An equity beta estimate for Australian energy network businesses

A REPORT PREPARED FOR ACTEWAGL DISTRIBUTION

February 2018

An equity beta estimate for Australian energy network businesses

Contents

An equity beta estimate for Australian energy network businesses

Figures

Tables

1 Executive summary

1 Frontier Economics has been retained by ActewAGL Distribution to provide an expert opinion on the approach to estimating the equity beta for use in the Sharpe-Lintner Capital Asset Pricing Model (SL-CAPM).

2 Specifically, we have been asked to:

a. Set out the AER's methodology—as specified in the AER's 2013 Rate of Return Guideline (Guideline)—for deriving estimates of the equity beta for Australian energy network businesses;

b. Update the statistical estimates of the equity beta using the AER's methodology using market data that has become available since the publication of the Guideline;

c. Consider the latest evidence on Australian energy network businesses published by the Economic Regulation Authority of Western Australia (ERA), noting that the Guideline had regard to similar evidence published by the ERA in 2013;

d. Consider any adjustments that the AER has made in the past to its statistical estimate of the equity beta to arrive at its final equity beta estimate; and

e. Provide an expert opinion on a reasonable, current estimate of the equity beta for Australian energy network businesses.

1.1 The AER's approach

3 In its Guideline, the AER adopted a "primary range" of 0.4 to 0.7 for the equity beta of the benchmark efficient entity (BEE).[1] This primary range is based on a set of domestic comparators for a regulated energy distribution business. Only three of the nine domestic comparator companies considered by the AER at the time of the Guideline remain listed today: APA Group, AusNet Services and Spark Infrastructure.

4 In a series of decisions, the AER has explained that:

a. It considers the "best empirical estimate" of beta to be 0.5;[2] and

[1] AER Rate of Return Guideline, p. 15.

[2] TransGrid Draft Decision, 2017, Attachment 3, p. 3-243.

b. The allowed beta is to be set to 0.7 due to three additional considerations:[3]

   i. "international estimates" – the fact that the weight of evidence from international comparators supports a beta estimate materially above the AER's domestic starting point estimate of 0.5;

   ii. "consideration of the theory of the Black CAPM" – the fact that the Black CAPM evidence is that the unadjusted SL-CAPM will systematically understate the required return on low-beta stocks; and

   iii. "investor certainty" – the fact that instability in equity beta allowances may cause investors to increase their assessment of regulatory risk.

5 Thus, the AER's approach is to begin with its "best empirical estimate" of 0.5 from domestic comparators, and then select a final point estimate (i.e., 0.7) above this level on the basis of a number of other considerations.

6 Approximately four years have elapsed since the analysis that was performed at the time of the AER's Guideline, providing approximately 200 more recent weekly returns observations. This report demonstrates that the more recent evidence results in an increase in the statistical beta estimates.

1.2 Recent analysis by the ERA

7 The ERA has recently updated its equity beta estimates for the BEE and concluded that the latest available data supports a best statistical beta estimate of 0.7, as compared to the AER's 2013 best statistical estimate of 0.5.

8 That is, the ERA has concluded that equity beta estimates based on current data for domestic regulated network comparators are materially higher than the estimates at the time of the Guideline.

9 For its Final Decision for DBP, the ERA updated its beta estimates for domestic comparators and concluded that:

> …the Authority considers that a 95 per cent confidence interval range of equity beta using the most recent data is from 0.479 and 0.870 based on the portfolio results (see Appendix 4A, Table 21 and Table 22). The central estimate given by the average of the portfolios is 0.699. The Authority notes that portfolio estimates have a narrower range than the individual assets.
>
> Based on its own analysis and the other evidence before it, together with the recognition that estimates of equity beta from empirical studies exhibit a high level of

[3] TransGrid Draft Decision, 2017, Attachment 3, p. 3-165

> imprecision, the Authority is of the view that the point estimate of equity beta of 0.7 (rounded) provides a conservative and appropriate central best estimate for beta for use in the SL-CAPM.[4]

10 Unlike the AER, the ERA does not reflect in its final point estimate the international evidence, low-beta bias or investor certainty. Rather, the ERA compiles what it considers to be the best statistical estimate and adopts that figure – which it currently considers to be 0.7. Any accounting by the AER for additional factors, such as those accounted for in the Guideline, would result in a higher estimate than is indicated by the statistical evidence alone.

1.3 Recent empirical evidence

11 In this report, we compile a range of equity beta estimates using the most recent data that is available on domestic network comparators. Our main findings are:

a. Equity beta estimates for domestic regulated network comparators have increased since the 2013 Guideline. Using the same firms that the AER and ERA analyse and using the same estimation method, current estimates are higher than the "best statistical estimate" at the time of the Guideline; and

b. Equity beta estimates for a broader sample of domestic unregulated infrastructure firms are also higher than the 0.5 "best statistical estimate" at the time of the Guideline.

12 Consequently, we conclude that application of the AER's Guideline approach (i.e., begin with a best empirical estimate and select a point estimate from the top the equity beta range to account for the additional considerations set out above) to the most recently available data would support an equity beta of at least 0.7. Indeed, recent empirical evidence supports a final beta allowance of at least 0.7, even if the AER adopts what is considers to be the best empirical estimate, rather than the Guideline approach of adopting the top of the range of empirical estimates, as its point estimate for the equity beta.

1.4 Author of report

13 This report has been authored by Professor Stephen Gray, Professor of Finance at the UQ Business School, University of Queensland and Director of Frontier Economics, a specialist economics and corporate finance consultancy. I have Honours degrees in Commerce and Law from the University of Queensland and a PhD in Financial Economics from Stanford University. I teach graduate level courses with a focus on cost of capital issues, I have published widely in high-level

[4] DBP Final Decision, Attachment 4, Paragraphs 473-474.

academic journals, and I have more than 20 years' experience advising regulators, government agencies and regulated businesses on cost of capital issues. I have published a number of papers that specifically address beta estimation issues. A copy of my curriculum vitae is attached as an appendix to this report.

14 My opinions set out in this report are based on the specialist knowledge acquired from my training and experience set out above. I have been provided with a copy of the Federal Court's Expert Evidence Practice Note GPN-EXPT, which comprises the guidelines for expert witnesses in the Federal Court of Australia. I have read, understood and complied with the Practice Note and the Harmonised Expert Witness Code of Conduct that is attached to it and agree to be bound by them.

2 Background and context

2.1 The role of equity beta

15 The approach that the AER uses to determine the allowed return on equity is known as the Sharpe-Lintner Capital Asset Pricing Model (SL-CAPM).[5] Under the SL-CAPM, the return on equity that investors would require in the current market conditions, r_e, is given by:

$$r_e = r_f + \beta \times (r_m - r_f)$$

where:

a. r_f represents the **risk-free rate** of return. This is the return that is available to investors on an investment that is completely free of risk. Commonwealth government bonds are usually assumed to be such a risk-free investment;

b. r_m represents the **expected return on the market**, which is the expected return that investors require to invest in an asset of average risk;

c. $(r_m - r_f)$ represents the **market risk premium**, which is the amount of extra return (over and above the return on a risk-free asset) that investors would require for investing in an asset of average risk; and

d. β represents the **equity beta**, which indicates the extent to which the particular investment has more or less risk than average. For example, an equity beta of 1.2 indicates that the investment is 20% more risky than average, in which case it would require a risk premium (over and above the risk-free rate) that is 20% more than would be required for an investment of average risk.

2.2 The estimation of equity beta

16 In the SL-CAPM, the equity beta is defined to be:

[5] This formula was independently derived by Sharpe (1964) and Lintner (1965). Sharpe, W., 1964, "Capital asset prices: A theory of market equilibrium under conditions of risk," *Journal of Finance,* 19, 425-442; and Lintner, J., 1965, "The valuation of risk assets and the selection of risky investments in stock portfolios and capital budgets," *Review of Economics and Statistics,* 13-37.

$$\beta = \frac{Cov(r_i, r_m)}{Var(r_m)}$$

where:

a. $Cov(r_i, r_m)$ is the covariance between the returns of the asset in question and the returns on the market portfolio; and

b. $Var(r_m)$ is the variance of the returns on the market portfolio.

17 The slope coefficient from an ordinary least squares (OLS) regression of stock returns on market returns has the same definition as beta above, so it is standard to estimate betas using OLS regression analysis:

$$r_{i,t} = \alpha + \beta r_{m,t} + \varepsilon_t .$$

18 This OLS estimation technique was employed by Henry (2014) in a report commissioned by the AER.[6] Henry (pp. 8-9) notes that he was instructed to also report estimates from the Least Absolute Deviations (LAD) approach. Because the LAD estimate does not correspond with the SL-CAPM definition of beta in Paragraph 16 above, we focus on the OLS estimates in this report. In this regard, Henry (2014) states:

> The AER also requires the construction of estimates of β using the Least Absolute Deviations (LAD) approach…The use of LAD in addition to the (standard) OLS was intended to provide a robustness check on the underlying data with regard to data outliers. The consultant was not requested to provide expert advice or analysis on this design decision.[7]

2.3 Comparator firms and re-levered equity beta estimates

19 The equity beta estimates for individual firms generally have poor statistical properties. For example, the statistical noise in stock return data results in equity beta estimates for individual firms being unstable over time (sometimes doubling or halving over the course of two years). In addition, the R-squared statistics tend to be very low, indicating that there is a high degree of firm-specific noise which makes it difficult to reliably quantify the relationship between stock and market returns.

[6] See Henry (2014), *Estimating β: An update*, April, Equation (4), p. 6. Henry (pp. 8-9) notes that he was instructed to also report estimates from the Least Absolute Deviations (LAD) approach

[7] Henry (2014), pp. 8-10.

20 For this reason, it is common to consider a set of comparator firms such that random statistical noise might tend to cancel out in a large enough sample of firms. There are two ways to distil the information from a set of comparator firms into a single beta estimate:

a. Estimate beta for each of the comparator firms and take the mean over this set of estimates; and

b. For each period, form the returns from each comparator firm into a portfolio return and use the portfolio returns in the OLS regression approach to produce a single estimate of beta.

21 In this report, we follow the standard approach of considering both of these techniques for reducing sampling error.[8]

22 When using a set of comparator firms, it is important to produce "re-levered" equity beta estimates. To explain this concept, we first note that beta is an estimate of the systematic risk of owning shares in the relevant company. There are two elements of this risk:

a. The asset beta – the inherent risk of the firm's operations; and

b. Leverage – the extent to which the firm has issued debt finance which ranks ahead of equity.

23 The asset beta reflects the extent to which some lines of business are inherently riskier than others. For example, high-end consumer products and financial services businesses tend to perform very well when the market is up and poorly when the market is down, whereas carton manufacturers and supermarkets tend to have more stable performance over market cycles.

24 Consider two firms with the same asset beta (because they operate in the same industry) but which have different leverage. The shareholders in the firm with higher leverage are subject to more risk. This is because the debt holders have a claim that ranks ahead of equity – they are entitled to be paid in full before the equity holders are entitled to any residual distribution.

25 Selecting comparator firms to match the relevant characteristics of the firm in question ensures that the sample firms all have similar operational risk (asset beta). However, the comparator firms may have different leverage. To correct for these differences in leverage, a procedure known as 're-levering' is used.

26 In the case at hand, the AER has determined that the benchmark efficient entity (BEE) has 60% debt finance. If a comparator firm has, for example, 50% leverage, its beta estimate must be re-levered to provide an estimate of what that beta estimate would have been if the firm had 60% debt commensurate with the BEE. The process of re-levering beta estimates to ensure that they are comparable is

[8] For example, these two approaches were adopted by Henry (2014).

standard academic and industry practice. All of the Henry (2014) beta estimates have been re-levered by multiplying the raw beta estimates by the following factor:

$$\omega = \frac{1-\overline{G}}{1-0.60}$$

where $\overline{G}$ represents the average leverage of the comparator firm over the relevant data period. We follow the Henry (2014) approach to re-levering throughout this report.

