TransGrid

TransGrid Revenue Proposal
2018/19 – 2022/23

Appendix Q

Frontier Economics:

An equity beta estimate for the benchmark efficient entity

An equity beta estimate for the benchmark efficient entity

REPORT PREPARED FOR TRANSGRID

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1 Executive summary

1.1 Instructions

1 Frontier Economics has been retained by TransGrid to provide our views on aspects of 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. Provide an updated set of estimates of equity beta using the current set of listed comparators that the AER uses to set its primary range for beta;

b. Provide a current set of beta estimates for other listed infrastructure firms that operate in workably competitive markets; and

c. Consider the implications of the updated estimates in (a) and (b) above for the AER's current equity beta allowance of 0.7.

1.2 Summary of primary conclusions

3 In this report, we begin by summarising the approach that the Australian Energy Regulator (AER) takes to estimating the equity beta – starting with a statistical estimate obtained from regression analysis applied to a small set of domestic comparators and then applying uplifts or corrections for various considerations.

4 We then note that the evidence from data since the AER's 2013 Rate of Return Guideline is that the starting point statistical estimate has risen over recent years. In this regard, we report evidence and conclusions from the Economic Regulation Authority of Western Australia (ERA) and present our own analysis.

5 Finally, we examine other domestic infrastructure firms that are comparable to the benchmark efficient entity in that they hold long-lived infrastructure assets that produce relatively stable cash flows over time. We find that the equity beta estimates for this expanded set of firms are above the AER's current equity beta allowance of 0.7.

6 Our conclusion is that the more recent evidence from the AER's set of domestic comparators and from an expanded set of infrastructure comparators all points towards an increase in estimates since the AER's 2013 Rate of Return Guideline. This leads us to conclude that the Guideline approach to estimating beta, when applied to the updated evidence, must produce a current estimate of at least 0.7.

The AER's approach

7 In its Rate of Return 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. Four such companies remain in existence: APA Group, Ausnet Services, DUET and Spark Infrastructure.

8 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

b. The allowed beta is to be set to 0.7 due to three "additional considerations":

i. "International estimates"[3] – 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. "Considerations of the Black CAPM"[4] – 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"[5] – the fact that instability in equity beta allowances may cause investors to increase their assessment of regulatory risk.

9 Thus, the AER's approach is to begin with its "best empirical estimate" of 0.5 from domestic comparators, and then apply an uplift to 0.7 on the basis of a number of other considerations.

10 Approximately three years have elapsed since the analysis that was performed at the time of the AER's Guideline, providing approximately 150 more recent weekly returns observations. This report demonstrates that the more recent evidence results in an increase in the statistical beta estimates.

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[1] AER Rate of Return Guideline, 2013, p. 15.

[2] Final Decision, Ausgrid distribution determination 2015-16 to 2018-19, Attachment 3 – Rate of Return, p. 3-129.

[3] JEN Final Decision, Attachment 3, p. 64.

[4] JEN Final Decision, Attachment 3, p. 64.

[5] JEN Final Decision, Attachment 3, p. 64.

Recent analysis by the ERA

11 The Economic Regulation Authority of Western Australia 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.

12 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 2013 Guidelines.

13 For its Final Decision for the Dampier to Bunbury natural gas pipeline,[6] 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.[7]

14 Unlike the AER, the ERA does not apply any uplift in relation to 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 uplift, such as that applied by the AER, would result in a higher estimate.

Recent empirical evidence

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

a. Equity beta estimates for 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 unregulated infrastructure firms that operate in workably competitive markets

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[6] ERA (WA), 2016, "Final Decision on Proposed Revisions to the Access Arrangement for the Dampier to Bunbury Natural Gas Pipeline 2016-2020, Appendix 4, Rate of Return, 30 June.

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

are also higher than the than the 0.5 "best statistical estimate" at the time of the Guideline.

16 Consequently, we conclude that application of the AER's Guideline approach (i.e., begin with a best empirical estimate and apply an uplift 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. If the starting point equity beta estimate is higher and the same type of uplift is applied for the same reasons, the final beta allowance must be at least 0.7.

1.3 Author of report

17 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 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.

18 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.

2 Background and context

2.1 The role of equity beta

19 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).[8] 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

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

[8] 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.

21 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:

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

22 This OLS estimation technique was employed by Henry (2014) in a report commissioned by the AER.[9] 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 CAPM definition of beta in Paragraph 20 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.[10]

2.3 Comparator firms and re-levered equity beta estimates

23 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.

24 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.

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[9] 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

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

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.

25 In this report, we follow the standard approach of considering both of these techniques for reducing sampling error.[11]

26 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.

27 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.

28 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.

29 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.

30 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

[11] 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

31 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.

