Discussion paper

Equity Beta

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Shortened forms

Shortened form	Extended form
ABS	Australian Bureau of Statistics
AEMC	Australian Energy Market Commission
AER	Australian Energy Regulator
ATO	Australian Tax Office
CCP	Consumer Challenge Panel
COAG	the Council of Australian Governments
DGM	dividend growth model
energy networks	electricity and gas network service providers
the Guideline	the allowed rate of return guideline
MRP	market risk premium
NEL	national electricity law
NEO	national electricity objective
NER	national electricity rules
NGL	national gas law
NGO	national gas objective
NGR	national gas rules
RBA	the Reserve Bank of Australia
regulatory period	an access arrangement period for gas network service providers and/or a regulatory control period for electricity network service providers
the rules	collectively, the NER and NGR

Contents

1 Introduction

Our role is to determine a rate of return that meets the National Electricity Objective (NEO)/National Gas Objective (NGO). The Rate of Return Guideline (Guideline) outlines our approach to setting the allowed rate of return for regulated gas and electricity network services.

We are currently reviewing the Guideline. As part of this, we are holding concurrent evidence sessions. This is because concurrent evidence can bring efficiency and disciple to the process of examining issues. By holding the concurrent evidence sessions, the AER Board can elicit expert evidence with more input and assistance from the experts themselves. The Board can use experts' differing views to assist in arriving at its own.

The purposes of this discussion paper are to:

- summarise submissions to the issues paper received from stakeholders on the approach for estimating equity beta;
- outline background material relevant to further consideration;
- set out our approach to date as a starting point for discussion and the concurrent expert evidence sessions;
- provide references to some differing expert views presented to us in the past;
- invite stakeholder submissions on reasons (and supporting evidence) that would warrant departure from the approach to date; and
- set out questions to frame that discussion.

We note that the information papers and questions for the topics, including those contained in this information paper, cover a broad range of material that stakeholders wish to have considered in the Guideline review. This material should not be taken to imply the AER has yet formed views on the appropriate approaches to apply, or numerical values to take, in the 2018 Guideline in determining the allowed rate of return.

2 Background

In this Discussion Paper, we explain our approach to date for determining the point estimate for equity beta and consider whether this approach is producing outcomes which promote the objectives of the regulatory framework.

This section sets out:

- An introduction to the equity beta parameter;
- Submissions received in response to our earlier issues paper; and
- Our previous approach for the equity beta.

2.1 Introduction to equity beta

The equity beta is a key parameter within the Sharpe–Lintner CAPM (SLCAPM).

The equity beta measures the 'riskiness' of a firm's returns compared with that of the market. Specifically, the equity beta measures the standardised correlation between the returns on an individual risky asset or firm with that of the overall market.[1]

In this context, the word 'risk' has a specific meaning.[2] Risk results from the possibility that actual returns will differ from expected returns. The greater the uncertainty around the returns of a firm, the greater its level of risk.

Generally, investors diversify away non-systematic (or business-specific risk). Therefore, investors do not require compensation for business specific risk[3], compensation is only required for bearing systematic risk. Sources of systematic risk include changes in real GDP growth, inflation, currency, prices, commodity prices and real long term interest rates. A firm's sensitivity or exposure to these risks will depend on its business activities and its level of financial leverage.[4]

Our regulatory task is to determine a rate of return that is commensurate with efficient financing costs. To this end, 'risk' must be considered in the context of a firm that is providing regulated energy network services. Accordingly, we use the data from such firms that are relevant to estimates of beta for our regulatory task, rather than the individual circumstances of any specific service provider.

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1 R. Brealey, S. Myers, G. Partington and D. Robinson, *Principles of corporate finance*, McGraw–Hill: First Australian edition, 2000, pp. 186–188 (Brealey et al, *Principles of corporate finance*, 2000).

