect on the observed beta. If the regulator happened by chance over a four-year sampling period to time announcements that had a negative impact on businesses' share prices in months when the market was 'up' then this would tend to create a negative beta that the regulator would later observe (and vice-versa). Similarly, the timing of news released to the market by regulated businesses could have effect their estimated betas. While 'may be unlikely, the possibility of its existence could create unwanted tensions in the regulatory process.

Attachment A to this report provides an example of statistical analysis carried out by NERA in the UK that suggests that removing the impact of a number of regulatory decisions from beta estimates of UK electricity distributors would substantially increase the estimated beta values over the last 5 years

3.4.3 Creating a cycle in returns

To understand the potential for a cycle in returns, consider how the WACC relates to the risk of a business. Consider a company that is initially worth $100. That company will last one period and is expected to generate an end-of-period net cash flow of $116. The return required by its shareholders given its risk (its WACC) is 16%. The risk-free rate is 10%. If the MRP is 6% and required returns are determined by the CAPM, then our firm's β is 1.

Now suppose the firm's expected future net cash flows double to $232. What will the company now be worth? If the reason that the firm's expected future net cash flows have doubled is that all its future net cash flows will be twice as large as originally anticipated, then logically the company's value will double. Its WACC is unaffected at 16% and the β of the company is unaffected. Where a $100 company might have earned, say, a 13% return under a given set of conditions and paid off $113 at the end of the period, the new company (now worth $200 today) will payoff $226 (exactly twice as much) under the same conditions and will again earn a 13% rate of return. Its returns are unchanged, their covariance with the market is unchanged and hence β and WACC are unchanged.

But if instead the reason that the firm's expected future net cash flow has doubled is that the firm has all its initial future net cash flows plus an extra $120 for certain, then its value will have more than doubled. The value will have more than doubled becuase the extra $120 is risk-free and when discounted at 10% is worth more than $100. This firm now has risky assets and risk-free assets. The beta of its portfolio of assets will have declined, as will the company's WACC. [7] The WACC declines since a portion of the firm's value is now risk-free.

Now turn to the valuation of a regulated company. Like any firm its future net cash flows have an expected component and a random component. A decrease in the allowed rate of return will decrease the expected component, but will not change the random component. Thus a decrease in the allowed rate of return is equivalent to removing some risk-free future payoffs from the regulated firm. The result that the firm's value will be lower is obvious. What is less obvious, but is equally true, is that the risk of the firm is increased by the reduction in the allowed rate of return. The sensitivity of the rate of return on this less-valuable firm to market-wide economic conditions will have increased. The firm's beta will have increased.

Suppose that at the end of a regulatory cycle, a regulator estimates a firm's historical beta over that cycle and concludes that the allowed rate of return going into the next cycle should be reduced relative to its past value. The regulated firm's value will decline and its true beta in that next cycle will be higher than it previously was. Now at the end of that next cycle the regulator will likely observe that the beta estimated from returns during that cycle was higher then the regulator has assumed when setting the allowed rate of return. In response to the higher beta, the regulator will then allow a higher rate of return in the third cycle. But that will mean that the firm's value will increase and its true beta in the third cycle will be lower. Given rational expectations by market participants, this cycle in beta will be smoothed as the market anticipates the implications of allowed rates of return in one period for likely betas in that period and hence allowed rates of return in the next period and hence likely betas in the next period, etc., etc. But the cycle induced through circulatory is none the less there, and is an unanticipated result of using a firm's past beta to determine its future allowed rate of return. This result is formally established within a CAPM setting in Attachment B.

3.5 Replicability of AGSM Results

As observed in section 3.2.2 the purposes for which the AGSM data is marketed are much broader than the regulation of TNSPs. The set of regulated firms will want to be able to replicate any measures derived from the AGSM data. For example, measures of the standard deviation of monthly returns on the AGSM data base do not exactly match the measures

[7] The value of the company will be $\$100 + \frac{\$120}{1.1} = \$109.09$. The WACC will be $\frac{\$100.00}{\$209.09}\times 16\% + \frac{\$109.09}{\$209.09}\times 10\% < 16\%$. The beta of the firm will be $\frac{\$100.00}{\$209.09}\times 1 + \frac{\$109.09}{\$209.09}\times 0 < 1$.