32 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.[12]

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

34 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:

[12] 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.[13]

35 The AER has rejected 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. As discussed in section D.2.2, we do not consider individual firm estimates in isolation as it is difficult to select an equity beta estimate from a particular comparator firm over a different estimate from another. Therefore, taking an average over all comparator firms is more likely to be reflective of the benchmark efficient entity. Considering equity beta estimates from various portfolios of comparator firms is also more likely to be reflective of the benchmark efficient entity because it combines the returns of various comparator firms.
>
> Therefore, we base our equity beta range for the benchmark efficient entity on averages of individual firm estimates and fixed weight portfolio estimates…these estimates show a consistent pattern of support for an empirical equity beta range of 0.4 to 0.7.[14]

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

37 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.[15]

38 However, the AER also notes that:

> …there are additional considerations that inform our determination of the equity beta point estimate from within the range.[16]

39 In its recent decisions, the AER has maintained its beta allowance at 0.7.[17] The uplift from 0.5 to 0.7 is said to be based on three considerations:

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

[14] Ausgrid Final Decision, Attachment 3, p. 3-430.

[15] Ausgrid Final Decision, Attachment 3, p. 3-129.

[16] Ausgrid Final Decision, Attachment 3, p. 3-129.

[17] JEN Final Decision, Attachment 3, p. 64.

a. "International estimates" [18] – 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"[19] – 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"[20] – 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.

40 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.

[18] JEN Final Decision, Attachment 3, p. 64.

[19] JEN Final Decision, Attachment 3, p. 64.

[20] JEN Final Decision, Attachment 3, p. 64.

3 The ERA's recent updated beta estimates

3.1 A current best statistical estimate of 0.7

41 In its recent Final Decision for DBP, 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.[21]

42 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.[22]

43 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 apply any uplift in relation to 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 uplift, such as that applied by the AER, would result in a higher estimate.

3.2 The ERA's estimation methodology

Currently existing comparators

44 The ERA's approach to estimating beta is to focus on the four remaining domestic comparators: APA Group, Ausnet Services, DUET and Spark Infrastructure. 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

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

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

to provide an estimate of beta that is commensurate with the prevailing conditions in the market for equity funds.

Portfolio estimates

45 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.[23] Our approach is to consider average and portfolio estimates.

Range of regression approaches

46 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.[24] 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.

Use of five years of data

47 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 (ten-year) periods.

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

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

4 Current equity beta estimates

48 This section sets out recent beta estimates for:

a. The remaining four domestic regulated utility comparator firms, APA Group, Ausnet Services, DUET and Spark Infrastructure; and

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

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

4.1 Data Source

50 We have obtained weekly and monthly total returns for each stock and the broad market index[25] 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

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

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

52 We have re-levered all estimates to be consistent with the 60% leverage assumption that is adopted for the benchmark efficient entity. 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:

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

[25] ASX 200 Total Return Index.

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

4.2.2 Equally weighted portfolio construction

53 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.

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

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

55 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.

56 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

57 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.

58 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

59 We begin by reporting current beta estimates for the four remaining firms in the AER's set of domestic comparators. 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

60 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 5-year period for the four domestic utilities.

61 Table 1 shows that the re-levered equity beta estimates for three of the four firms are in the order of 0.7 to 0.8, with the DUET estimate appearing to be an outlier in the sense that it is materially below the other three estimates. 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. The mean estimate over the four firms is 0.63, and if DUET is excluded the mean rises to 0.75.