2 Brealey et al, *Principles of corporate finance*, 2000, pp. 186–188.

3 G. Pierson, R. Brown, S. Easton and P. Howard, *Business Finance*, 8th Edition, p. 214.

4 M. McKenzie and G. Partington, *Report to the AER: Estimation of the equity beta (conceptual and econometric issues) for a gas regulatory process in 2012*, 3 April 2012, p. 5 (McKenzie and Partington, *Estimation of equity beta*, April 2012). This report is available on the AER website at: http://www.aer.gov.au/sites/default/files/RBP%20gas%20transmission%202012%20-20Equity%20Beta%20report%20-%20McKenzie%20and%20Partington%20(Public)%20-%203%20April%202012_0.pdf

2.2 Submissions

In response to our October 2017 issues paper, stakeholders have made submissions with the key points summarised in the table below.

Table 1 Submissions on equity beta

Submission	Comment
APA	The theory underlying the Black CAPM remains appropriate if the Sharpe-Lintner CAPM is used to estimate the rate of return on equity.[5] There is a clear case for adjusting the return on equity obtained using the Black CAPM to achieve the regulatory objective.[6] Consideration should be given to the data potentially available for beta estimation for the benchmark efficient entity.
ATCO Gas Australia	ATCO supports an approach to the estimation of the market risk premium and equity beta that results in regulatory stability and certainty in the cost of equity, rather than the individual components of the CAPM model.[7] The AER should consider the approach adopted by other regulators in determining their approach to setting the market risk premium and equity beta that assists in achieving regulatory stability and certainty in the cost of equity.[8] Black CAPM continues to remain appropriate to inform the equity beta estimate and suggests that the AER give due consideration to the ERA's approach of utilising information from the Black CAPM to establish the value of equity beta in the Sharpe-Lintner CAPM.[9]
APGA	The term the "theory of the Black CAPM" is an unhelpful way to frame the issue. The issue at hand is the well-known downward bias of the SL-CAPM for low-beta stocks. The key question is what to do about this to produce an outcome capable of being accepted by all stakeholders.[10] There may be scope to consider that gas and electricity in Australia have different levels of systematic risk based on results from the New Zealand Commerce Commission.[11]
Australia Institute	The use of the beta (β) in estimating the 'equity risk premium' is rather curious since an asset with a β = 0 would be set at the risk-free rate of return. That asset may even be more volatile than the market as a whole but just the fact that it is not correlated with the market means it would be treated as a risk-free asset. One wonders if that is really what the AER intended.[12]

5 APA, Review of the rate of return guidelines APA submission responding to AER issues paper, 12 December 2017, p. 9.

6 APA, Review of the rate of return guidelines APA submission responding to AER issues paper, 12 December 2017, p. 11.

7 ATCO gas, Re: Review of rate of return guideline-issues paper, 12 December 2017, p. 7.

8 ATCO gas, Re: Review of rate of return guideline-issues paper, 12 December 2017, p. 8.

9 ATCO gas, Re: Review of rate of return guideline-issues paper, 12 December 2017, p. 8–9.

10 Australian Pipeline and Gas Association, Submission to the Issues Paper: AER review of the rate of return guideline, 12 December 2017, p. 9,

11 Australian Pipeline and Gas Association, Submission to the Issues Paper: AER review of the rate of return guideline, 12 December 2017, p. 4,