obtained by directly calculating the standard deviation of the returns reported by DATASTREAM. The difference appears to be due to the calculation of returns when dividends are paid. The AGSM recognizes the dividend, but assumes that it is held in cash until the end of the month when it is then used to purchase more of the paying company's stock. DATASTREAM also recognizes the dividend, but DATASTREAM assumes that the dividend is immediately reinvested in the company's stock. Both series of returns are returns that include dividends, but in one case one is sometimes looking at the return from a share plus a little cash, while in the other one is always looking at the return on the share itself. These effects are likely to be trivial, but will not necessarily be well-understood. Of more importance is that sometimes the AGSM risk measures are calculated over a shorter sample period (i.e., with less observations) than one might have thought. The website of the AGSM's Risk Measurement Service states that:

> This sample period is normally the four years preceding the quarter to which the figures relate. If, however, the stock did not trade for this whole period, then only the period for which it did trade is included. If this period is less than two years, then no statistics can be computed. The number of months of data used in the computations is specified in the statistical report.

Alintagas began trading in October 2000. Its first month-end to month-end return was November 2000. Alintgas had experienced 20 monthly returns at the end of June 2002. The ACCC discussion paper uses the AGSM-calculated beta for the period ended June 2002. Yet the AGSM website states that no such statistic "can be computed." Clearly it can. But it is unlikely to be an accurate estimate of Alintgas's true beta. The June 2002 AGSM statistical report confirms that the beta was calculated on the basis of 20 monthly returns only; i.e., AGSM risk measures are not always calculated using even the apparent minimum of two years of data.

The AGSM calculates its own variant of the return on the market. It is a value-weighted combination of the return on all ASX-listed stock returns. In performing the calculation of returns it is again assumed that dividends are reinvested at the end of the month but held in cash over the month. But investors will be benchmarking to a publicly available measure of the return on the Australian market. A common benchmark is the return on the All Ordinaries Accumulation Index. The term "Accumulation" simply means including dividends. The All Ordinaries Accumulation Index is calculated assuming that dividends are immediately reinvested. More importantly, this index is based on only the 500 largest stocks. Thus those stocks that are most likely to suffer from thin trading are not included in the index. The AGSM monthly market return will reflect many stocks that don't trade in the month, or whose trades reflects information that was announced in the preceding month. Different market return series can give rise to different beta estimates. OLS betas of companies in the core sample can differ by as much as 0.12 when the beta is calculated relative to the All Ordinaries Index rather than the AGSM-determined variant of the return on the market.

4 *A PRIORI* BELIEFS AND STATISTICAL INFERENCE

The ACCC and some of its consultants have made a number of comments to the effect that an *a priori* view exists that that the true equity beta for TNSPs is significantly below the average for the market (ie, significantly below 1). This follows from the view that the regulatory framework delivers relative certainty of revenues over time and these returns are relatively secure irrespective of market conditions.

Without necessarily disagreeing with such an *a priori* view we do think that it is pertinent to note two factors that suggest caution should be exercised before acting on such views for the reasons outlined below.

4.1 Variance as Opposed to Covariance

Whether investors regard the regulatory framework as providing certainty is best tested by the variance of regulated businesses returns not by co-variance. If the variance of returns on a regulated business is similar to the variance of returns on a 5-year bond then the *a priori* view that the regulatory framework delivers certainty is supported. However, examination of the variance of returns on individual regulated businesses over time suggests that this is not the case. Consequently, the *a priori* view of certainty of returns (on which the belief that the equity beta should be low is based) does not appear to be borne out by empirical examination.

The Table below shows the monthly standard deviation of returns on two accumulation indices of default-free Australian government securities. The standard deviations are calculated from the returns over the 48 months preceding June, September and December 02. One index contains bonds with maturities between 3 and 5 years and the other contains bonds with between 5 and 7 years to maturity. If at the start of a regulatory interval the regulated firm really has the risk characteristics of a five-year bond, then the implicit duration of the firm (the time to maturity of the equivalent bond) will decline over the regulatory cycle. Hence the 3 to 5 year index should provide the better benchmark.

The Table also shows the average of the standard deviations of monthly returns on the five core firms as reported by the AGSM Risk Measurement Service. The standard deviations of each one of the five core firms exceeded that of the bond indices.