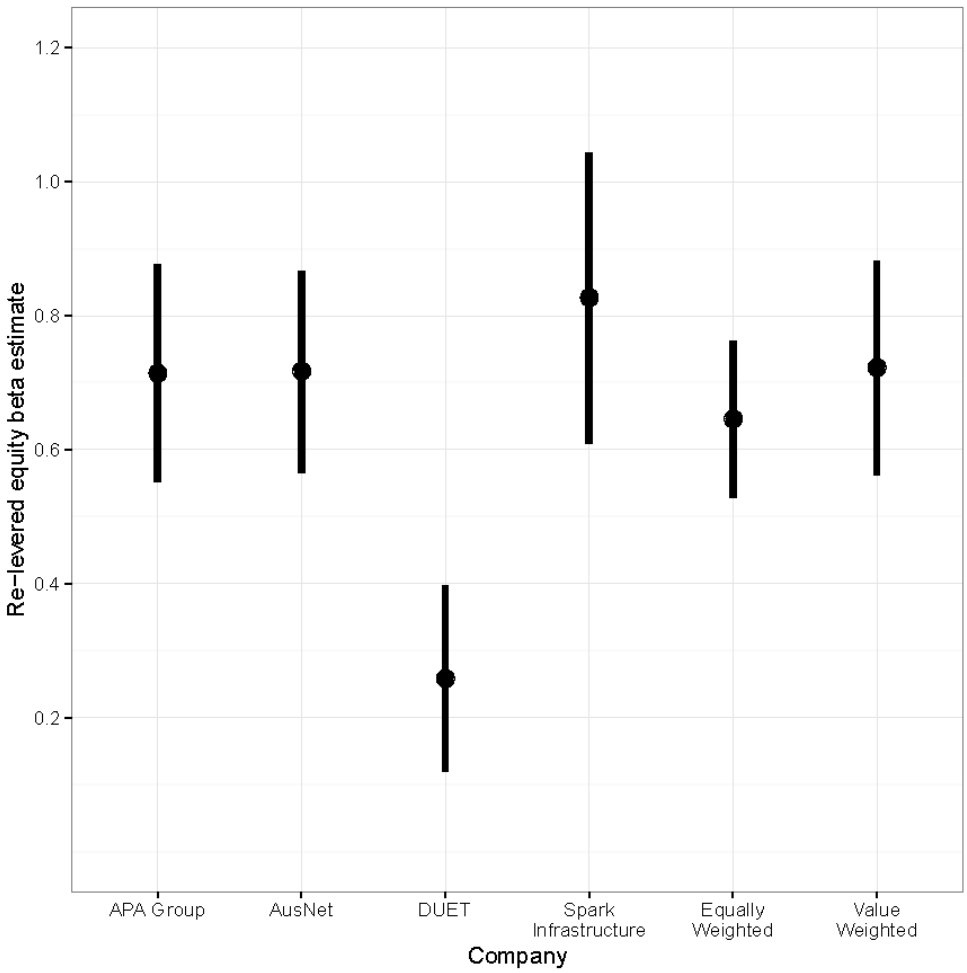
The value and equally-weighted portfolio estimates are 0.65 and 0.72 respectively, which corresponds closely to the estimates for three of the four comparator firms. The mean of the two portfolio estimates is 0.68.

Table 1: Weekly beta estimates over the last 5 years

Statistic	APA Group	AusNet	DUET	Spark Infrastructure	Equally- Weighted Portfolio	Value-Weighted Portfolio
Average gearing	0.50	0.60	0.65	0.30	0.52	0.53
Adjustment factor	1.25	1.00	0.87	1.75	1.21	1.18
Raw beta	0.57	0.71	0.30	0.47	0.53	0.61
Re-levered beta	**0.71**	**0.72**	**0.26**	**0.83**	**0.65**	**0.72**
Standard error	0.08	0.08	0.07	0.11	0.06	0.08
Confidence interval upper bound	0.55	0.57	0.12	0.61	0.53	0.56
Confidence interval lower bound	0.88	0.87	0.40	1.04	0.76	0.88
R^2	0.19	0.25	0.06	0.11	0.27	0.21
Observations	260	260	260	260	260	260

Source: Datastream, Frontier Economics calculations. Five years to September 2016.

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



Source: Datastream, Frontier Economics calculations

62 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 0.62;

b. The equally-weighted portfolio estimate is 0.77;

c. The value-weighted portfolio estimate is 1.03;

d. The average of the two portfolio estimates is 0.90.

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

63 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 September 2006 to September 2016. The results are set out in Table 2. The re-levered equity beta estimates for the individual firms vary between 0.34 and 0.66 and the portfolio estimates are 0.52 and 0.57 respectively. These figures are generally lower than the estimates for the most recent five-year period, indicating that the relationship between stock returns and market returns has increased materially over the two most recent five-year periods. We also note that the two portfolio estimates are above the AER's Guideline starting point equity beta estimate of 0.5.

Table 2: Weekly beta estimates over the last 10 years

Statistic	APA Group	AusNet	DUET	Spark Infrastructure	Equally-Weighted Portfolio	Value-Weighted Portfolio
Average gearing	0.57	0.61	0.71	0.40	0.58	0.58
Adjustment factor	1.09	0.97	0.73	1.50	1.06	1.05
Raw beta	0.61	0.37	0.47	0.37	0.49	0.54
Re-levered beta	**0.66**	**0.36**	**0.34**	**0.55**	**0.52**	**0.57**
Standard error	0.05	0.05	0.05	0.08	0.04	0.05
Confidence interval upper bound	0.56	0.26	0.24	0.39	0.44	0.47
Confidence interval lower bound	0.77	0.47	0.44	0.71	0.60	0.66
R^2	0.21	0.08	0.10	0.06	0.23	0.21
Observations	522	522	522	522	522	522

Source: Datastream, Frontier Economics calculations. Ten years to September 2016.