12 The Australia Institute, Submission to the review of the rate of return guidelines, December 2017, p. 5

Canegrowers	MRP and ß are short term measures of risk and volatility respectively. The reality for a regulated network business is that the short-term risks they face are very low. Network businesses face a risk of regulatory failure. This risk should be removed through the AER's current review process, not compensated for by higher risk premiums.[13]
Cheung Kong Infrastructure	We support the current approach to setting the return on equity. However, the increased structural changes in energy markets and the unprecedented challenges faced by networks as a result of emerging technologies are also relevant. These risks need to be considered.[14] The inclusion of delisted firms in a sample of empirical estimates does not reflect prevailing market conditions, including changes in risk since the firm was delisted (especially if the beta estimate is informed by data that is almost 20 years old).[15] Cheung Kong Infrastructure supports the Energy Networks Australia submission that the estimate of equity beta is informed by a broader range of empirical estimates, including estimates from international energy network businesses and domestic infrastructure firms. The evidence of low beta bias is well-accepted. It is therefore important in this review that the AER continues to take account of the low-beta bias in estimating the return on equity.
Consumer Challenge Panel – CCP16	The AER's current approach is fundamentally sound. However, the AER should: • be clear that there are merits in stability of the beta and a high burden of proof would be required • give less weight to the Black CAPM given its limited use in practice and give greater weight to the practice of advisors and investment analysts; and • consider measures of profitability and RAB multiples in assessing the overall return on equity and feed this back into the decision on beta.[16] Strengthening the weight given to observable market practice and reducing the weight given to theories of finance yet to find general acceptance in the investment community is likely to result in decisions on the return on equity and beta that better achieve the ARORO.[17] Justin De Lorenzo (Sydney Desalination Plant) and Professor Stephen Gray both cautioned against placing too much emphasis on short term volatility of beta. IPART noted that while a larger data set is desirable, a note of caution ("*even if …*") is expressed on the use of overseas data. [18]
Energy Consumers Australia	The Black CAPM is a model incapable of providing an empirical estimate. If something is incapable of providing empirical estimates it should not be used in any way in the determination of a value. It remains unclear how when the benchmark efficient entity is an Australian entity

13 Canegrowers, Submission to AER review of the rate of return guideline, 19 December 2017, p. 4

14 Cheung Kong Infrastructure, AER Issues Paper – Review of the rate of return guideline, 12 December 2017, pp. 3–4.

15 Cheung Kong Infrastructure, AER Issues Paper – Review of the rate of return guideline, 12 December 2017, p. 5.

16 Consumer Challenger Panel (sub-panel 16), Submission to the AER on its rate of return guideline issues paper, December 2017, p. 89.

17 Consumer Challenger Panel (sub-panel 16), Submission to the AER on its rate of return guideline issues paper, December 2017, p. 90.

18 Consumer Challenger Panel (sub-panel 16), Submission to the AER on its rate of return guideline issues paper, December 2017, p. 96.

	international estimates would have any relevance. As the range fully encompasses the Australian range, it would appear to be a confirmation of the range, not a rejection of it.[19] The choice of the equity beta at the top of the range is inconsistent with the 2012 advice received by the AER's consultants – noted in the 2013 Guideline Explanatory Statement – from McKenzie and Partington.[20] Greater weight should be placed on the observations of McKenzie and Partington about the very low levels of risk faced by the network businesses (and indeed the reasons why these assets face significantly lower risk than overall market risk). Subject to any additional empirical analysis provided by the AER we believe that there is no basis for an asset beta any higher than 0.5.[21]
Energy Networks Australia	Energy Networks Australia considers that: • Evidence from firms that have been delisted for some years should not be used to construct a binding primary range that is consistent with the prevailing market conditions. • Three comparators are insufficient to be deriving statistically-reliable estimates of beta. [22] • The changing risk profile of energy network businesses should be recognised and accounted for somewhere within the AER's application of the regulatory framework.[23] • The evidence of low-beta bias should be properly reflected in the allowed return on equity, whether by an adjustment to the raw SL-CAPM beta estimates (per the AER's existing approach) or by some other method. • If the AER proposes to move away from its current foundation model approach, a full consultation should be undertaken. • The comparator set should include existing domestic energy network businesses, international energy network businesses, domestic infrastructure businesses, the evidence of low-beta bias and the Black CAPM. [24]
Ergon Energy and Energex	The AER could be more transparent in its exercise of judgement, in particular, in relation to the relative weight placed on other (secondary) evidence in selecting the point estimates for equity beta. [25] It remains unclear to Ergon Energy and Energex what exactly the 'theory of the Black CAPM' entails. Ergon Energy and Energex believe that it would be an error on the AER's part to disregard low-beta bias.[26]

19 Energy Consumers Australia, Review of the rate of return guideline response to the AER Issues Paper, December 2017, p. 23.