Table 6: Comparison of Variance on Core Sample and on Risk Free Bonds

	June 02	Sept 02	Dec 02
Standard Deviation of monthly return on 3-5 year bonds	3.7%	3.4%	3.3%
Standard Deviation of monthly return on 5-7 year bonds	3.8%	3.5%	3.4%
Average of the AGSM Standard Deviation of monthly returns on the Core Sample of firms	6.5%	6.3%	6.3%

4.2 Why the Regulatory Framework may not Deliver Low Covariance

A basic assumption underlying an *a priori* view that regulated businesses have low systemic risk is that regulatory decisions are uninfluenced by the state of the economy. That is, it is assumed that investors believe that regulators will ignore wider economic circumstances when setting prices/revenues equal to cost recovery for each firm. Under these circumstances it is argued that investors will tend to view equity in regulated businesses more like investment in risk free bonds than investment in the market portfolio (ie, will have a beta significantly below 1). In fact, a comparison of the variance of returns on equity for regulated businesses and the variance on returns for risk free bonds identified above suggests that investors have not experienced, and are unlikely to believe, that they hold the similar levels of risk as do investors in Commonwealth bonds.

If asked, it is likely that most investors would believe that regulators when setting a revenue path are cognisant not simply of the evidence on a business's costs but also of the price impact that would result from allowing recovery of those costs. Indeed, it is common for regulators to set explicit 'side constraints' on how prices to individual customers can change over-time in order to prevent 'price shocks'. The ACCC does not impose side constraints on TNSPs as TNSP's prices are not set at the level of the individual customer. However, we feel confident that many investors would regard as naïve the idea that the ACCC would pay no attention to 'price shocks' when it makes its five year regulatory decision. Indeed, a cursory examination of ACCC press releases could lead to the conclusion that price impacts are given a great deal of weight by the ACCC.

Given this background, it would appear to us reasonable for investors in a regulated business to place a lower probability on 'generous' regulatory decisions in periods when full cost recovery requires significant price increases (say due to falling volumes). By contrast, investors in a regulated business may well reasonably believe that when growth is expected to be high and there is low pressure on prices then the regulator may be more inclined to be generous/less harsh in its regulatory decisions. This would create a positive expectation of covariance with the market, ie, a positive beta expectation by investors.

Moreover, if it is believed that in periods of recession the pressure on regulators is at its greatest not to allow significant price increases then this would further increase the investor's expected beta.

While the ACCC may well believe that it is immune to such political pressure, the critical question is whether investors believe this. We believe that it would be a strong assumption to act as if this is the case. Rather, this expectation can only be expected to be created over long periods of experience under regulation that is immune to such pressures.

5 NERA CONCLUSIONS

In order to assess the merits of attempting to implement the ACCC's preferred position it is necessary to have some form of criteria by which it is assessed. It appears to us that the appropriate criteria by which to assess the process used to determine the allowed equity beta would include:

- stability of results;
- neutrality of incentives; and
- transparency of process.

Stability of results appears a reasonable criterion given that there is little reason to expect the equity beta associated with regulated assets to vary significantly over time. Moreover, stability of results also tends to reduce the range of outcomes expected by regulated businesses and this can help prevent a wedge being driven between what businesses expect to earn over an investments life and what they are actually earning at the beginning of that investment's life. Neutrality of incentives is required to achieve economically efficient outcomes and transparency of process increases the ability of stakeholders to engage in informed consultation.

We believe that the ACCC's preferred position scores poorly on all three criteria.

In terms of stability in the allowed equity beta, the ACCC's own analysis in Table 5.2 of the discussion paper (reproduced above) shows how the regulated equity beta can change dramatically over time. For example, with only two quarters of different data, the equity beta calculated by the ACCC for the four years ending June 2002 is around 60% higher than the equity beta calculated for the four years ending December 2002. The ACCC's preferred position may also involve the introduction of cycles in the returns for regulated businesses.

In terms of transparency, it will be very difficult for the ACCC to carry out the necessary statistical procedures in a transparent manner. Inevitably, there will be great debate over such issues as what businesses are comparable and what is the appropriate sampling period/interval? It is unlikely that it would be possible to set out sufficient detail in advance of regulatory decisions as to how such debates should be answered at the time of each regulatory decision. Moreover, at the time of a decision it would be unlikely that even truly independent experts would agree on how these questions should be resolved. Consequently, a degree of arbitrariness must inevitably enter the estimation process.