64 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 0.56;

b. The equally-weighted portfolio estimate is 0.65;

c. The value-weighted portfolio estimate is 0.75;

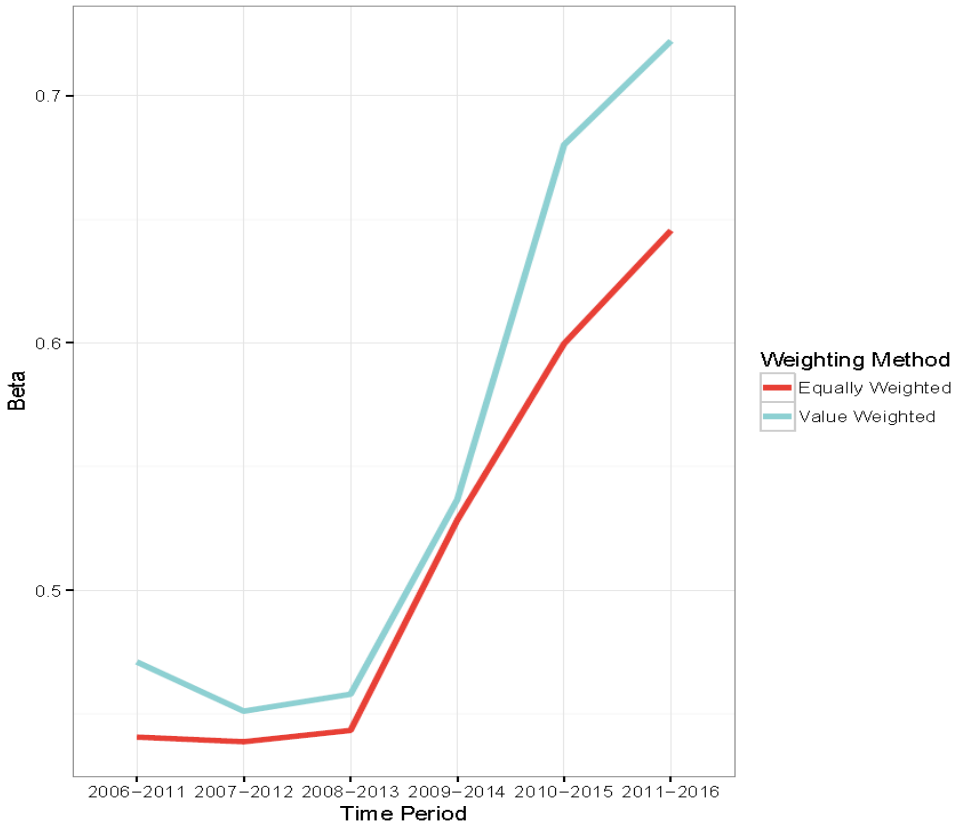
d. The average of the two portfolio estimates is 0.68.

65 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 5-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

66 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 and 2016 is introduced, replacing older data from 2006-2008. 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