2.4 The AER approach to beta

27 The AER's approach to setting the allowed beta involves two steps:

a. The first step is to determine a range for beta from an analysis of domestic comparators; and

b. The second step is to use all other relevant evidence to guide the selection of a point estimate from within that range.

28 In its Guideline materials, the AER summarised its approach as follows:

> …the AER proposes to estimate the range for the equity beta based on empirical analysis using a set of Australian energy utility firms the AER considers reasonably comparable to the benchmark efficient entity. This approach leads to a range for equity beta from 0.4 to 0.7.
>
> The AER then proposes to use other information sources to inform the selection of a point estimate from within the empirical range of equity beta estimates. This additional information includes:
>
> - empirical estimates of overseas energy networks.
> - the theoretical principles underpinning the Black CAPM.
>
> This approach leads to a point estimate of 0.7 for equity beta, chosen from within the range 0.4 to 0.7.[9]

29 The AER has maintained its 0.7 beta allowance in all of its decisions since the Guideline.

30 In relation to the first step of establishing a primary range based on a consideration of statistical estimates from domestic comparators only, the AER commissioned the Henry (2014) report. Henry advised the AER that:

[9] AER Rate of Return Guideline, p. 15.

> In the opinion of the consultant, the majority of the evidence presented in this report, across all estimators, firms and portfolios, and all sample periods considered, suggests that the point estimate for β lies in the range 0.3 to 0.8.[10]

31 The AER has not adopted the advice from Henry (2014) and has instead adopted a primary range of 0.4 to 0.7. The AER has explained its rationale as follows:

> …while Henry appears to base his range on all his estimates (including individual firm estimates), we consider the most useful empirical estimates in our regulatory context are averages of individual firm estimates and fixed weight portfolio estimates. We note, in any case, that a point estimate of 0.7 is consistent with, and at the higher level of, the range identified by Henry.[11]

32 Consequently, while we report individual firm estimates below, our primary focus is on the average and portfolio estimates of beta.

33 The second step of the AER's approach to beta is to select a point estimate from within its primary range. The AER begins this task by concluding that:

> We also consider Henry's 2014 results indicate a best empirical estimate of approximately 0.5 for the benchmark efficient entity. This is because most of the [average and portfolio] estimates are clustered around 0.5...[12]

34 However, the AER also notes that there are additional considerations that inform its determination of the equity beta point estimate from within the range. In its recent decisions, the AER has maintained its beta allowance at 0.7. The choice of the final point estimate of 0.7—which is at the top of the AER's estimated equity beta range, and above the AER's best empirical estimate of 0.5—is said to be based on three considerations:[13]

a. "International estimates" – due to the fact that the weight of evidence from international comparators supports a beta estimate materially above the AER's domestic starting point estimate of 0.5;

b. "Considerations of the Black CAPM" – due to the fact that the Black CAPM evidence is that the unadjusted SL-CAPM will systematically understate the required return on low-beta stocks; and

c. "Investor certainty" – due to the fact that a larger movement from the AER's previous 0.8 allowance may cause investors to increase their assessment of regulatory risk.

[10] Henry (2014), p. 63.

[11] TransGrid Draft Decision, 2017, Attachment 3, p. 3-274.

[12] TransGrid Draft Decision, 2017, Attachment 3, p. 3-243.

[13] TransGrid Draft Decision, 2017, Attachment 3, p. 3-165.

35 Nowhere in its decisions does the AER quantify how much of the uplift from 0.5 to 0.7 is due to each of the three factors that it has documented. Moreover, the AER has not stated whether it considers any of the three factors to be more or less important than the others.

3 The ERA's recent updated beta estimates

3.1 A current best statistical estimate of 0.7

36 In its recent (June 2016) Final Decision for DBP,[14] the ERA noted that it had adopted a range of 0.3 to 0.8, consistent with the advice from Henry (2014):

> The Authority noted in the Draft Decision it considered that the 95 per cent confidence interval for the beta estimate was 0.3 to 0.8. The Authority then determined a point estimate for beta at 0.7, allowing for some adjustment towards the top end of the range to account for the theory underpinning the Black CAPM.[15]

37 For its Final Decision, the ERA updated its beta estimates for domestic comparators and concluded that:

> …the Authority considers that a 95 per cent confidence interval range of equity beta using the most recent data is from 0.479 and 0.870 based on the portfolio results (see Appendix 4A, Table 21 and Table 22). The central estimate given by the average of the portfolios is 0.699. The Authority notes that portfolio estimates have a narrower range than the individual assets.
>
> Based on its own analysis and the other evidence before it, together with the recognition that estimates of equity beta from empirical studies exhibit a high level of imprecision, the Authority is of the view that the point estimate of equity beta of 0.7 (rounded) provides a conservative and appropriate central best estimate for beta for use in the SL-CAPM.[16]

38 That is, the ERA has concluded that the latest available data supports a best statistical beta estimate of 0.7, as compared to the AER's 2013 best statistical estimate of 0.5. Unlike the AER, the ERA does not reflect in its final point estimate the international evidence, low-beta bias or investor certainty. Rather, the ERA compiles what it considers to be the best statistical estimate and adopts that figure – which it currently considers to be 0.7. Any accounting for the factors identified by the AER in the Guideline as relevant to the selection of the final point estimate would result in a higher estimate.

[14] ERA, Final Decision on Proposed Revisions to the Access Arrangement for the Dampier to Bunbury Natural Gas Pipeline 2016 – 2020, 30 June 2016.

[15] DBP Final Decision, Attachment 4, Paragraph 469.

[16] DBP Final Decision, Attachment 4, Paragraphs 473-474.

3.2 The ERA's estimation methodology

3.2.1 Currently existing comparators

39 The ERA's approach to estimating beta was to focus on the four domestic comparators that still remained listed at the time the ERA conducted its analysis: APA Group, AusNet Services, DUET and Spark Infrastructure.[17] The ERA does not estimate betas using firms that were once listed but that have subsequently been delisted. We agree with this approach and adopt it in our empirical analysis below. In our view, regression analysis applied to firms that have not existed for several years is unlikely to provide an estimate of beta that is commensurate with the prevailing conditions in the market for equity funds.

3.2.2 Portfolio estimates

40 The ERA draws its conclusions on the basis of portfolio estimates, considering both equally weighted and value weighted portfolios. Whereas the ERA also reports mean estimates over the four remaining comparators, it places less weight on them. This is primarily because the beta estimates for one of the four comparators, DUET, are materially below all of the other individual firm estimates and all of the portfolio estimates.[18] Our approach is to consider average and portfolio estimates.

3.2.3 Range of regression approaches

41 The ERA uses four variations of regression analysis – standard OLS analysis and three other methods. The beta estimates from OLS analysis are generally lower than the estimates from the other techniques.[19] However, it is only the estimate from OLS regression that corresponds to the CAPM definition of beta, so we focus on OLS estimates in our empirical analysis below.

3.2.4 Use of five years of data

42 The ERA focuses on estimates from the most recent five years of data. When estimating beta there is a trade-off between using a short data period to ensure that the estimate is commensurate with prevailing conditions, and using a longer period to improve statistical precision. Our view is that a five-year period is generally insufficient to provide sufficient statistical precision, so we also consider estimates from longer (10-year) periods.

---

[17] DUET was de-listed in May 2017, leaving just three listed domestic energy network comparator firms.

[18] DBP Final Decision, Attachment 4, Paragraphs 470-471.

[19] DBP Final Decision, Attachment 4, Table 2, p. 102.

4 Current equity beta estimates

43 This section sets out recent beta estimates for:

a. The four domestic regulated utility comparator firms that remained listed until May 2017: APA Group, AusNet Services, DUET and Spark Infrastructure;[20] and

b. A broader set of firms that have investments in long-lived infrastructure assets.

44 We report beta estimates for individual firms, mean estimates across firms, and portfolio estimates (equal and value-weighted portfolios).

4.1 Data Source

45 We have obtained weekly and monthly total returns for each stock and the broad market index[21] from Datastream for the most recently available 10-year period, 2006-09-01 to 2016-09-01. Our main results are based on the full 10-year period, but we also consider periods of different lengths as a robustness test.

4.2 Methodology

4.2.1 Regression analysis

46 All of the beta estimates reported below are estimated by OLS as set out in Section 2.2 above:

$$r_{i,t} = \alpha + \beta r_{m,t} + \varepsilon_t .$$

47 We have re-levered all estimates to be consistent with the 60% leverage assumption that the AER has adopted. We have used the same re-levering process that was adopted by Henry (2014) and which has been used consistently by the AER in every decision since its inception. Specifically, the re-levering is performed by multiplying the raw OLS beta estimates by the following factor:

$$\omega = \frac{1-\overline{G}}{1-0.60}$$

where $\overline{G}$ represents the average leverage of the comparator firm over the relevant data period.

[20] DUET was delisted in May 2017, leaving just three comparator firms in the AER's sample listed.

[21] ASX 200 Total Return Index.

4.2.2 Equally weighted portfolio construction

48 We construct equally-weighted portfolio estimates for two portfolios:

a. The set of four domestic regulated gas and electricity distribution businesses; and

b. The broader set of infrastructure firms.

49 In each case, the equally weighted portfolio is created by assigning the same weight to the returns of each firm for each period:

$$r_{p,t} = \frac{1}{N}\sum_{i=1}^{N} r_{i,t} .$$

50 For example, when computing a weekly estimate, we compute the portfolio return for each week as the simple mean of the returns of each of the firms in the portfolio. This produces a single time series of portfolio returns, which are regressed against the corresponding market returns to produce a raw beta estimate.

51 The raw beta estimate is then re-levered using the AER approach, as set out above. The average leverage is computed by constructing an equally-weighted average of the leverage of each component firm for each week or month, and then by averaging over all weeks or months:

$$\overline{G}_p = \frac{1}{T}\sum_{t=1}^{T}\left(\frac{1}{N}\sum_{i=1}^{N} G_{i,t}\right).$$

4.2.3 Value weighted portfolio construction

52 The value weighted portfolio return for each week or month is constructed by applying a number of steps:

a. For each week or month, the "portfolio market value of equity" is created as the sum of the market value of equity for each constituent firm:

$$E_{p,t} = \sum_{i=1}^{N} E_{i,t} .$$

b. The weight applied to each constituent firm (for that period, *t*) is then constructed as the ratio of the firm's market value of equity to that of the portfolio:

$$w_{i,t} = \frac{E_{i,t}}{E_{p,t}}.$$

c. The portfolio return for each period, *t*, is then constructed as a weighted average of the returns of each constituent firm:

$$r_{p,t} = \sum_{i=1}^{N} w_i r_{i,t}$$

This produces a single time series of portfolio returns, which are regressed against the corresponding market returns to produce a raw beta estimate.

53 The raw beta estimate is then re-levered using the AER approach, as set out above. The average leverage is computed by constructing a value weighted average of the leverage of each component firm for each period, *t*, and then by averaging over all weeks or months:

$$\overline{G}_p = \frac{1}{T}\sum_{t=1}^{T}\left(\sum_{i=1}^{N} w_{i,t} G_{i,t}\right).$$

4.3 Current beta estimates for domestic utilities

54 We begin by reporting current beta estimates for the four firms in the AER's set of domestic comparators that remained listed until May 2017. In all cases, we report raw OLS beta estimates and re-levered estimates in a table structure that follows Henry (2014).

4.3.1 Beta estimates over the past five years

55 We begin by considering beta estimates over the most recent five-year period. Although our view is that a sample of five years and four comparator firms is too small to produce reliable estimates, we report these results:

a. To provide an indication of the direction of movement in equity beta estimates since the 2013 Guideline; and

b. To provide a point of comparison with the ERA's recent approach, which was to rely almost exclusively on estimates from the most recent five-year period for the four domestic utilities.

Table 1 shows that the re-levered equity beta estimates for three of the four firms are in the order of 0.7 to 0.9, with the DUET estimate appearing to be an outlier in the sense that it is materially below the other three estimates.

56 Figure 1 shows that the 95% confidence interval for DUET does not overlap the interval for any of the other estimates, indicating that the DUET estimate is significantly different from all other estimates.