20 Energy Consumers Australia, Review of the rate of return guideline response to the AER Issues Paper, December 2017, p. 23.

21 Energy Consumers Australia, Review of the rate of return guideline response to the AER Issues Paper, December 2017, p. 27.

22 Energy Network Australia, AER Rate of return guidelines response to issues paper, 12 December 2018, p. 31.

23 Energy Network Australia, AER Rate of return guidelines response to issues paper, 12 December 2018, p. 31.

24 Energy Network Australia, AER Rate of return guidelines response to issues paper, 12 December 2018, p. 34.

25 Ergon Energy and Energex, AER Issues paper review of the rate of return guidelines Ergon Energy and Energex submission, 12 December 2017, p. 2

26 Ergon Energy and Energex, AER Issues paper review of the rate of return guidelines Ergon Energy and Energex submission, 12 December 2017, p. 6

Energy Users Association of Australia (EUAA)	The EUAA generally agree with the "higher priorities" proposed in the Issues Paper though we would give more emphasis to: • Examination of the risks networks face and whether the market risk premium and beta accurately reflect that risk allocation – confidence in the regulatory regime requires transparency around the evidence used to arrive at a rate of return that appropriately compensates networks for the risk they bear – and the risk that they pass on to consumers • Measure of market risk premium and beta[27] We support the AER in exploring the merits of changing their approach to setting MRP and equity beta. We support the issues raised in the Energy Consumers Australia submission around the application of the AER's approach to developing range of values and then the selection of the point estimate for MRP and beta. There seems to be inconsistencies around the recommendations of their advisors and the selection of point estimates by the AER for the equity beta. We support the investigation of a "stable" equity risk premium that would be applied in a mechanistic way for all determinations and the development of triggers for the early review of this premium.[28]
Ian McAuley	A ß calculated over short-term sampling periods carries little information about the risk faced by long-term investors. Conceptually a ß calculated over very long sampling periods may be appropriate, but there is no practical way to make such a measure. In other words, ß and therefore the CAPM model appears to be inappropriate for long-term investors.[29] It is not clear why electricity transmission lines, gas pipelines and electricity distribution networks should all be subject to the same WACC.[30]
Major Energy Users	The MEU considers that there needs to be a serious examination of equity beta as to whether: • It is a true measure of the risks faced by networks; • There is sufficient data on which to base a viable assessment for all networks; and • The data is too much compromised by unregulated revenue biasing the measure.[31] The MEU considers that the use of the volatility of a firm's share price is not a good surrogate for the underlying risks faced by the firm.[32]
Origin Energy	We support the AER using its current approach to setting the allowed rate of return as a starting point for the review, rather than adopting a 'blank slate' approach.[33]
Spark Infrastructure	It remains appropriate for the Black CAPM to inform the equity beta estimate. If the Black CAPM is no longer to be used then the application of the SLCAPM must also be re-considered and compared with other models and methods. Qualitative adjustments will need to be made to the AER's estimated beta range

27 EUAA, EUAA submission – AER rate of return review issues paper October 2017, 18 December 2017, p. 5
28 EUAA, EUAA submission – AER rate of return review issues paper October 2017, 18 December 2017, p. 9
29 Ian McAuley, Submission to Australian Energy Regulator on rate of return guidelines, December 2017, p. 3.
30 Ian McAuley, Submission to Australian Energy Regulator on rate of return guidelines, December 2017, p. 3.
31 Major Energy Users Inc, Review of the rate of return guidelines issues paper submission by the Major Energy User Inc, December 2017, p. 12.
32 Major Energy Users Inc, Review of the rate of return guidelines issues paper submission by the Major Energy User Inc, December 2017, p. 16.
33 Origin Energy, Review of rate of return guideline, 12 December 2017

because it is derived statistically from a small handful of domestic listed firms with investments in energy networks. These adjustments include evidence on overseas comparators, and academic evidence that the standard SLCAPM tends to under-estimate required returns for low-beta stocks.