In relation to the neutrality of incentives we note in section 3.4.1 that the ACCC's approach would create incentives for businesses regulated in the core sample to take on additional systemic risk to the extent that their observed equity beta would affect their allowed equity beta (this will be most likely to be true in a small sample). This would create non-neutral incentives and some businesses may take on systemic risk that is most efficiently held by other businesses. In addition, by creating instability in expected returns, the ACCC's preferred position would widen the range of expectations businesses held about future returns. This would increase the risk that businesses investment actions are driven by an expected WACC that is different to the WACC they are currently receiving. That is, the price signal businesses base their supply decisions on would not be consistent with the price signal customers face to consume.

Of course, simply adopting an equity beta of 1.0 on the basis of historical practice is itself arbitrary. However, it does have the advantage of providing stability of returns over time. The ACCC could deliver the same certainty of returns if it adopted any other level of the equity beta and committed not to deviate from that level unless exceptional circumstances arose. For example, if the ACCC, after reviewing all the arguments and evidence, truly believed that the equity beta required to be "Y%" sure of adequately compensating businesses for systemic risk was "X" then it could simply adopt this value and incorporate it into the SRP.

The ACCC could potentially use statistical procedures to assist it in arriving at its estimate of "X" but it would, in NERA's view, be inappropriate to continually update that estimate over time based on statistical procedures that deliver highly variable results. In this regard we note that adopting the 95% confidence level for the upper bound equity beta in the ACCC's combined sample over the periods the ACCC reports provides a rationale for setting the allowed equity beta at 1.0 or above.

ATTACHMENT A – NERA TOPIC #25 – RECENT EVIDENCE ON BETA AND THE COST OF CAPITAL FOR UK ELECTRICITY COMPANIES

ATTACHMENT B – CYLICITY IN RETURNS

Let us assume that, aside from the Cost of Capital, the ACCC's estimates of costs and quantities are unbiased.

Let *A* denote the valuation of the regulated entity's assets on which it will be allowed to earn a return, *R*. In theory *R* should reflect the beta risk of the regulated entity's future net cash flow.

For simplicity assume a one-period world. A tilde denotes a random variable. The allowed revenue of $A(1+R)+E\{\tilde{Costs}\}+E\{\tilde{Taxes}\}$ determines the price, *p*, such that given the expected quantity, $E\{\tilde{q}\}$,

$$p\times E\{\tilde{q}\}=Allowed\ Revenue=A(1+R)+E\{\tilde{Costs}\}+E\{\tilde{Taxes}\}.$$

The regulated entity's <u>actual</u> end-of-period net cash flow will be:

$$\begin{aligned}
&p\times\tilde{q}-\tilde{Costs}-\tilde{Taxes}\\
&=p\times(\tilde{q}-E\{\tilde{q}\})+p\times E\{\tilde{q}\}-E\{\tilde{Costs}\}-(\tilde{Costs}-E\{\tilde{Costs}\})-E\{\tilde{Taxes}\}-(\tilde{Taxes}-E\{\tilde{Taxes}\})\\
&=p\times E\{\tilde{q}\}-E\{\tilde{Costs}\}-E\{\tilde{Taxes}\}+p\times(\tilde{q}-E\{\tilde{q}\})-(\tilde{Costs}-E\{\tilde{Costs}\})-(\tilde{Taxes}-E\{\tilde{Taxes}\})\\
&=Allowed\ Revenue-E\{\tilde{Costs}\}-E\{\tilde{Taxes}\}+\left[p\times(\tilde{q}-E\{\tilde{q}\})-(\tilde{Costs}-E\{\tilde{Costs}\})-(\tilde{Taxes}-E\{\tilde{Taxes}\})\right]\\
&=Allowed\ Revenue-E\{\tilde{Costs}\}-E\{\tilde{Taxes}\}+\tilde{\varepsilon}\\
&=A(1+R)+\tilde{\varepsilon}
\end{aligned}$$

where $\tilde{\varepsilon}\equiv p\times(\tilde{q}-E\{\tilde{q}\})-(\tilde{Costs}-E\{\tilde{Costs}\})-(\tilde{Taxes}-E\{\tilde{Taxes}\})$.

The regulated entity's <u>expected</u> end-of-period net cash flow will be $A(1+R)$.

ε is the mean-zero random component of returns that reflects the randomness in whether realized costs and quantities were more or less than initially expected when the ACCC determined the fixed price for the good produced by the regulated entity. It is the covariance between this random component of net cash flows and the market returns that in part determines the beta of the regulated entity. The beta will also be affected by the ACCC's determination of the quantity *R*.