57 As noted above, DUET is no longer listed, so is no longer available to the AER as a comparator contributing current information towards the estimate of the equity beta. The mean estimate over the four firms is 0.67, and if DUET is excluded the mean rises to 0.79.

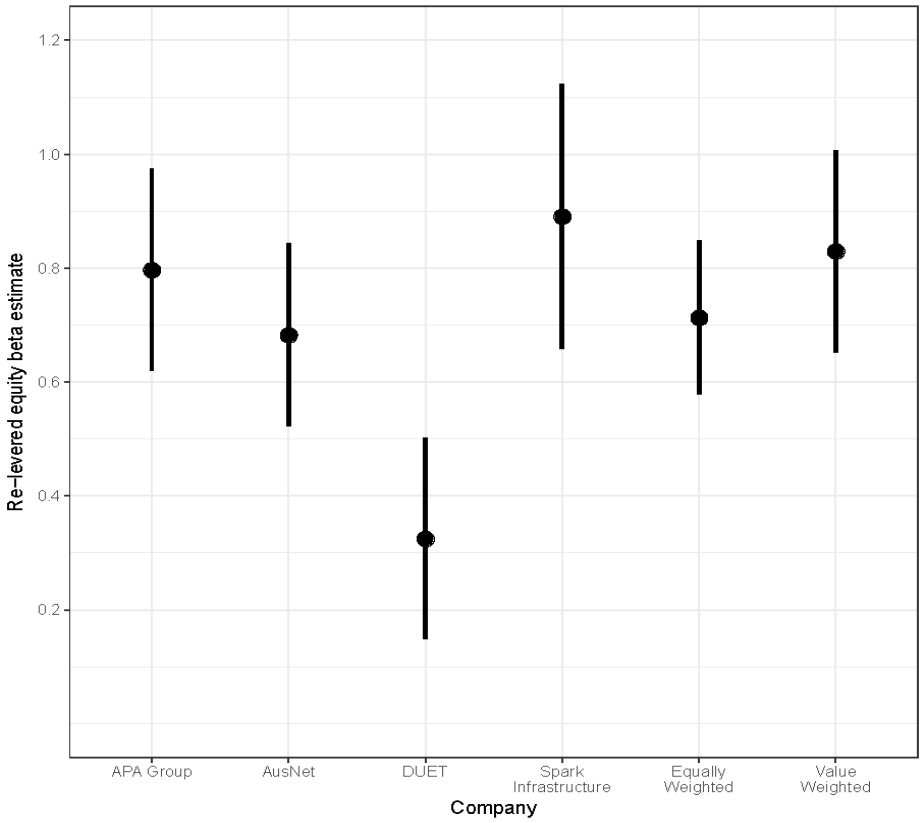
58 The value and equally-weighted portfolio estimates are 0.71 and 0.83 respectively, which corresponds closely to the estimates for three of the four comparator firms. The mean of the two portfolio estimates is 0.77.

Table 1: Weekly beta estimates over the last 5 years

Statistic	APA	AST	DUE	SKI	Equally-Weighted Portfolio	Value-Weighted Portfolio
Average gearing	0.50	0.58	0.64	0.28	0.50	0.52
Adjustment factor	1.24	1.04	0.90	1.80	1.24	1.20
Raw beta	0.64	0.66	0.36	0.49	0.58	0.69
Re-levered beta	0.80	0.68	0.33	0.89	0.71	0.83
Standard error	0.09	0.08	0.09	0.12	0.07	0.09
Confidence interval upper bound	0.97	0.84	0.50	1.12	0.85	1.01
Confidence interval lower bound	0.62	0.52	0.15	0.66	0.58	0.65
R^2	0.20	0.21	0.05	0.11	0.25	0.21
Observations	260	260	260	260	260	260

Source: Datastream, Frontier Economics calculations. Five years to beginning of May 2017.

Figure 1: 95% confidence intervals for weekly beta estimates over the last 5 years



Source: Frontier Economics

59 We have also compiled beta estimates using monthly data over the last five years. The key monthly point estimates are as follows:

a. The mean estimate over the four comparator firms is 0.82;

b. The equally-weighted portfolio estimate is 0.96;

c. The value-weighted portfolio estimate is 1.20;

d. The average of the two portfolio estimates is 1.08.

That is, the monthly estimates are generally higher than the weekly estimates.

60 It is clear that these recent re-levered equity beta estimates are materially higher than the best statistical estimate of 0.5 adopted by the AER in its decisions since the Rate of Return Guideline.

4.3.2 Beta estimates over the past ten years

As set out above, our view is that a sample of four firms and five years of data is insufficient to provide statistically reliable estimates of beta. In this section, we expand the sample period to ten years, examining a period from May 2007 to May 2017. The results are set out in Table 2.

Table 2: Weekly beta estimates over the last 10 years

Statistic	APA	AST	DUE	SKI	Equally-Weighted Portfolio	Value-Weighted Portfolio
Average gearing	0.56	0.61	0.71	0.37	0.57	0.57
Adjustment factor	1.09	0.97	0.73	1.57	1.08	1.07
Raw beta	0.62	0.38	0.48	0.42	0.51	0.56
Re-levered beta	0.68	0.37	0.35	0.65	0.55	0.59
Standard error	0.05	0.05	0.05	0.07	0.04	0.05
Confidence interval upper bound	0.79	0.47	0.46	0.80	0.63	0.69
Confidence interval lower bound	0.57	0.26	0.24	0.51	0.47	0.50
R^2	0.21	0.08	0.10	0.09	0.24	0.22
Observations	521	521	521	521	521	521

Source: Datastream, Frontier Economics calculations. Ten years to beginning of May 2017.

61 We have also compiled beta estimates using monthly data over the last ten years. The key monthly point estimates are as follows:

a. The mean estimate over the four comparator firms is 0.83;

b. The equally-weighted portfolio estimate is 0.68;

c. The value-weighted portfolio estimate is 0.80;

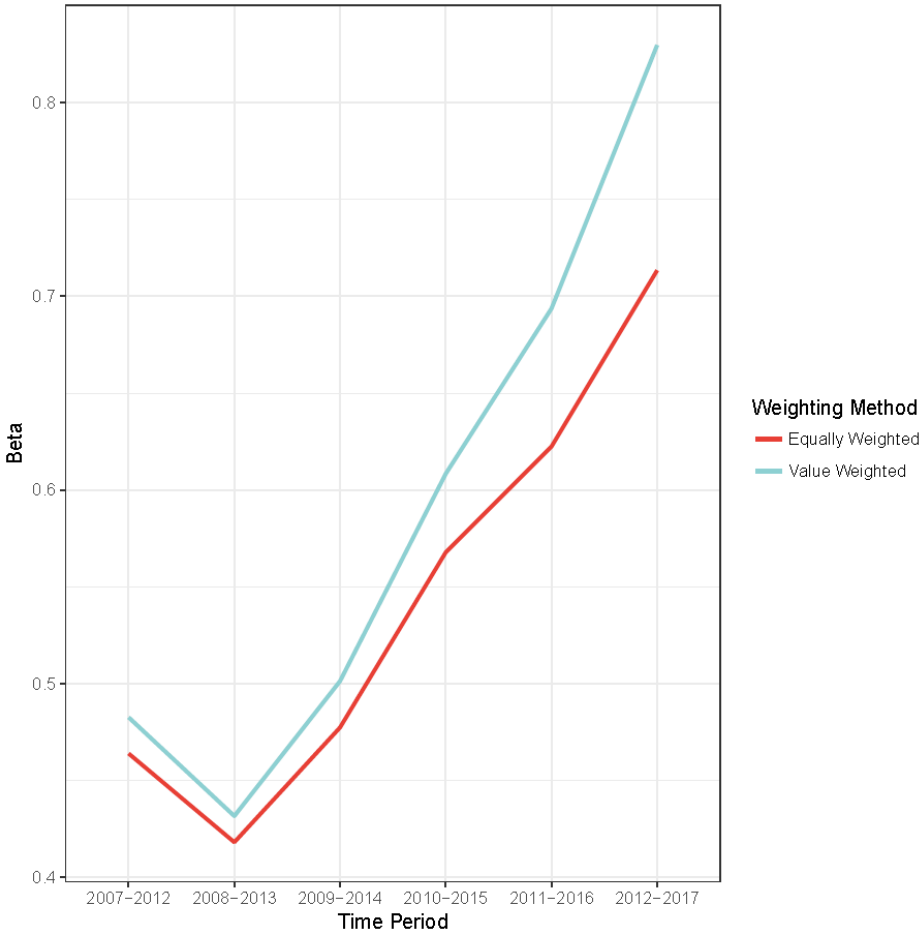
d. The average of the two portfolio estimates is 0.74.

62 The general pattern of results is that the 10-year estimates are lower than the 5-year estimates. This is consistent with the pattern of results reported by the ERA – the ERA's estimates from the most recent five-year period are materially higher than those that were relied upon in its Guideline estimate of beta. This suggests that the correlation between stock returns and market returns (for the four sample firms) has increased markedly over the last five years. Expanding the sample period to ten years includes data from prior to the Guideline and has the effect of reducing the equity beta estimates. This observation leads us to examine a series of rolling beta estimates in the following sub-section.

4.3.3 Rolling beta estimates

63 Figure 2, below shows rolling 5-year beta estimates for the two portfolio methods. We have estimated the re-levered portfolio betas for a number of five-year periods. There is an obvious increase in the portfolio beta estimates as data from 2014, 2015, 2016 and 2017 is introduced, replacing older data from 2007-2008. This is consistent with the notion that the relationship between the domestic comparator stock returns and market returns has become stronger in the years that have passed since the Guideline.

Figure 2: Rolling 5-year portfolio estimates of beta



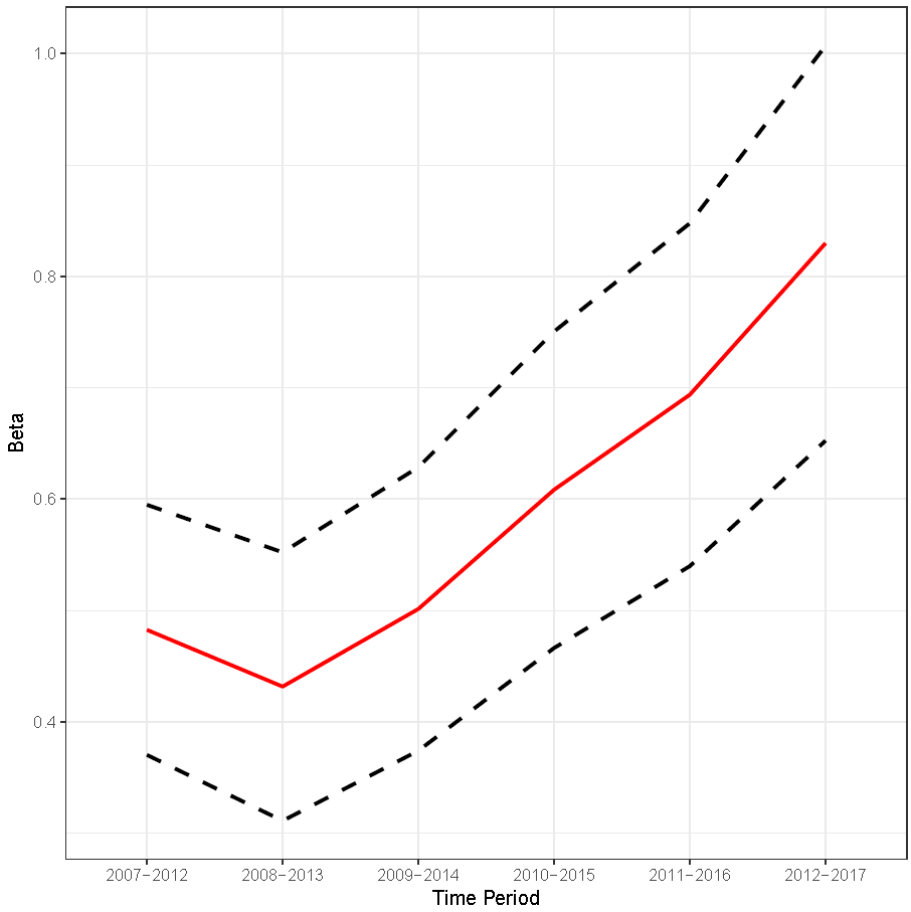
Source: Datastream, Frontier Economics calculations.