Investors would like to see further transparency and predictability in the AER's adjustments to the estimated beta range for evidence from overseas comparators and the Black CAPM evidence.

We seek clarity regarding the method for determining the range and point in the range for equity beta, when and how the estimate is to be updated during the term of the ROR Guideline term, and the characteristics of systematic risks considered to be incorporated in to the equity beta.

We consider that there have been some material changes in the risks faced by NSP's since the Current ROR Guideline, so it will be important that the equity beta is updated to reflect the latest possible information at the time the ROR Guideline becomes effective to ensure that any contemporary systematic risks can be captured in the equity beta.[34]

Source: AER analysis of submissions

2.3 Previous approach

We previously estimated an equity beta of 0.8 in the 2009 WACC review for transmission and distribution businesses.[35] This represented a reduction from a value of 0.9 or 1.0 generally applied by previous state-based regulators.[36]

The 2009 review determined an estimate of 0.8 based on a number of considerations, including:[37]

- Empirical evidence considered in the review suggested a value in the range of 0.41 to 0.68 based on our estimates and those from the Allen Consulting Group for the Joint Industry Associations.[38]
- However, this was balanced with other considerations such as the likely precision of estimates,[39] the need to achieve an outcome that is consistent with the NEO, the revenue and pricing principles and the importance of regulatory stability.[40]

34 Spark Infrastructure, Re: Response to issues paper on the review of the rate of return guideline, 12 December 2017, pp. 9-10

35 AER, Final Decision Electricity transmission and distribution network service providers review of the weighted average cost of capital (WACC) parameters, May 2009, p. v; Henry, *Estimating β*, April 2009.

36 AER, Final Decision Electricity transmission and distribution network service providers review of the weighted average cost of capital (WACC) parameters, May 2009, p. 254.

37 AER, Final Decision Electricity transmission and distribution network service providers review of the weighted average cost of capital (WACC) parameters, May 2009, p. xvii.

38 AER, Final Decision Electricity transmission and distribution network service providers review of the weighted average cost of capital (WACC) parameters, May 2009, p. 343.

39 AER, Final Decision Electricity transmission and distribution network service providers review of the weighted average cost of capital (WACC) parameters, May 2009, p. 302.

40 AER, Final Decision Electricity transmission and distribution network service providers review of the weighted average cost of capital (WACC) parameters, May 2009, p. xvii.

- Limited weight was given to international estimates due to the additional uncertainties and indeterminate nature of adjustments required to ensure that these estimates would be comparable with Australian estimates.[41]
- Conceptual considerations did not give grounds to form a conclusive view on the equity beta of a benchmark efficient network service provider.[42]

41 AER, Final Decision Electricity transmission and distribution network service providers review of the weighted average cost of capital (WACC) parameters, May 2009, p. xvi.

42 AER, Final Decision Electricity transmission and distribution network service providers review of the weighted average cost of capital (WACC) parameters, May 2009, p. 343.

3 Approach to date

The approach to date for estimating the equity beta was published in our 2013 Guideline as part of the foundational model approach for estimating the return on equity.

We considered a wide range of relevant evidence for informing estimates of the equity beta based on their strengths, weaknesses and suitability for our regulatory task which we distilled to the following:[43]

- Australian empirical estimates – we give primary consideration to Australian empirical estimates.[44] We estimate the range for the equity beta based on empirical analysis using a set of Australian energy utility firms we consider reasonably comparable to the benchmark efficient entity.
- Conceptual analysis – we use conceptual analysis to cross check our range for the equity beta. This is because our conceptual analysis suggests that the systematic risks of a benchmark efficient entity would be less than the systematic risks of a market average entity (that is, less than 1.0) but would not provide a quantitative answer.
- Theory of the Black CAPM and international estimates – we use the theory of the Black CAPM and estimates from international energy firms to inform a point estimate from within the empirical range of equity beta estimates.