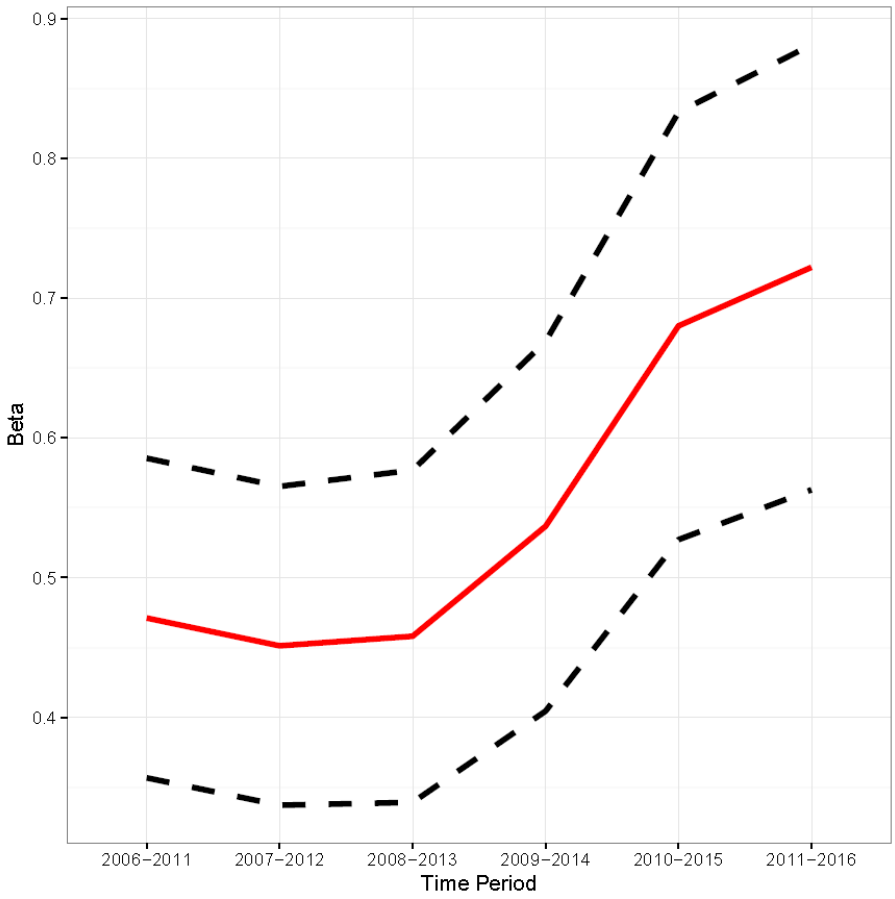


Source: Datastream, Frontier Economics calculations.

67 Figure 3 shows the 95% confidence interval around the rolling 5-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.

68 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



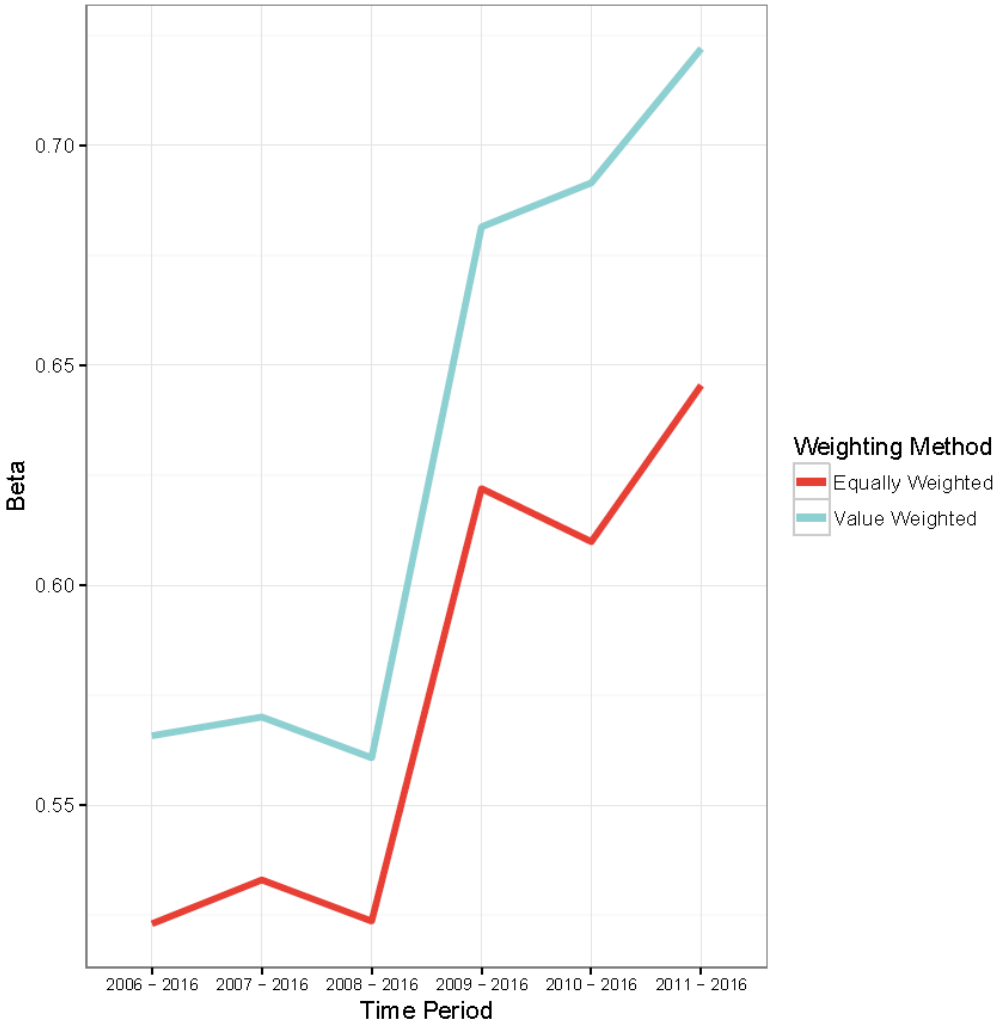
Source: Datastream, Frontier Economics calculations.

69 Figure 4 shows the re-levered portfolio equity beta estimates for different sample periods, all ending with the most recent data from September 2016. 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 2016 data.

70 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 2013 Rate of Return Guideline.

Figure 4: Expanding window beta estimates



Source: Datastream, Frontier Economics calculations.

4.3.4 Conclusions in relation to domestic energy network comparators

71 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.