64 Figure 3 shows the 95% confidence interval around the rolling five-year weekly value-weighted portfolio estimates. This figure shows that the starting point estimate of 0.5 that the AER adopted from its Guideline analysis does not fall within the standard 95% confidence interval for the most recent estimate.

65 Moreover, there is little or no overlap between the bottom of the current confidence interval and the top of the interval around the time of the Guideline.

This suggests that the estimates have increased significantly since the time of the Guideline.

Figure 3: Rolling average of the value-weighted portfolio, showing 95% confidence intervals

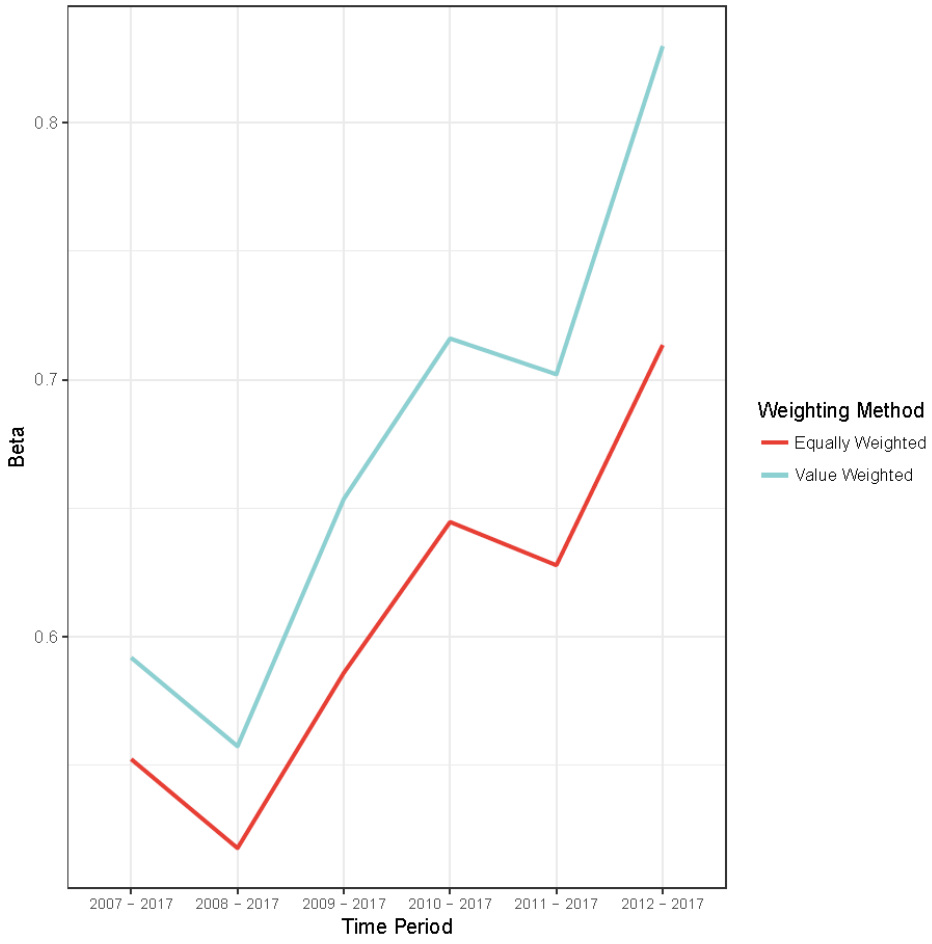


Source: Datastream, Frontier Economics calculations.

66 Figure 4 shows the re-levered portfolio equity beta estimates for different sample periods, all ending with the most recent data from May 2017. The estimates at the left-hand end of the figure are based on a longer sample period of ten years. Moving from left to right sees the length of the sample period decline, always ending with the 2017 data.

67 Again, the pattern in the estimates is obvious – including the older data has the effect of materially reducing the equity beta estimates. This evidence is consistent with the notion that the relationship between the domestic comparator stock returns and market returns has become stronger in the years since the Guideline.

Figure 4: Varying window beta estimates



Source: Datastream, Frontier Economics calculations.

4.3.4 The AER's 2017 update of Henry's estimates

68 In its latest Decisions, the AER states that it has updated the empirical estimates of the equity beta using the methodology employed by Henry (2014) and data up to 28 April 2017.[22] The AER concludes that:[23]

a. the updated empirical estimates continue to support Henry's empirical range of 0.3 to 0.8; and

b. there is insufficient evidence to depart from the AER's estimated beta range of 0.4 to 0.7, or its point estimate of 0.7.

[22] AER Staff Beta Analysis June 2017, published 7 February 2018.

[23] TransGrid Draft Decision, 2017, Attachment 3, p. 63-4.

69 Section 6 explains why we consider the AER has drawn incorrect conclusions from its updated analysis.

70 In essence, the AER's updated beta analysis continues to include five delisted comparators; at the time the AER completed its 2017 analysis, only four of the nine comparators used in the Henry (2014) study remained listed.

71 The problem with including delisted comparators in the sample is that the beta estimates of such firms at the time of delisting become determinative at whatever the estimate happened to be at that time. In other words, because no information on the returns of those comparators is available beyond the date of delisting, the beta estimate at the time of delisting becomes permanently 'frozen' in time. As such, delisted comparators provide no information about how beta estimates may have changed since the date of delisting. Yet, the AER continues to use estimates from firms that have in most cases been delisted for several years (more than a decade in two instances) to derive a *current* estimate of the beta of Australian energy networks.

72 We show in the Attachment that the beta estimates of all of the comparators that remained listed at the time the AER completed its updated beta study have increased since 2014. This supports the findings in this report that the beta of Australian energy networks has increased recently.

4.3.5 Conclusions in relation to domestic energy network comparators

73 The evidence set out above supports the conclusion that the equity beta estimates for the AER's preferred four domestic comparator firms have increased since the 2013 Rate of Return Guideline. Thus, the AER's starting point, or "best statistical estimate" of beta must now be at least what it was at the time of the Guideline.

4.3.6 Evidence from other domestic network utility firms

74 Currently, only three of the nine domestic energy network comparator firms considered by the AER remain listed, following DUET's delisting in May 2017. In our view, it is not possible to derive statistically-reliable beta estimates using just three comparator firms. Therefore, in order to obtain statistically-reliable beta estimates, it is necessary to expand the sample of comparators. A natural way to do this would be to include in the sample energy network comparator firms listed overseas. Whilst the AER has some regard to such firms when determining its final equity beta point estimate, the AER considers that such firms should not be used to estimate primary equity beta range or the best empirical estimate of beta. Therefore, the only remaining way to improve the statistical reliability of beta estimates is to consider empirical estimates from listed domestic non-energy networks.

75 Consequently, we examine the beta estimates of a set of firms that are comparable to an energy distribution business. Specifically, we consider a set of firms that demonstrate the characteristics of:

a. Ownership of very long-lived, tangible, infrastructure assets;

b. Capital intensive businesses;

c. Provision of an access service to customers that provides a relatively stable series of cash flows;

d. Being listed on the ASX.

76 This leads us to consider a set of transport-related infrastructure firms identified as such by the Thomson-Reuters classification scheme. A brief summary of the operations of each of the relevant firms is presented in section 7 of this report.

77 For the avoidance of doubt, we do not claim that these domestic transport infrastructure firms are perfect comparators to energy networks regulated by the AER. However, they share a number of important characteristics with energy networks (outlined above) that are likely to contribute towards the systematic risk of those firms. Therefore, in our view, they are useful in informing the estimate of the equity beta of Australian energy network businesses.

78 Table 3 documents the re-levered equity beta estimates for the set of transport infrastructure firms using weekly data over the last 10 years. For those firms that have not been listed on the ASX for the full 10-year period, estimates are based on the life of those firms.

79 Table 3 shows that the re-levered equity beta estimates range from 0.73 to 1.76, with a mean of 1.23.

80 We have also computed estimates based on different estimation periods and using monthly rather than weekly observations and summarise the results as follows:

a. The mean estimate based on weekly data over the last 5 years is 1.15;

b. The mean estimate based on monthly data over the last 5 years is 1.22; and

c. The mean estimate based on monthly data over the last 10 years is 1.30.

81 In summary, however the estimates are computed for this set of unregulated infrastructure firms, the result is a mean point estimate materially above the AER's current equity beta allowance of 0.7.

Current equity beta estimates

Table 3: Weekly transport infrastructure beta estimates over the last 10 years: Individual firm estimates

Statistic	Auckland International Airport	Aurizon	Macquarie Atlas Roads	Qube Logistics	Sydney Airport	Transurban
Average gearing	0.27	0.20	0.32	0.19	0.51	0.38
Adjustment factor	1.84	2.00	1.71	2.02	1.23	1.55
Raw beta	0.40	0.73	0.93	0.87	0.84	0.51
Re-levered beta	0.73	1.45	1.58	1.76	1.03	0.80
Standard error	0.07	0.10	0.14	0.10	0.07	0.07
Confidence interval upper bound	0.86	1.66	1.85	1.96	1.17	0.93
Confidence interval lower bound	0.59	1.25	1.32	1.56	0.89	0.66
R^2	0.10	0.23	0.17	0.23	0.24	0.14
Observations	521	344	387	521	521	521

Source: Datastream, Frontier Economics calculations. Ten years to July 2017.

82 Table 4 summarises portfolio beta estimates using weekly data over the last 10 years. For each week of the 10-year sample period, we construct the portfolio return using the firms that were listed during that week and we record the average leverage of the firms that were listed in that week. That is, as new firms are listed on the ASX, they enter the portfolio. This produces a series of weekly portfolio returns and weekly leverage estimates. The re-levered beta estimates are then computed in the standard way, as set out above.

83 Table 4 shows that the re-levered equity beta estimates are 1.02 and 0.81 for the equally-weighted and value-weighted portfolios, respectively.

Table 4: Weekly transport infrastructure beta estimates over the last 10 years: Portfolio estimates

Statistic	Equally- Weighted	Value- Weighted
Average gearing	0.32	0.35
Adjustment factor	1.70	1.62
Raw beta	0.60	0.50
Re-levered beta	1.02	0.81
Standard error	0.05	0.06
Confidence interval upper bound	0.92	0.68
Confidence interval lower bound	1.13	0.94
R^2	0.31	0.16
Observations	521	521

Source: Datastream, Frontier Economics calculations. Ten years to July 2017.

84 We have repeated this exercise using monthly data and report similar re-levered equity beta estimates of 1.01 and 0.70, respectively.

85 The conclusion from this analysis of unregulated infrastructure firms is that the re-levered equity beta estimates are all materially above the AER's current starting-point "best statistical" equity beta estimate. Thus, if this evidence were to be afforded any weight, the result would be an increase in the equity beta allowance.

5 Declaration

86 I confirm that I have *made all the inquiries that* I *believe are desirable and appropriate and no matters of significance that I regard as relevant have, to my knowledge, been withheld from the Court.*

Professor Stephen Gray

6 Appendix: Comment on the AER's 2017 beta analysis

87 In the Guideline, the AER concludes on the basis of the Henry (2014) empirical analysis that an appropriate range for the equity beta is 0.4 to 0.7. That study used data for a set of Australian energy network comparators up to 28 June 2013.

88 In its latest Decisions, the AER states that it has updated the empirical estimates of the equity beta using the methodology employed by Henry (2014) and data up to 28 April 2017. The AER published this study in February 2018.[24] The AER concludes that:[25]

a. the updated empirical estimates continue to support Henry's empirical range of 0.3 to 0.8; and

b. there is insufficient evidence to depart from the AER's estimated beta range of 0.4 to 0.7, or its point estimate of 0.7.

89 In this section we comment on the AER's conclusion (which differs from our own) that there is insufficient evidence to suggest that the beta of Australian energy networks has increased since Henry (2014).