We adopt the same point estimate and range for equity beta across each of the energy sectors we regulate (electricity transmission, electricity distribution, gas distribution and gas transmission).

We outline below a summary of our considerations during the 2013 Guideline process.

3.1 Empirical studies

Empirical estimates of equity beta are based on regressions that relate the returns on a set of comparator firms to the return on the market.

During the 2013 Guideline, we developed a set of criteria for assessing the relevance and suitability of materials for informing our estimation of the rate of return and its parameters. This allows identification of the relative strengths, weaknesses and suitable roles.

Our assessment of empirical studies indicated that they aligned with our rate of return criteria.[45] That is, empirical estimates were assessed as:

- Based on available market data and derived with sound, econometric techniques.

43 AER, Better Regulation Explanatory Statement Rate of Return Guideline, December 2013, pp. 83–86.

44 AER, Better Regulation Explanatory Statement Rate of Return Guideline, December 2013, p. 83.

45 AER, *Explanatory statement to the rate of return guideline*, December 2013, pp. 23–26, 83-84,

- Fit for purpose as they are based on businesses that most closely, albeit imperfectly, meet our definition of the benchmark efficient entity.
- Implemented in accordance with good practice as they are derived from robust, transparent and replicable regression analysis. We note that consistent results are derived from different studies using different econometric techniques and sampling periods.
- Based on quantitative modelling in that they are derived using robust regression techniques with no arbitrary adjustment to the data.
- Based on market data that is credible, verifiable, comparable, timely and clearly sourced.

As a result, empirical studies were assessed as likely to contribute to a rate of return estimate that achieves the allowed rate of return objective and they were used as the primary determinant of equity beta.[46]

The 2013 Guideline used Professor Olan Henry's 2014 study to inform our empirical estimates.[47] This report presented empirical estimates on equity beta for a comparator set of nine Australian energy network firms, using available data from 29 May 1992 to 28 June 2013.[48] This report also presented estimates for individual firms as well as various portfolio specifications, and used a range of different estimation methods and time periods.

We assessed the equity beta estimates presented in Henry's empirical analysis and concluded that they support a range of 0.4 to 0.7. We have also updated Henry's study–using the same methodology–by including data up to 30 April 2017 which continued to support a range of 0.4–0.7.[49]

Comparator set

To ensure as close a match to the efficient required compensation for firms in the provision of regulated energy network services, we use market data.

The 2013 Guideline noted that, ideally, firms that share all or most of the key characteristics of the benchmark efficient entity would be used when conducting our empirical analysis to estimate the equity beta. However, in practice, few firms would fully reflect this benchmark. Therefore market data for domestic businesses that are considered to be reasonable comparators to the benchmark efficient entity to inform the equity beta estimate were used.

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46 AER, *Explanatory statement to the rate of return guideline (appendices)*, December 2013, p. 46

47 While Professor Henry's report was published in 2014, estimates were provided to the AER during 2013 to inform the Rate of Return Guideline review. For example, see: AER, Final decision APA VTS gas access arrangement 2018 to 2022 Attachment 3–Rate of return, November 2017, pp. 64–67.

48 Henry, *Estimating β: An update*, April 2014, p. 9.

49 In this update, we estimated Ordinary Least Squares (OLS) and Least Absolute Deviation (LAD) estimates of equity beta for our comparator firms just as Professor Henry did in his 2014 study. See AER, staff beta analysis, June 2017.