4.3.5 Beta estimation of transport utilities

72 In its February 2016 *Ausgrid* decision, the Australian Competition Tribunal considered the definition of the benchmark efficient entity (BEE) and concluded that the BEE should be considered to be a hypothetical unregulated competitor:

> The BEE, in the view of the Tribunal, is likely to refer to the hypothetical efficient competitor in a competitive market for those services. Such a BEE is not a regulated competitor, because the regulation is imposed as a proxy for the hypothetical unregulated competitor. Otherwise, the starting point would be a regulated competitor in a hypothetically regulated market. That would not be consistent with the policy underlying the purpose of the NEL and the NGL in relation to the fixing of terms on which monopoly providers may operate. [26]

73 In reaching this conclusion, the Tribunal cited a determination of the Australian Energy Markets Commission (AEMC) which set out the objective of regulation as being:

> …to reproduce, to the extent possible, the production and pricing outcomes that would occur in a workably competitive market in circumstances where the development of a competitive market is not economically feasible.[27]

74 Consequently, we examine the beta estimates of a set of firms that are comparable to an energy distribution business, but which operate in workably competitive markets. 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. Listed on the ASX.

75 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 set out in the appendix to this report.

76 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. Table 3 shows that the re-levered equity beta estimates range from 0.76 to 1.72, with a mean of 1.19.

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[26] *Ausgrid*, Paragraph 914.

[27] Ausgrid, Paragraph 80.

77 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 1.11;

b. The mean estimate based on monthly data over the last 5 years is 1.11; and

c. The mean estimate based on monthly data over the last 10 years is 1.29.

78 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.

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	0.26	0.20	0.37	0.19	0.53	0.38
Adjustment factor	1.84	2.00	1.58	2.02	1.17	1.56
Raw beta	0.41	0.70	0.96	0.85	0.84	0.51
Re-levered beta	**0.76**	**1.39**	**1.51**	**1.72**	**0.98**	**0.79**
Standard error	0.07	0.11	0.13	0.10	0.07	0.07
Confidence interval upper bound	0.62	1.18	1.24	1.51	0.84	0.66
Confidence interval lower bound	0.89	1.61	1.77	1.92	1.12	0.93
R^2	0.11	0.21	0.19	0.22	0.24	0.14
Observations	521	300	343	503	521	521

Source: Datastream, Frontier Economics calculations. Ten years to September 2016.

79 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. Table 4shows that the re-levered

equity beta estimates are 0.98 and 0.79 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	0.37	0.37
Adjustment factor	1.58	1.57
Raw beta	0.62	0.51
Re-levered beta	**0.98**	**0.79**
Standard error	0.05	0.06
Confidence interval upper bound	0.88	0.67
Confidence interval lower bound	1.08	0.91
R^2	0.30	0.17
Observations	521	521

Source: Datastream, Frontier Economics calculations. Ten years to September 2016.

80 We have repeated this exercise using monthly data and report similar re-levered equity beta estimates of 1.00 and 0.70, respectively.

81 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. This, evidence suggests that an equity beta of 0.7 is conservatively low.

5 Declaration

82 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: Descriptions of expanded comparator set

83 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.

6.1.1 Auckland International Airport Limited (AIA)

84 Auckland International Airport Limited provides airport facilities and supporting infrastructure in Auckland, New Zealand. 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.

6.1.2 Aurizon Holdings Limited (AZJ)

85 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.

6.1.3 Macquarie Atlas Roads Group (MQA)

86 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 kilometers of motorway network; Dulles Greenway, which is a toll road located in northern Virginia, the United States, and covers over 20 kilometers 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 kilometers 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.

6.1.4 Qube Holdings Limited (QUB)

87 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.

6.1.5 Sydney Airport (SYD)

88 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.

6.1.6 Transurban Group (TCL)

89 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.

7 Appendix: Instructions

TransGrid

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Professor Stephen Gray
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27 January 2017

Dear Stephen

Expert Advice on Rate of Return and Value of Imputation Credits

TransGrid is preparing its revenue proposal for the 2018/19 to 2022/23 regulatory period. To assist TransGrid in the preparation of the proposal, TransGrid seeks advice on the following matters from a suitably qualified expert. The advice should be in the form of an expert report that complies with the Federal Court's Expert Evidence Practice Note GPN-EXPT.

In relation to the estimation of the **market risk premium**, the expert is asked to:

a. Explain where the estimation of the MRP fits within the AER's regulatory framework;

b. Explain the approach to estimating the MRP that the AER set out in its 2013 Rate of Return Guideline;

c. Summarise the evolution of the relevant evidence and empirical estimates since 2013;

d. Explain the implications of applying a constant, or substantially constant, MRP to contemporaneous estimates of the MRP; and

e. Provide a current estimate of the MRP by applying the approach set out in the AER's 2013 Rate of Return Guideline to the updated evidence.