90 It appears to us that the main reason the AER concludes that there is insufficient evidence that the beta of Australian energy networks has increased is because in its 2017 beta study, the AER relies on several comparators that have been delisted many years. This can be seen in Table 5 below, which reports the full range of the time series (for each individual firm) used in the AER's 2017 beta study.

91 The Table shows that, at the time of completion of the AER's 2017 beta study:

a. Only four (APA, DUE, SKI and AST) of the original nine comparators used in Henry (2014) remained listed;

b. Two comparators (AGL and GAS) used in Henry (2014) had been delisted for over a decade; and

c. Five comparators (AAN, AGL, ENV, GAS and HDF) used in Henry (2014) had been delisted for more than two years.

[24] AER Staff Beta Analysis June 2017, published 7 February 2018.

[25] TransGrid Draft Decision, 2017, Attachment 3, p. 63-4.

Table 5: Availability of data used in AER's 2017 beta study

Comparator	Starting date	Ending date	Listed at the time of AER 2017 beta study?
Alinta (AAN)	20/10/2000	17/08/2007	No
Australian Gas Light (AGL)	29/05/1992	06/10/2006	No
APA Group (APA)	16/06/2000	28/04/2017	Yes
DUET Group (DUE)	13/08/2004	28/04/2017	Yes
Envestra (ENV)	29/08/1997	12/09/2014	No
GasNet Australia (GAS)	21/12/2001	10/11/2006	No
Hastings Diversified Fund (HDF)	17/12/2004	23/11/2012	No
Spark Infrastructure (SKI)	02/03/2007	28/04/2017	Yes
SP AusNet (AST)	16/12/2005	28/04/2017	Yes

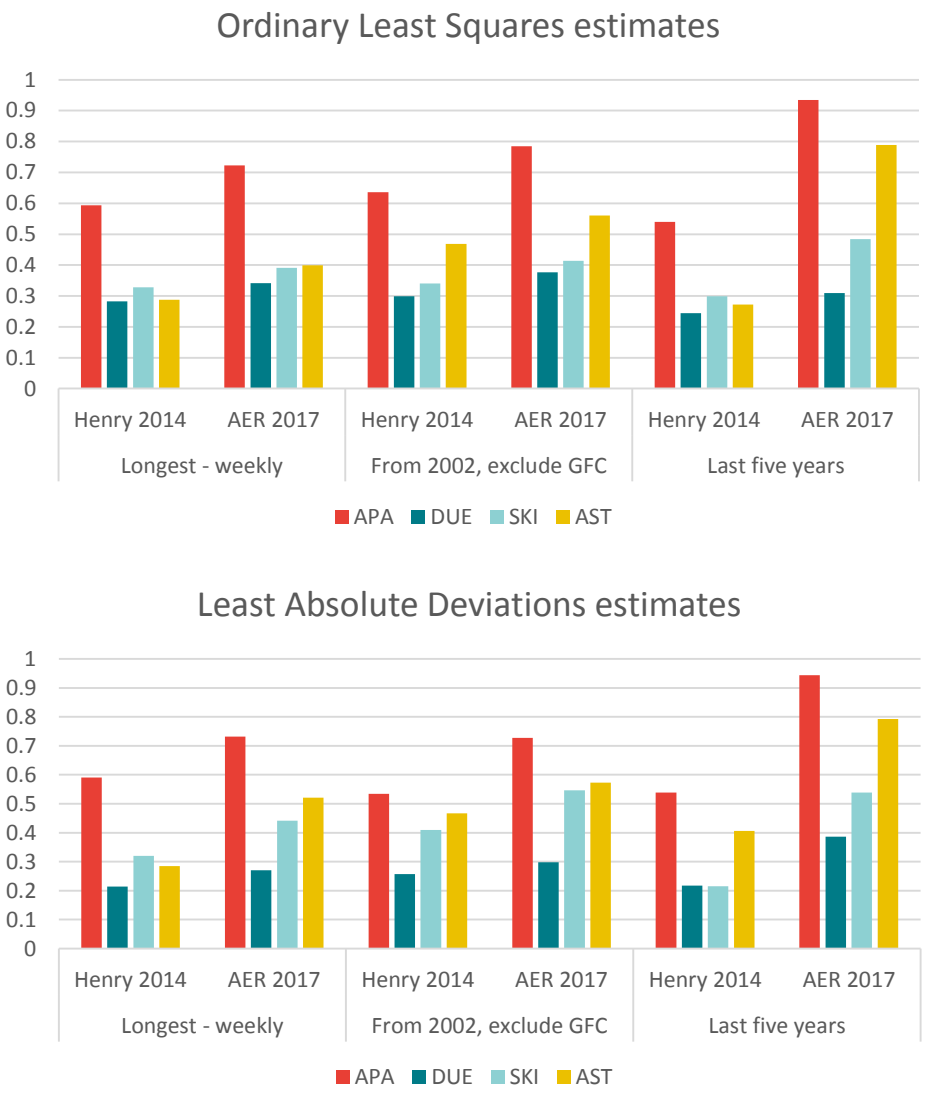
Source: AER 2017 beta study, Table 3, p. 15.

92 The problem with including delisted comparators in the sample is that the beta estimates of such firms at the time of delisting become determinative at whatever the estimate happened to be at that time. In other words, because no information on the returns of those comparators is available beyond the date of delisting, the beta estimate at the time of delisting becomes permanently 'frozen' in time. As such, delisted comparators provide no information about how beta estimates may have changed since the date of delisting.

93 However, a comparison of the individual beta estimates for the four comparators that remain listed at the time of the AER's 2017 beta study with the beta estimates for the same firms in Henry (2014) shows that in every instance the beta estimates have increased. This can be seen in Figure 5 below, which plots the re-levered OLS and LAD estimates for APA, DUE, SKI and AST, as reported in the AER's 2017 beta study and in Henry (2014).

94 Figure 6 shows that the average beta estimate across the four surviving comparators has increased between Henry (2014) and the AER's 2017 beta study.

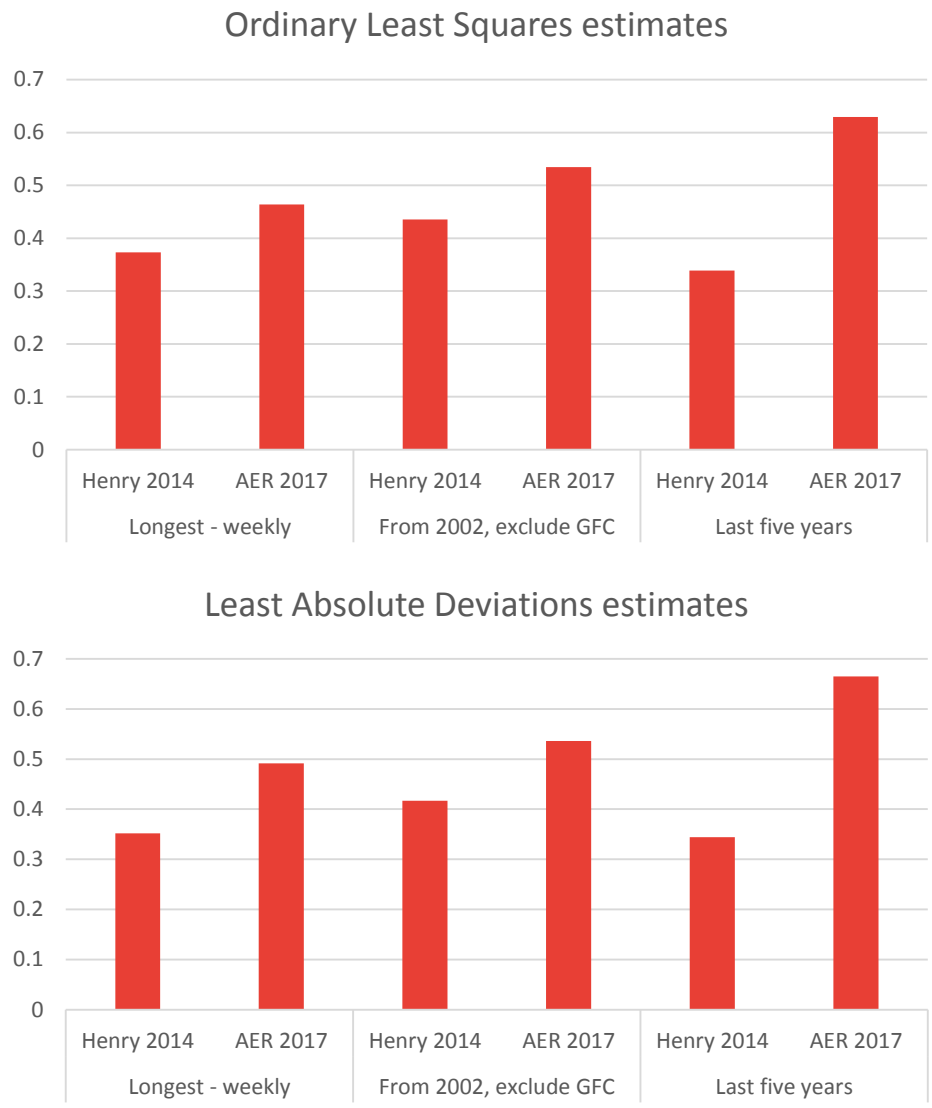
Figure 5: Comparison of 2014 and 2017 individual beta estimates (re-levered) for comparators that remain listed at the time of the AER's 2017 beta study



Source: Henry (2014), AER 2017 beta study

Appendix: Comment on the AER's 2017 beta analysis

Figure 6: Comparison of 2014 and 2017 average beta estimates (re-levered) across comparators that remain listed at the time of the AER's 2017 beta study



Source: Henry (2014), AER 2017 beta study

95 Finally, Figure 7 shows that the beta estimates for a portfolio constructed using only the four comparators that remained listed at the time of the AER's 2017 beta study (referred to by the AER as 'portfolio 6') have increased since 2014.[26]

[26] Since Henry (2014) did not derive estimates for portfolio 6, we have derived the 2014 estimates reported in Figure 7 using data up to 28 June 2013 and the methodology described in the AER's 2017 beta study. We were unable to replicate the 2017 estimates derived by the AER (using Bloomberg data and the methodology described in the AER's 2017 beta study). However, our estimates and those reported in the AER's 2017 beta study differ only slightly. In order to ensure as much comparability as possible, the estimates presented in Figure 7 were derived by Frontier Economics using consistent methodology and the same dataset (albeit for different time periods). The measure of gearing for SKI used in the

Figure 7: Comparison of 2014 and 2017 portfolio estimates (OLS, re-levered) constructed using comparators that remain listed at the time of the AER's 2017 beta study

Source: Frontier analysis

96 The analysis above shows that the most recent estimates derived using only those firms that remain listed — and that therefore provide current information on how

AER's 2017 beta study made use of data obtained from annual reports. We have made no adjustments for data from annual reports; the data used in our analysis were obtained from Bloomberg. Finally, we note that whilst Henry (2014) adopted a net debt approach, the AER's 2017 beta study adopted a total debt approach. For comparability with the AER's results, we have adopted the AER's net debt approach.

Appendix: Comment on the AER's 2017 beta analysis

the beta of Australian energy networks may have evolved since Henry (2014) — have increased.

97 The only way to conclude that the beta of Australian energy networks has not increased since Henry (2014) is by giving material weight to beta estimates derived using stocks that have been delisted for many years (in some cases more than a decade), and therefore have no ability to inform on how the beta of Australian energy networks may have changed recently.

98 For the avoidance of doubt, we are not arguing that statistically reliable beta estimates can be derived using a sample of only four listed comparators.

99 Our fundamental point is that:

a. The AER has some evidence that the beta of Australian energy networks has increased since 2014; but

b. This evidence is muted and masked by the inclusion in the AER's sample of delisted comparators that are capable of providing no information on how the beta of Australian energy networks has changed since 2014.

Appendix: Comment on the AER's 2017 beta analysis

7 Appendix: Transport comparator firms

100 In this appendix we provide a short explanation of what each of the firms in the transport utility portfolios does. These explanations are taken directly from Thompson Reuters.