During the 2013 Guideline process, nine firms were identified that may be considered as reasonable comparators to the benchmark efficient entity. They are ASX listed firms that provide regulated electricity and/or gas network services operating within Australia.[50]

Some service providers have suggested our sample of Australian comparators is too small to produce reliable estimates.[51] They stated that as a result, international data, particularly the data from a sample of US firms, should be considered in addition to the Australian sample in determining the equity beta of a benchmark efficient entity.[52]

We also noted APA's submission stated that comparator firms must have a similar degree of risk as that of a service provider in respect of the provision of regulated services.[53] APA further suggested that international evidence may have a role to play in certain specific circumstances, but not in beta estimation.[54]

In the 2013 Guideline, we recognised there are only nine reasonable Australian comparators and a larger comparator set would be desirable in an ideal world.[55] However, we noted that the international firms suggested by some experts are less relevant comparators.[56] We considered that including these firms simply to increase the number of our observations would not be a preferable option. We agreed with APA on this issue that while increased statistical reliability is desirable, it would not be preferable if it substantially reduces the relevance of the data.

We have also noted that a number of the comparator firms are no longer trading. Another firm, AGL Energy Limited, has changed its operations such that it no longer closely represents a benchmark efficient firm.[57] This is addressed by only including data over an applicable time period for these firms. For the remaining listed firms, we considered more recent data (up to 30 April 2017) as part of our 2017 update. We noted that Envestra Ltd was delisted on 17 October 2014[58] and DUET ceased trading on 1 May 2017, and was delisted on 16 May 2017.[59]

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50 For example, see: AER, Final decision APA VTS gas access arrangement 2018 to 2022 Attachment 3–Rate of return, November 2017, pp. 64–73; AER, Final decision SA Power Networks determination 2015–16 to 2019–20, October 2015, pp. 451–463.

51 AER, *Explanatory statement to the rate of return guideline (appendices),* December 2013, pp. 48-49.

52 ActewAGL, *Response to beta issues paper*, October 2013, p. 3; ENA, *Submission to beta issues paper*, October 2013, pp. 28–29; Spark, *Response to beta paper*, October 2013, p. 2.

53 APA, *Submission on beta issues paper*, October 2013, p. 8.

54 APA, *Submission on beta issues paper*, October 2013, p. 9,16–17.

55 AER, *Explanatory statement to the rate of return guideline (appendices),* December 2013, pp. 48-49.

56 For example, SFG previously suggested that 56 US energy firms should be included in the sample.

57 In October 2006, AGL sold its infrastructure and asset management business to Alinta and acquired a portion of Alinta's retail and co-generation businesses.

58 See: http://www.asx.com.au/asx/statistics/announcements.do?by=asxCode&asxCode=ENV&timeframe=Y&year=2014 .

59 http://member.afraccess.com/media?id=CMN://2A1014230&filename=20170515/DUE_01857326.pdf
http://duet.net.au/Overview.html

Estimation methodology for empirical studies

Empirical estimates of equity beta are based on regressions that relate the returns for a set of compactor firms to the return on the market. As noted in section 3.1, Henry's study was used to inform empirical estimates in the 2013 Guideline.

Henry's empirical estimates used both Ordinary Least Squares (OLS) and Least Absolute Deviation (LAD) estimators.[60] We relied more on OLS estimates because OLS appeared to be the most commonly used estimation method for estimating beta.[61] Recent expert reports we have received have solely used OLS for producing estimates.[62]

We have considered the time period over which empirical studies are conducted. We considered that there is generally a trade–off in determining the length of the estimation period. Older data might be considered less reflective of current systematic risk assessments (which would suggest a shorter, more recent period). On the other hand, a longer time period provides more observations, which improves the accuracy of estimates, all else equal.

On balance, we considered it reasonable to use an estimation period of at least five years measured over a number of different periods, including:[63]

- The longest period available (which Henry recommends in his 2014 report)
- The period after the 'technology bubble' and before the global financial crisis (GFC)[64]
- The last five years of available data.

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60 Henry, *Estimating β: An update*, April 2014.