In relation to the estimation of the **equity beta** for the benchmark efficient entity, the expert is asked to:

a. Provide an updated set of estimates of equity beta using the current set of listed comparators that the AER uses to set its primary range for beta;

b. Provide a current set of beta estimates for other listed infrastructure firms that operate in workably competitive markets; and

c. Consider the implications of the updated estimates in (a) and (b) above for the AER's current equity beta allowance of 0.7.

In relation to **low-beta bias**, the expert is asked to:

a. Explain the concept of low-beta bias in the context of the SL-CAPM;

b. Examine the approaches for correcting for low-beta bias;

c. Summarise the evidence about the quantum of low-beta bias; and

d. Provide your opinion about the reasonableness of the AER's approach to correcting for low-beta bias.

In relation to the estimation of **gamma**, the expert is asked to:

a. State their views about whether gamma should be interpreted in terms of the market value of imputation credits or in terms of the proportion of credits that are available to be redeemed;

b. Having regard to the answer to (a) above, provide their opinion about what is the best currently available empirical estimate of gamma and of each component of gamma, the distribution rate and the value of distributed credits, theta;

c. State their views about the econometric issues that the AER has raised and maintained in relation to dividend drop-off analysis; and

d. State their views of the issues raised in the Lally (2016) report commissioned by the AER (Lally, M., 2016, "Gamma and the ACT decision," 23 May).

In relation to **dividend drop-off estimation of gamma**, the expert is asked to:

a. Update the SFG (2013) dividend drop-off analysis to incorporate more recent data. (SFG, 2013, "Updated Dividend drop-off estimate of theta," report for the Energy Networks Association, 7 June).

In relation to **transition arrangements for the allowed return on debt**, the expert is asked to provide a short note in letter form that:

a. Sets out the appropriate economic framework for considering whether a transition period should be used when moving to the trailing average approach to the allowed return on debt; and

b. Apply that framework to the benchmark efficient entity and draw conclusions about the economic rationale for the AER's proposed 10-year transition.

Yours sincerely

Nicola Tully
Manager / Prescribed Revenue and Pricing

8 Appendix: Curriculum Vitae of Professor Stephen Gray

Stephen F. Gray

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Frontier Economics
Email: Stephen.Gray@frontier-economics.com.au

Academic Qualifications

1995 Ph.D. (Finance), Graduate School of Business, Stanford University.
Dissertation Title: Essays in Empirical Finance
Committee Chairman: Ken Singleton
1989 LL.B. (Hons), Bachelor of Laws with Honours, University of Queensland.
1986 B.Com. (Hons), Bachelor of Commerce with Honours, University of Queensland.

Employment History

2000-Present	Professor of Finance, UQ Business School, University of Queensland.
1997-2000	Associate Professor of Finance, Department of Commerce, University of Queensland and Research Associate Professor of Finance, Fuqua School of Business, Duke University.
1994-1997	Assistant Professor of Finance, Fuqua School of Business, Duke University.
1990-1993	Research Assistant, Graduate School of Business, Stanford University.
1988-1990	Assistant Professor of Finance, Department of Commerce, University of Queensland.
1987	Specialist Tutor in Finance, Queensland University of Technology.
1986	Teaching Assistant in Finance, Department of Commerce, University of Queensland.

Academic Awards

2014 E Yetton Prize for best paper in the Australian Journal of Management, Brailsford, T., S. Gray and S. Treepongkaruna, (2013), "Explaining the bid-ask spread in the foreign exchange market: A test of alternate models."
2006 Outstanding Professor Award, Global Executive MBA, Fuqua School of Business, Duke University.
2002 Journal of Financial Economics, All-Star Paper Award, for Modeling the Conditional Distribution of Interest Rates as a Regime-Switching Process, JFE, 1996, 42, 27-62.
2002 Australian University Teaching Award – Business (a national award for all university instructors in all disciplines).
2000 University of Queensland Award for Excellence in Teaching (a University-wide award).
1999 Outstanding Professor Award, Global Executive MBA, Fuqua School of Business, Duke University.
1999 KPMG Teaching Prize, Department of Commerce, University of Queensland.
1998 Faculty Teaching Prize (Business, Economics, and Law), University of Queensland.
1991 Jaedicke Fellow in Finance, Doctoral Program, Graduate School of Business, Stanford University.
1989 Touche Ross Teaching Prize, Department of Commerce, University of Queensland.
1986 University Medal in Commerce, University of Queensland.

Large Grants (over $100, 000)

- Institute of Teaching and Learning Innovation Grant 2016-17, Technology-enhanced Learning Grant ($200,000), with K. Benson, B. Oliver and J. Birt.