7.1.1 Auckland International Airport Limited (AIA)

101 Auckland International Airport Limited provides airport facilities and supporting infrastructure in Auckland, New Zealand. Whilst AIA is a New Zealand firm, it is listed on the ASX. The Company operates in three segments: Aeronautical, Retail and Property. The aeronautical business provides services that facilitate the movement of aircraft, passengers and cargo, and provides utility services that support the airport. The aeronautical business also earns rental revenue from space leased in facilities, such as terminals. The retail business provides services to the retailers within the terminals and provides car parking facilities for airport staff, visitors and passengers. The property business earns rental revenue from space leased on airport land outside the terminals, including cargo buildings, hangars and standalone investment properties. Its subsidiaries include Auckland Airport Limited, Auckland Airport Holdings Limited and Auckland Airport Holdings (No. 2) Limited.

7.1.2 Aurizon Holdings Limited (AZJ)

102 Aurizon Holdings Limited is engaged in rail-based transport business. The Company acts as a heavy haul freight railway operator and rail transporter of coal from mine to port for export markets, and also engages in bulk general and containerized freight businesses and rail services activities. Its segments include Network, Commercial & Marketing, Operations and Other. The Network segment provides access to, operation and management of the Central Queensland Coal Rail Network. The Network segment is also engaged in the provision of overhaul and maintenance of rail network assets. The Commercial & Marketing segment is responsible for commercial negotiation of sales contracts and customer relationship management. The Operations segment is responsible for the national delivery of coal, iron ore, bulk and intermodal haulage services. It also includes yard operations, fleet maintenance, operations, engineering and technology, engineering program delivery and safety, health and environment.

7.1.3 Macquarie Atlas Roads Group (MQA)

103 Macquarie Atlas Roads Group is an Australia-based global infrastructure developer and operator. The Company comprises Macquarie Atlas Roads Limited and Macquarie Atlas Roads International Limited. Its portfolio assets have interests in five international toll roads, including Autoroutes Paris-Rhin-Rhone (APRR), which is a toll road network located in the east of France and covers over 2,320

kilometres of motorway network; Dulles Greenway, which is a toll road located in northern Virginia, the United States, and covers over 20 kilometres toll road which forms part of a commuter route into Washington District of Columbia; Warnow Tunnel, which is a toll tunnel located in Rostock, Germany, and covers over two kilometres toll road and tunnel under the Warnow River in the northern German city of Rostock, and M6 Toll, which is a toll road located in the West Midlands, United Kingdom, and covers over 43 approximately tolled motorway in the West Midlands of the United Kingdom.

7.1.4 Qube Holdings Limited (QUB)

104 Qube Holdings Limited is an Australia-based logistics and infrastructure company. The principal activities of the Company consist of logistics solutions across various aspects of the import-export supply chain, and the management and development of strategic properties into inland rail terminals, bulk terminals and related logistics facilities. Its segments include Logistics, which provides a range of services relating to the import and export of containerized cargo; Ports & Bulk, which consists of port and bulk logistics wherein port logistics activities are focused on the provision of an integrated logistics solution for the automotive industry, and bulk logistics activities are aimed at offering customers a logistics solution from mine-to-ship covering various activities, such as transport, stockpile management, ship loading facilities and stevedoring; Strategic Assets, which consists of the Company's interests in the Moorebank Industrial Property Trust, and Corporate and Other.

7.1.5 Sydney Airport (SYD)

105 Sydney Airport Holdings Limited the ownership of Sydney Airport. The Company's investment policy is to invest funds in accordance with the provisions of the governing documents of the individual entities within the Company. The Company is consists of Sydney Airport Limited (SAL) and Sydney Airport Trust 1 (SAT1).The Trust Company (Sydney Airport) Limited (TCSAL) is the responsible entity of SAT1.

7.1.6 Transurban Group (TCL)

106 Transurban Group is engaged in the development, financing, operation and maintenance of toll roads networks, as well as management of the associated customer and client relationships. The Company's segments include Victoria (VIC), New South Wales (NSW), Queensland (QLD) and the Greater Washington Area (GWA). Its VIC segment's operations include CityLink operations and development of CityLink Tulla Widening and Western Distributor. Its NSW segment's operations include GLIDe tolling system and the development of NorthConnex. Its QLD segment's operations include AirportlinkM7 and the development of Inner City Bypass (ICB), Gateway Upgrade North and Logan Enhancement Project. Its GWA segment's operations include 95 Express Lanes

and the development of I-66, I-395 and Southern Extensions to 95 Express Lanes. The Company manages and develops urban toll road networks in Australia and the United States. Its subsidiaries include Transurban Holdings Limited and Transurban Holdings Trust.

Appendix: Transport comparator firms

8 Appendix: Instructions

Professor Stephen Gray
Frontier Economics

By email: Stephen.Gray@frontier-economics.com.au

ACTEWAGL DISTRIBUTION - EXPERT REPORT ON EQUITY BETA

ActewAGL Distribution (**AAD**) is seeking an expert report from Frontier Economics in relation to estimating the equity beta, for the purposes of determining the return on equity, in the context of the Australian Energy Regulator's (**AER's**) distribution determination for AAD for the 2019-24 regulatory period.

BACKGROUND

AAD is the distribution network service provider (**DNSP**) for the Australian Capital Territory electricity distribution network.

AAD is currently preparing its regulatory proposal for the 2019-24 regulatory period, which is due to be submitted to the AER in January 2018. AAD's regulatory proposal is required to include a building block proposal for direct control services classified under the proposal as standard control services.

The building block proposal must be prepared in accordance with (among other things) the requirements of Part C of Chapter 6 of the National Electricity Rules (**NER**). In particular, the building block proposal must be prepared in accordance with clause 6.4.3 of the NER, which specifies the building blocks by which the 'annual revenue requirement' for a DNSP for each year of a regulatory control period is to be determined. The building blocks include a return on capital for that year (calculated in accordance with clause 6.5.2 of the NER).

NER provisions

Clause 6.5.2(a) of the NER provides that the return on capital for each regulatory year must be calculated by applying a rate of return for the relevant DNSP for that regulatory year that is determined in accordance with clause 6.5.2 (the allowed rate of return) to the value of the regulatory asset base for the relevant distribution system as at the beginning of that regulatory year. Clause 6.5.2(b) of the NER provides that the allowed rate of return is to be determined such that it achieves the allowed rate of return objective. It further requires that both the return on equity and the return on debt are to be estimated such that they contribute to the achievement of the allowed rate of return objective. The allowed rate of return objective is that the rate of return for a DNSP is to be commensurate with the efficient financing costs of a benchmark efficient entity with a similar degree of risk as that which applies to the DNSP in respect of the provision of standard control services.

Clause 6.5.2(d) of the NER provides that, subject to clause 6.5.2(b), the allowed rate of return for a regulatory year must be:

- a weighted average of the return on equity for the regulatory control period in which that regulatory year occurs (as estimated under clause 6.5.2(f)) and the return on debt for that regulatory year (as estimated under clause 6.5.2(h)); and

- determined on a nominal vanilla basis that is consistent with the estimate of the value of imputation credits referred to in clause 6.5.3.

Under clause 6.5.2(e), in determining the allowed rate of return, regard must be had to:

- relevant estimation methods, financial models, market data and other evidence;

- the desirability of using an approach that leads to the consistent application of any estimates of financial parameters that are relevant to the estimates of, and that are common to, the return on equity and the return on debt; and

- any interrelationships between estimates of financial parameters that are relevant to the estimates of the return on equity and the return on debt.

Clause 6.5.2(f) and (g) of the NER requires that the return on equity must be estimated such that it contributes to the achievement of the allowed rate of return objective, having regard to the prevailing conditions in the market for equity funds.

Rate of Return Guideline

In accordance with clauses 6.2.8(a) and 6.5.2(m) and (n) of the NER, on 17 December 2013 the AER published a Better Regulation Rate of Return Guideline, December 2013 (Rate of Return Guideline) which sets out the AER's proposed approach to determining the allowed rate of return (including the return on equity) in accordance with the National Electricity Law (NEL) and the NER.

Due to recent proceedings in the Australian Competition Tribunal (Tribunal) and Federal Court (discussed below), clause 6.5.2(p) of the NER was amended to provide the AER with up to 5 years (i.e. until December 2018) to review the Rate of Return Guideline. The rule change introduced transitional arrangements for affected service providers (including AAD) that will be part way through the regulatory determination process when the new Guideline is published[1]. To provide regulatory certainty, the transitional arrangements apply the 2013 Rate of Return Guideline to the full 2019-24 regulatory determination process, regardless of when the AER publishes the revised Guideline.

Clause 6.2.8(c) of the NER provides that the Rate of Return Guideline is not mandatory. However, a building block proposal must identify any departure from the methodologies set out in the Rate of Return Guideline and the reasons for that departure, and, if the AER makes a distribution determination that is not in accordance with the Guideline, the AER must state its reasons for departing from the Guideline in that determination (clauses 6.2.8(c) and S6.1.3(9) of the NER).

[1] AEMC 2016, Rule Determination: National Electricity Amendment (Rate of Return Guidelines Review) Rule 16, National Gas Amendment (Rate of Return Guidelines Review) Rule 2016, October.

The Rate of Return Guideline states that the AER's proposed approach to estimating the return on equity is to:

- use the Sharpe Lintner Capital Asset Pricing Model (SL-CAPM) as the 'foundation model'. The SL-CAPM is estimated by adding the product of the equity beta and market risk premium (MRP) to the risk free rate;
- adopt a risk free rate determined by reference to the yields on Commonwealth Government Securities (CGS) with a 10 year term over an averaging period of 20 consecutive business days as close as practicably possible to the commencement of the regulatory control period;
- use a point estimate of 0.7 for the equity beta;
- estimate a range for the MRP having regard to theoretical and empirical evidence, and then select a point estimate from within that range; and
- determine a final point estimate for the expected return on equity equal to the foundation model point estimate, or alternatively, a different value that is a multiple of 25 basis points (drawing on the analysis and evaluation of a range of other information).

The Rate of Return Guideline states that the AER proposes that:

- the Black capital asset pricing model informs the equity beta estimate input to the SL-CAPM;
- dividend growth models inform the MRP estimate input to the SL-CAPM; and
- the Fama-French Three Factor Model has no role.

Return on equity in 2015-19 period

In the AER's distribution determination for AAD for the 2015-19 period, the AER used a foundation model approach to estimating the return on equity and used the SL-CAPM as the foundation model. The AER adopted a risk free rate of 2.55%, an equity beta of 0.7 and a MRP of 6.5% as the input parameter values for the SL CAPM, resulting in a return on equity of 7.1%.

The AER's decision in respect of return on equity was the subject of an application to the Tribunal in 2015. AAD sought a review of the AER's decision in respect of the return on equity estimate, and proposed a return on equity of 9.83% (estimated by reference to four models - the SL-CAPM, Black-CAPM, Fama-French Three Factor Model and Dividend Growth Model).

In the Tribunal proceedings, the Tribunal concluded that the grounds of review in relation to the AER's return on equity estimate were not made out, and did not find error in the AER's use of the SL-CAPM as the foundation model or its selection of an equity beta of 0.7 and MRP of 6.5%. The Tribunal's reasons are set out in *Applications by Public*

Interest Advocacy Service Ltd and Ausgrid Distribution [2016] ACompT 1 (**the Ausgrid decision**).

AAD proposal

AAD proposes to adopt the AER's 2013 Rate of Return Guideline in respect of the return on equity for its regulatory proposal for 2019-24. Specifically, AAD currently anticipates that it will adopt the SL-CAPM as the foundation model, consistent with the decision of the Tribunal on the cost of equity in the Ausgrid decision and estimate the risk free rate using the prevailing yield on 10 year CGS. As set out further below, AAD is seeking your expert opinion on the appropriate estimate for the equity beta for the purposes of its regulatory proposal.