In this one-period setting the value of the regulated entity, *V*, is given by:

$$
\begin{aligned}
V &= \frac{E\left\{\widetilde{Net\ Cash\ Flow}\right\} - cov\left(\widetilde{Net\ Cash\ Flow}, \tilde{r}_m\right)\dfrac{E\left(\tilde{r}_m\right) - r_f}{\sigma^2\left(\tilde{r}_m\right)}}{1 + r_f} \\
&= \frac{A(1+R) - cov\left(A(1+R) + \tilde{\varepsilon}, \tilde{r}_m\right)\dfrac{E\left(\tilde{r}_m\right) - r_f}{\sigma^2\left(\tilde{r}_m\right)}}{1 + r_f} \\
&= \frac{A(1+R) - cov\left(\tilde{\varepsilon}, \tilde{r}_m\right)\dfrac{E\left(\tilde{r}_m\right) - r_f}{\sigma^2\left(\tilde{r}_m\right)}}{1 + r_f}.
\end{aligned}
$$

Now $V = A$ if and only if

$$
R = r_f + \frac{cov\left(\dfrac{\tilde{\varepsilon}}{A}, \tilde{r}_m\right)}{\sigma^2\left(\tilde{r}_m\right)}\left(E\left(\tilde{r}_m\right) - r_f\right). \qquad \text{(I)}.
$$

If R exceeds the right-hand-side of (I) then V will exceed A.

If R is less than the right-hand-side of (I) then V will be less than A.

The beta, β, of the regulated entity will be

$$\beta = \frac{cov\left(\frac{\widetilde{Net\ Cash\ Flow}}{V}, \tilde{r}_m\right)}{\sigma^2(\tilde{r}_m)}$$

$$= \frac{cov\left(\frac{A(1+R)+\tilde{\varepsilon}}{V}, \tilde{r}_m\right)}{\sigma^2(\tilde{r}_m)}$$

$$= \frac{cov\left(\frac{\tilde{\varepsilon}}{V}, \tilde{r}_m\right)}{\sigma^2(\tilde{r}_m)}$$

$$= \frac{cov\left(\frac{\tilde{\varepsilon}}{\frac{A(1+R)-cov(\tilde{\varepsilon}, \tilde{r}_m)\frac{E(\tilde{r}_m)-r_f}{\sigma^2(\tilde{r}_m)}}{1+r_f}}, \tilde{r}_m\right)}{\sigma^2(\tilde{r}_m)}$$

$$= \left(\frac{1+r_f}{(1+R)-\frac{cov\left(\frac{\tilde{\varepsilon}}{A}, \tilde{r}_m\right)}{\sigma^2(\tilde{r}_m)}\left(E(\tilde{r}_m)-r_f\right)}\right)\frac{cov\left(\frac{\tilde{\varepsilon}}{A}, \tilde{r}_m\right)}{\sigma^2(\tilde{r}_m)}.$$

If R exceeds the value on the right-hand-side of in (I), then V exceeds A and the beta of the regulated firm is less than $\frac{cov\left(\frac{\tilde{\varepsilon}}{A}, \tilde{r}_m\right)}{\sigma^2(\tilde{r}_m)}$.

If R is less than the value on the right-hand-side of in (I), then V is less than A and the beta of the regulated firm is greater than $\frac{cov\left(\frac{\tilde{\varepsilon}}{A}, \tilde{r}_m\right)}{\sigma^2(\tilde{r}_m)}$.

If R equals the value on the right-hand-side of in (I), then V is equal to A and the beta of the regulated firm is greater than $\frac{cov\left(\frac{\tilde{\varepsilon}}{A}, \tilde{r}_m\right)}{\sigma^2(\tilde{r}_m)}$.

If, in a multi-period setting, the regulator overestimates beta in one cycle, he/she will set R too high, but this will cause V to rise above A and the actual beta will then be low. In fact, so low that if that beta were accurately estimated in that cycle and used to set R in the next cycle, that next R would be too low and V at the start of the next cycle will be less than A, but then in that next cycle beta would be too high, etc. Thus errors in forecasting betas will affect subsequent betas in the opposite direction and set up a cycle of over/under-estimates followed by under-estimates. The ACCC needs to be alerted to this consequence of using data on a given firm's beta to determine the future WACC of that same firm.