- Australian Research Council Linkage Grant, 2008—2010, Managing Asymmetry Risk ($320,000), with T. Brailsford, J.Alcock, and Tactical Global Management.
- Intelligent Grid Cluster, Distributed Energy – CSIRO Energy Transformed Flagship Collaboration Cluster Grant, 2008-2010 ($552,000)
- Australian Research Council Research Infrastructure Block Grant, 2007—2008, Australian Financial Information Database ($279,754).
- Australian Research Council Discovery Grant, 2006—2008, Capital Management in a Stochastic Earnings Environment ($270,000).
- Australian Research Council Discovery Grant, 2005—2007, Australian Cost of Equity.
- Australian Research Council Discovery Grant, 2002—2004, Quantification Issues in Corporate Valuation, the Cost of Capital, and Optimal Capital Structure.
- Australian Research Council Strategic Partnership Grant, 1997—2000, Electricity Contracts and Securities in a Deregulated Market: Valuation and Risk Management for Market Participants.

Current Research Interests

Benchmark returns and the cost of capital. Corporate Finance. Capital structure. Real and strategic options and corporate valuation. Financial and credit risk management. Empirical finance and asset pricing.

Publications

Gray, S. and D. Morrison, (2017), 'Phoenixing at the fulcrum: Less faff, faster forward formulation," *Insolvency Law Journal*, forthcoming.

Gray, S. and J. Nowland, (2016), Director workloads, attendance and firm performance, *Accounting Research Journal*, forthcoming.

Gray, S., (2016), "Dividend imputation and the corporate cost of capital," *JASSA*, http://finsia.com/news/news-article/2016/04/18/dividend-imputation-and-the-corporate-cost-of-capital

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Teaching

Fuqua School of Business, Duke University, Student Evaluations (0-7 scale):

- Financial Management (MBA Core): Average 6.5 over 7 years.
- Advanced Derivatives: Average 6.6 over 4 years.
- Empirical Issues in Asset Pricing: Ph.D. Class

1999, 2006 Outstanding Professor Award, Global Executive MBA, Fuqua School of Business, Duke University.

UQ Business School, University of Queensland, Student Evaluations (0-7 scale):

- Finance (MBA Core): Average 6.6 over 10 years.
- Corporate Finance Honours: Average 6.9 over 10 years.

2002 Australian University Teaching Award – Business (a national award for all university instructors in all disciplines).
2000 University of Queensland Award for Excellence in Teaching.
1999 Department of Commerce KPMG Teaching Prize, University of Queensland.
1998 Faculty Teaching Prize, Faculty of Business Economics and Law, University of Queensland.
1998 Commendation for Excellence in Teaching, University-wide Teaching Awards, University of Queensland.
1989 Touche Ross Teaching Prize, Department of Commerce, University of Queensland.

Board Positions

2012 - Present: Director, Children's Hospital Foundation, Queensland.

2002 - Present: Director, Financial Management Association of Australia Ltd.
2003 - 2012: Director, Moreton Bay Boys College Ltd. (Chairman from 2007).
2002 - 2007: External Risk Advisor to Board of Enertrade (Queensland Power Trading Corporation Ltd.)

Consulting

SFG Consulting: 1997-2014.
Frontier Economics: 2014-Present.

Twenty years' experience in consulting to companies, government-owned corporations, government and regulatory agencies. Examples include:

- *Regulatory cost of capital*: Preparation of submissions in regulatory determinations. Clients include all Australian energy transmission and distribution businesses, FOXTEL, Telstra, BBI, ACCC, IPART, ERA.

- *Corporate cost of capital reviews*: Review of cost of capital estimates for project evaluation and impairment testing purposes. Clients include QANTAS, Stanwell Corporation, Ecowise.

- *Executive stock option valuation*: Clients include Collins Foods Group, Ground Probe, Crater Gold Mining, Beach Petroleum.

- *New Project Evaluation*: Assisting companies and GOCs to evaluate proposed new projects. Particular focus is on quantifying risk and uncertainty and presenting possible outcomes in a probabilistic framework. Clients include Queensland Treasury Corporation, Queensland Accommodation Group, Stanwell, EnerTrade.

- *Financial modelling and forecasting*: Clients include ATO (forecasting delinquent payments), ASX (forecasting trading volumes), Compass Resources (integrated mine valuation model).

Retained as a valuation expert in many litigation cases; produced many expert witness reports; appeared in Court for cross examination many times including:

- *Macquarie Generation*: Witness for AGL in competition case.
- *Telstra v. ACCC*: Witness for Telstra in rate of return regulation case.
- *C7 Case*: Witness for PBL, Newscorp, Telstra re valuation of Seven's failed cable TV network.
- *Alcan v. NT Commissioner of Revenue*: Witness for Alcan re valuation of combined bauxite mine and alumina refinery for stamp duty purposes.

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