SCOPE OF WORK

AAD would like Frontier to provide a report giving your expert opinion on the appropriate equity beta for estimating the return on equity and WACC for AAD for the 2019-24 regulatory period. Your expert report should address the appropriate approach to estimating equity beta within the framework of the SL-CAPM and NER, including:

- an update of the statistical estimates of the equity beta using the AER's 2013 Guideline methodology and market data that has become available since the publication of the 2013 Guideline;
- consideration of the adjustments that the AER has made in the past to its statistical estimate of the equity beta to arrive at its final equity beta estimate;
- consideration of the latest evidence on Australian energy network businesses published by the Economic Regulation Authority of Western Australia (ERA), given that the 2013 Guideline had regard to similar evidence published by the ERA in 2013;
- a reasonable, current estimate of the equity beta for Australian energy network businesses; and
- any other matters that you consider relevant.

In undertaking the above work, AAD expects Frontier to consider the following information:

- Such information that, in your opinion, should be taken into account to address the questions outlined above.
- Relevant literature on estimating the return on equity.
- The AER's 2013 Rate of Return Guideline, including explanatory statements and supporting expert material.
- Material submitted to the AER as part of its consultation on the Rate of Return Guideline.

- Previous decisions of the AER and other relevant regulators on the return on equity and value of imputation credits, and any supporting expert material, including in expert material relied on by the AER in recent decisions

- Previous decisions of the Tribunal and Federal Court on the return on equity, and the submissions made by the parties in the relevant proceedings before them and any supporting expert material.

EXPERT WITNESS

AAD anticipates providing a copy of your report to the AER.

Attached to this letter is the Federal Court of Australia Expert Evidence Practice Note (GPN-EXPT) including Annexure A (Harmonised Expert Witness Code of Conduct) to that Practice Note. The Practice Note replaces the Federal Court's Practice Note CM 7, titled 'Expert witnesses in Proceedings in the Federal Court of Australia', with effect from 25 October 2016.

Please read the Practice Note carefully and ensure that your report complies with each of its elements, including in particular clause 5 of the Practice Note and clause 3 of the Code, which set out requirements for the content of your report. Please also:

- Confirm in your report that:
    - you have read, complied with and agree to be bound by the Practice Note; and
    - your opinions are based wholly or substantially on specialised knowledge arising from the expert's training, study or experience.
- Declare that you have made all the inquiries you believe are desirable and appropriate (save for any matters identified explicitly in your report) and that no matters of significance which you regard as relevant have, to your knowledge, been withheld.
- Annex your curriculum vitae, containing your qualifications and relevant experience, to your report.

Limitations and qualifications

You must qualify the opinion given in your report if either of the following apply:

- you consider your report may be incomplete or inaccurate without the qualification; or
- you are unable to form a conclusive opinion because of insufficient research, insufficient information, or for any other reason.

If you change your opinion

You must provide a supplementary report if you change your opinion after giving us your original report.

TIMING

AAD requests that Frontier deliver its final report or reports by 20 December 2017.

Please let us know if you have any questions regarding this letter.

Yours sincerely

Alexis Hardin
Manager Regulatory Finance and Strategy
Regulatory Affairs, ActewAGL

ActewAGL House 40 Bunda Street Canberra ACT 2600 I GPO Box 366 Canberra ACT 2601
t 13 14 93 I actewagl.com.au

9 Appendix: Curriculum Vitae of Professor Stephen Gray

Stephen Gray is Professor of Finance at the University of Queensland Business School and Chairman of Frontier Economics (Australia). He has Honours degrees in Commerce and Law from the University of Queensland and a PhD in financial economics from the Graduate School of Business at Stanford University.

In his university role, he teaches a range of award and executive education courses in financial management, asset valuation, and corporate finance. He has received a number of teaching awards, including a national award for university teaching in the field of business and economics. He has published widely in highly-ranked journals and has received a number of manuscript awards, most notably at the *Journal of Financial Economics*.

Stephen is also an active consultant to industry on issues relating to valuation, cost of capital, and corporate financial strategy. He has acted as a consultant to many of Australia's leading companies, government-owned corporations, and regulatory bodies. His clients include the Independent Pricing and Regulatory Tribunal (IPART), Australian Competition and Consumer Commission (ACCC), Melbourne Water, Qantas, Telstra, Origin Energy, AGL, Foxtel, ENERGEX, Queensland Treasury Corporation, Rio Tinto Alcan and the Australian Securities and Investments Commission (ASIC). Projects include corporate cost of capital reviews, asset valuation, independent valuation of executive stock options, and the assessment of capital structure and financing strategies.

He has also appeared as an independent expert in several court proceedings relating to the valuation of assets and businesses and the quantification of damages.

Key experience

Cost of capital

Energy sector

- **TransGrid (2015) –** Advised the electricity transmission operator in NSW on the appropriateness of the Australian Energy Regulator's (AER's) proposed transitional arrangements before the full introduction of a trailing average approach to setting the cost of debt allowance for regulated networks. The AER recently revised its rate of return methodology. In doing so, the AER announced that it would adopt a trailing average approach to setting cost of debt allowances (similar to the approach used by Ofgem in Great Britain). However, the AER argued that it should phase this approach in to allow businesses sufficient time to align their debt management practices to the new

methodology. Frontier prepared a report on behalf of TransGrid explaining the circumstances in which such transitional arrangements would not be appropriate.

- **Australian Energy Markets Commission (AEMC) (2012)** – The regulator (AER) and a group of large energy users (EURCC) proposed changes to the National Electricity Rules and National Gas Rules (Rules). The AEMC, which is the government agency that is responsible for maintaining the Rules, conducted a year-long review and consultation process in relation to the proposed rule changes. Stephen was appointed to advise the AEMC on rate of return issues. His role involved the provision of advice to the AEMC secretariat and board, the preparation of a number of public reports, the co-ordination and chairing of public hearings, and a series of one-on-one meetings with key stakeholders. The process resulted in material changes being made to the Rules, with revised Rules being published in November 2012.

- **Energy Networks Association (2013) –** The National Electricity Rules and National Gas Rules (Rules) require the regulator to publish a series of regulatory guidelines every three years. The Australian Energy Regulator (AER) conducted a year-long process in 2013 that ended with the publication of its first Rate of Return Guideline. Throughout this process, Stephen advised the Energy Networks Association (ENA) on rate of return issues. This involved working with the ENA's Regulatory Affairs Committee, specialist working groups, and legal advisors, preparing expert reports, drafting submissions, and representing the ENA at stakeholder forums.

- **TransGrid (2013) Return on Debt Analysis –** The 2012 changes to the National Electricity Rules included, inter alia, a provision that permitted the allowed return on debt to be set according to a trailing average approach. TransGrid sought an analysis of the effect that such a change would have on the residual cash flows that were available to its shareholders. Stephen developed a Monte Carlo simulation model that generated many scenarios for the possible future evolution of interest rates, incorporating empirical relationships between government bond yields, credit spreads, and inflation. His analysis quantified the extent to which the trailing average approach would better match the actual cost of servicing debt under TransGrid's longstanding debt management approach, thereby reducing the volatility of the cash flow to equity holders.

- **Aurizon Network (2014) Split Cost of Capital Analysis –** In a discussion paper, the Queensland Competition Authority advocated consideration of a split cost of capital regulatory approach. Under the proposed approach the regulator would allow a standard "debt and equity" regulated return on assets during their construction, but a "100% debt" return once the asset had been included in the firm's regulatory asset base. Stephen was retained by Aurizon (operator of a regulated coal rail network). His role was to prepare an expert report that considered the economic and financial basis for the proposed approach, and which considered the likely consequences of such an approach. After his presentation to the QCA board, the proposal was shelved indefinitely.

- **Energy Networks (2014-15) Regulatory Reviews –** Stephen has prepared expert reports and submissions on behalf of all businesses that are in the current rounds of regulatory resets. These reports cover the whole range of regulatory cost of capital issues. Clients over the last year include ATCO Gas, DBP, ActewAGL, TransGrid, Jemena, United Energy, CitiPower, Powercor, SA Power Networks, Ausgrid, Essential Energy, Endeavour Energy, ENERGEX, and Ergon Energy.

- **Legal and Appeal Work –** Stephen has assisted a number of regulated business, and their legal teams, through merits review and appeal processes. One example is the 2011 *Gamma* case in the Australian Competition Tribunal. That case involved the "gamma" parameter, which quantifies the impact that dividend imputation tax credits have on the cost of capital. The regulator (AER) proposed an estimate that was based on (a) an assumption that was inconsistent with the observed empirical evidence, and (b) a point estimate that was based partly on a paper with questionable reliability and partly on data that was irrelevant to the task at hand. Stephen's role was to prepare a series of expert reports, to assist the legal team to understand the issues in detail, and to attend the hearings to advise as the matter was heard. The end result was that the Tribunal set aside the entire basis for the AER's proposed estimate and directed us to perform a "state of the art" empirical study. Stephen performed the required study and its results were accepted in full by the Tribunal, who set the estimate of gamma on the basis of it.

Water sector

- **Melbourne Water (2015) –** In preparation for the 2016 Victorian price review, Stephen is part of the Frontier team currently advising Melbourne Water on ways in which the rate of return methodology used by the Victorian regulator,

the Essential Services Commission (ESC), could be improved, and the likely revenue impact of any methodological changes. At the last (i.e. 2013) price reset, the ESC indicated that it intended to review its rate of return methodology but to date has not done so. By comparison, most other major Australian regulators have revised their methodologies significantly, in part due to recognition of the need to make their estimation approaches more resilient to the effects of global financial crises. A comparison of the methodologies used by different regulators in Australia suggests that the ESC's methodology is out of line with best regulatory practice. Frontier's advice has focused on identifying the areas for improvement, and the development of the economic arguments that would support the case for change.

- **Unity Water, SEQ Water, Gladstone Area Water Board (2013-14) –** Stephen has prepared a series of reports for a number of Queensland water utilities. These reports include (a) a response to the QCA's (Queensland regulator) proposed split cost of capital approach (which has now been shelved indefinitely), and (b) a response to the QCA's proposed cost of capital estimates.

Telecommunications sector

- **NBN Co (2012-13) –** Stephen advised NBN Co on a range of cost of capital issues in relation to their proposed special access undertaking. This work included the drafting of expert reports, meetings with and presentations to various NBN Co committees and working groups, and representing NBN Co in discussions with the regulator (ACCC). Key issues included the length of the proposed access arrangement, the extent to which higher risk during the construction and proof-of-concept phases justified a higher allowed return, and the process by which early year losses might be capitalized into the regulatory asset base.

- **C7 Case (2006-07), Federal Court of Australia**

  The Seven Network brought an action against a number of Australian media and entertainment firms in relation to the abandonment of its cable TV business, C7. Seven alleged that the respondents colluded to prevent C7 from securing the rights to broadcast AFL and NRL matches and that this prevented its C7 business from being economically viable.

  Stephen was retained by a group of respondents including PBL, Telstra, and News Corporation. His role was to address various matters relating the quantification of damages. He prepared several reports, was involved in several discussions with other valuation expert witnesses, and was cross examined in the Federal Court.

The Court found in favour of the respondents.

Transport sector

- **CBH Group (2015) –** Stephen was part of the Frontier team that developed, on behalf of CBH (a major Australian grain producer and access seeker to rail infrastructure in Western Australia) and its legal counsel, a submission to the Economic Regulation Authority (ERA) of Western Australia on the regulator's approach to estimating WACC. The submission focused on, amongst other issues, the ERA's approach to estimating the market risk premium, the estimation approach to beta, and the way in which the WACC ought to be used within the negotiate-arbitrate arrangements within the rail access regime.

- **Brockman Mining Australia (2015) –** Stephen was part of the Frontier team that advised Brockman, a potential access seeker to rail infrastructure in Western Australia, on its submission to the Economic Regulation Authority (ERA) of Western Australia in relation to the ERA's approach to WACC under the Railways (Access) Code 2000. Subsequently, the ERA released a Revised Draft Decision on its proposed WACC methodology. Frontier was engaged again by Brockman to help develop its submission to the ERA on the Revised Draft Decision. The submissions focused on the appropriateness of the beta estimates proposed by the ERA, the methodology used to estimate the market risk premium (and consistency between the methodologies used by the ERA in different sectors), the appropriateness of the ERA's credit rating assumption for the benchmark efficient entity (which affects the cost of debt allowance under the ERA's methodology).

- **Brookfield Rail (2014) –** The WA Railways (Access) Code requires railway operators to provide certain information to access seekers to enable them to compute "floor" and "ceiling" prices as defined in the Code. Brookfield provided access seekers with certain information and other relevant information was available from public sources. Stephen prepared an expert report that considered whether the information available to an access seeker, together with specialist assistance from relevant experts, would be sufficient to compute floor and ceiling prices.

- **Brisbane Airport Corporation (2013-14) –** Stephen was engaged by Brisbane Airport Corporation (BAC) to advise on a range of regulatory and cost of capital issues in relation to the development of the airport's new parallel runway (NPR). BAC identified the need for an additional runway to accommodate steadily increasing demand. The development of a new runway required a large capital commitment ($1.5 billion) and would take

approximately eight years to complete. BAC proposed that the airlines would contribute to the financing of the NPR during construction – the alternative being the capitalisation of a return on capital expenditure until completion and a sharp spike in landing fees when the NPR become operational. One of the key issues in the negotiations with airlines was the WACC that would be used to determine the return on capital. Stephen's role was twofold. He produced an expert report providing a strong basis for BAC's proposed WACC. He also advised BAC on the likely approach of the ACCC (the regulator in question) should they become involved – the regulatory arrangements provide for the parties to negotiate a commercial outcome and for the regulator to become involved if they are unable to do so. BAC was successful in their negotiations with the relevant airlines and the NPR is now under construction.

- **Abbott Point Coal Terminal (2014) –** Stephen was engaged by a consortium of mining companies in relation to arbitration with Adani, the owner and operator of the Abbott Point Coal Terminal. The parties had in place a user agreement that was similar to a regulatory-style building block model. Stephen advised on a range of cost of capital and other issues including detailed reports on the cost of debt and the level of corporate costs.

Financial litigation support

- **APLNG (2014-15)**
  The Australia-Pacific LNG (APLNG) project is a joint venture between Origin Energy, ConocoPhillips and Sinopec that involves the extraction of coal seam methane and processing into liquefied natural gas (LNG) for export. The relevant Queensland royalties legislation provides that a 10% royalty is to be levied on the value of the gas at the first point of disposal. Since the project is integrated from end-to-end, there is no arm's length price at the relevant point. Stephen was retained by APLNG to prepare an expert report on the process for determining what the arm's length price at the first point of disposal would be if such a thing existed. This involves estimating the costs, including a fair return on capital, for a hypothetical upstream gas producer and a hypothetical downstream LNG operator, and allocating any excess profit between the parties.

- **CDO Case (2013)**
  This case involved a class action against the Australian distributor of collateralised debt obligations (CDOs) and the international credit ratings agency that assigned credit ratings to them. The CDOs in question were financial products with a payoff that depended on the number of defaults (or

"credit events") among a reference set of 150 different corporate bonds issued by companies in different industries and different geographical locations. A typical CDO structure would involve the investor being repaid all of their initial investment plus an attractive rate of interest so long as there were less than say 7 defaults out of the reference set of 150 bonds during the five-year life of the CDO. However, if there were say 11 or more defaults, the investor would lose their entire investment. If the number of defaults was between 7 and 11, the return to the investor would be proportional (e.g., 8 defaults would involve a 25% loss of principal).

The CDOs in question were created by US investment banks and were distributed in Australia by a large Australian commercial bank. One of the key issues in the case was whether the Australian distributor made proper disclosures about risk to investors, which included individuals, self-managed superannuation funds, and local councils. The CDOs in question were assigned strong investment grade credit ratings by an international ratings agency. The process used to assign those ratings did not properly take into account the correlation between defaults – the empirical fact that during recessions and financial crises many bonds default at the same time.

Stephen's role was to prepare an expert report that explained to the Court how CDOs were structured, how they operated, and what risks were involved. His report also examined the risk disclosures that were contained in the materials that were provided to potential investors and the process by which the credit rating agency assigned ratings.

- **Wright Prospecting litigation (2012-14)**
  Wright Prospecting Pty Ltd (WPPL) is involved in several legal disputes about the payment of royalty streams in relation to iron ore and coal mining operations. WPPL had assigned various rights and licenses in relation to iron ore mines in WA and coal mines in Queensland to other parties, in return for royalties on the revenues received from the sale of the ore. Stephen's role was to prepare a series of expert reports quantifying the present value of the royalty streams.

- **Public Trustee of QLD v. Octaviar Ltd (2009), Supreme Court of Queensland**
  The Octaviar Group (formerly the MFS Group) is a Gold Coast based group of listed companies with funds management and leisure services businesses.

Octaviar was unable to refinance a loan in early 2008 and sought to raise equity via a rights issue as part of a substantial corporate restructure. The stock price fell some 70% on this announcement and Octaviar subsequently sold a 65% interest in its leisure business known as Stella. Octaviar then sought to make arrangements with its creditors, including the Public Trustee, as trustee for note holders.

Stephen was retained by the Public Trustee. His role was to prepare several reports on (a) whether the companies in the Octaviar Group were insolvent, (b) the date the companies became insolvent, and (c) whether the note holders would be made better or worse off by the proposed arrangement, relative to a liquidation. He was cross examined by four parties with an interest in these proceedings on issues relating to the date of the insolvency.

- **Telstra v. ACCC (2008), Federal Court of Australia**
  Telstra brought an action against the ACCC in relation to access charges that Telstra was allowed to charge its retail competitors for access to its fixed line and broadband networks – arguing that the return on capital allowed by the ACCC was unreasonably low.

Stephen was retained by Telstra. His role was to prepare several reports on the issue of whether the ACCC has been inconsistent in its application of valuation methods – in a way that reduced Telstra's allowed return. He was also involved in several discussions with other valuation expert witnesses, prepared a joint statement of experts, and was cross examined in the Federal Court individually and in a "hot tub" setting.

- **Alcan Northern Territory Alumina Pty Ltd v. Commissioner of Taxes (2006-07), Supreme Court of Northern Territory**
  First Engagement: Consulting Expert

Alcan bought out the equity of its joint venture partner in a combined bauxite mine and alumina refinery in the Northern Territory. The NT Revenue Authority claimed that the transaction was caught by the NT "land rich" provision, under which the transaction would be subject to stamp duty if more than 60% of the consideration was attributable to land assets.

The key economic issue is the apportionment of value between the mine (predominately land assets) and the refinery (substantially intangible assets arising out of intellectual property and expertise).

Stephen was retained by Alcan as consulting experts. Their role was to prepare a range of financial models and analysis to support the view that a substantial portion of the value of the transaction was attributable to non-land assets in the refinery. This involved complex financial modelling and market analysis. A full integrated model was produced, allowing users to select whether they preferred the appellant's or respondent's submission on each input parameter, and automatically re-calculating the land-rich ratio.

Stephen worked closely with Alcan's legal team, Counsel, and various independent experts. Stephen assisted the legal team during the trial and in preparing sections of final submissions.

Second Engagement: Independent Expert

The initial judgment contained findings about certain matters and was sent back to the Commissioner for re-assessment. A dispute arose between the parties about the effect of the judgment. In particular, the value of a primary 10-year lease had to be disaggregated from the value of an option to continue the project.

Stephen was retained by Alcan to produce an expert valuation report that addressed the matters in dispute. Two expert reports were prepared and Stephen was cross-examined on this material. Stephen prepared an easy to use spreadsheet calculator to assist the Court in testing how different input assumptions (where the experts could not agree) affected the bottom line. This was used by His Honour as an *aide memoire* and was considered to be particularly helpful in the case in terms of simplifying the effects of a number of complex matters.

Judgment was in favour of Alcan. Stephen's evidence was accepted and endorsed by the Court.

Career: Professional

2014-Present	Chair, Frontier Economics
1997-2014	Director, SFG Consulting

Key experience

Career: Academic

2000 - Present	Professor of Finance, UQ Business School, University of Queensland
1997-1999	Associate Professor of Finance, UQ Business School, University of Queensland
1997-2001	Research Associate Professor of Finance, Fuqua School of Business, Duke University
1995-1997	Assistant Professor of Finance, Fuqua School of Business, Duke University

Education

1987	Bachelor of Commerce (Hons), University of Queensland
1989	Bachelor of Laws (Hons), University of Queensland
1995	PhD, Stanford University

Papers and publications: Cost of capital

- Gray, S. and J. Nowland, 2015, "The Diversity of Expertise on Corporate Boards in Australia," *Accounting and Finance*, forthcoming.
- Darat, A., S. Gray, J. C. Park and S. Wu, (2014), "Corporate governance and bankruptcy risk" *Journal of Accounting, Auditing and Finance,* forthcoming.
- Gray, S., I. Harymawan and J. Nowland, (2014), "Political and government connections on corporate boards in Australia: Good for business?" *Australian Journal of Management,* forthcoming.
- Brailsford, T., S. Gray and S. Treepongkaruna, (2013), "Explaining the bid-ask spread in the foreign exchange market: A test of alternate models," *Australian Journal of Management*, forthcoming.
- Faff, R., S. Gray and M. Poulsen, (2013), "Financial inflexibility and the value premium," *International Review of Finance*, forthcoming.
- T. Fitzgerald, S. Gray, J. Hall and R. Jeyaraj, (2013), "Unconstrained estimates of the equity risk premium" *Review of Accounting Studies,* 18, 560-639.
- Feuerherdt, C., S. Gray and J. Hall, (2010), "The Value of Imputation Tax Credits on Australian Hybrid Securities," *International Review of Finance*, 10, 3, 365-401.

- Gray, S., J. Hall, D. Klease and A. McCrystal, (2009), "Bias, stability and predictive ability in the measurement of systematic risk," *Accounting Research Journal*, 22, 3, 220-236.
- Costello, D., S. Gray, and A. McCrystal, (2008), "The diversification benefits of Australian equities," *JASSA*, 2008, 4, 31-35.
- Gray, S. and J. Hall, (2008), "The Relationship Between Franking Credits and the Market Risk Premium: A Reply," *Accounting and Finance*, 48, 1, 133-142.
- Gray, S., A. Mirkovic and V. Ragunathan, (2006), "The Determinants of Credit Ratings: Australian Evidence," *Australian Journal of Management*, 31(2), 333-354.
- Choy, E., S. Gray and V. Ragunathan, (2006), "The Effect of Credit Rating Changes on Australian Stock Returns," *Accounting and Finance*, 46(5), 755-769.
- Gray, S. and J. Hall, (2006), "The Relationship Between Franking Credits and the Market Risk Premium," *Accounting and Finance*, 46(3), 405-428.
- Cannavan, D., F. Finn and S. Gray, (2004), "The Value of Dividend Imputation Tax Credits in Australia," *Journal of Financial Economics*, 73, 167-197.
- Dahlquist, M. and S. Gray, (2000), "Regime-Switching and Interest Rates in the European Monetary System," *Journal of International Economics*, 50(2), 399-419.
- Bollen, N., S. Gray and R. Whaley, (2000), "Regime-Switching in Foreign Exchange Rates: Evidence from Currency Options," *Journal of Econometrics*, 94, 239-276.
- Bekaert, G. and S. Gray, (1998), "Target Zones and Exchange Rates: An Empirical Investigation," *Journal of International Economics*, 45(1), 1-35.
- Gray, S. (1996), "Modeling the Conditional Distribution of Interest Rates as a Regime- Switching Process," *Journal of Financial Economics*, 42, 27-62.
- Gray, S. (1996), "Regime-Switching in Australian Interest Rates," *Accounting and Finance*, 36(1), 65-88.

FRONTIER ECONOMICS
BRISBANE | MELBOURNE | SINGAPORE | SYDNEY
Frontier Economics Pty Ltd 395 Collins Street Melbourne Victoria 3000
Tel: +61 (0)3 9620 4488 Fax: +61 (0)3 9620 4499 www.frontier-economics.com.au
ACN: 087 553 124 ABN: 13 087 553 124