61 Greene noted, 'Chapter 2 defined the linear regression model…There are a number of different approaches to estimation of the parameters of the model. For a variety of practical and theoretical reasons that we explored, the method of least squares has long been the most popular'. See: Greene, *Econometric analysis*, Pearson Education (Prentice Hall): Fifth edition, 2003, p. 19. Additionally, OLS is the method used for beta estimation in: Peirson, Brown, Easton, Howard, Pinder, *Business Finance*, McGraw-Hill Australia: Tenth edition, 2009, p. 195. Also, Bloomberg, the Australian Graduate School of Management (AGSM), Morningstar and ValueLine estimate equity beta using regression analysis of stock and market index returns. Also, Grant Samuel and Associates (Grant Samuel) relied on equity beta estimates from Bloomberg and AGSM in its 2014 independent valuation report for Envestra. The Economic Regulation Authority (ERA) also estimates the equity beta using regression analysis of stock and market index returns. See: Grant Samuel and Associates, Envestra financial services guide and independent expert's report (appendix 3), March 2014, p. 6 (this shows Bloomberg and AGSM estimates); ValueLine, *Using Beta*, 2 October 2012, viewed on 16 April 2015, link: http://www.valueline.com/Tools/Educational_Articles/Stocks/Using_Beta.aspx#.VS96wNR--Uk; Morningstar, *Investing glossary: Beta*, viewed on 16 April 2015, link: http://www.morningstar.com/InvGlossary/beta.aspx; ERA, *Rate of return guideline explanatory statement*, December 2013, p. 165.

62 For example, see: Frontier, An equity beta estimate for Australian energy network businesses, December 2016; Frontier, An equity beta estimate for the benchmark efficient entity, January 2017; Frontier, Updated rate of return parameter estimates, August 2017.

63 Henry, *Estimating β: An update*, April 2014, pp. 11–12, 63. Henry uses data up to 28 June 2013.

64 AER, *Explanatory statement to the rate of return guideline (appendices)*, December 2013, p. 50.

We continue to have regard to estimates for the time periods above in our regulatory decisions and 2017 update of Henry's study.[65] However, as noted in Section 4.6, expert reports what were submitted have more regard for shorter-term estimates when estimating equity beta.[66]

We note the raw equity beta estimates of comparator businesses will reflect varying levels of actual financial leverage. These raw estimates can be de-levered to obtain the asset beta of the business. The result of de-levering reflects the beta of the asset if the asset was financed 100 per cent by equity, with zero debt. These asset betas can then be re-levered to match the level of gearing associated with the benchmark efficient entity (as adopted by the regulator).

We have adopted a gearing ratio of 60 per cent for the benchmark efficient entity, and we use the Brealey–Myers formula (assuming a debt beta of zero) to de-lever and re-lever the comparable businesses' equity beta estimates.[67] That is:

$$\beta_e = \beta_a \left(1 + \frac{D}{E}\right)$$

where:

- β_e is the equity beta
- β_a is the un-levered asset beta, and
- $\frac{D}{E}$ is the debt to equity ratio

In assuming a debt beta of zero, we have previously acknowledged that this formula may not necessarily produce an exact representation of the circumstances of a particular business.[68] However, we noted the average gearing of our comparator set of Australian energy network firms is similar to our benchmark gearing of 60 per cent. So the choice of whether or not to adjust raw equity beta estimates for leverage appears unlikely to be material on the average of individual firm estimates.

McKenzie and Partington has previously stated that the assumption of a debt beta of zero in above formula may not be a correct assumption.[69] They added that the de-levering and re-levering process 'can take you to a range of different destinations'.[70] Partington and Satchell has also cautioned against the re-levering process and that

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65 AER, Final decision APA VTS gas access arrangement 2018 to 2022 Attachment 3–Rate of return, November 2017.

66 CEG, Replication and extension of Henry's beta analysis, September 2016, p. 13; Frontier, An equity beta estimate for Australian energy network businesses, December 2016, pp. 19–20.

67 AER, *Explanatory statement to the rate of return guideline (appendices)*, December 2013, pp. 50–51.

68 AER, Final decision SA Power Networks determination 2015–16 to 2019–20, October 2015, p. 441.

69 McKenzie and Partington, *Report to the AER, Part A: Return on equity*, October 2014, p. 10; Partington, *Report to the AER: Return on equity (Updated)*, April 2015, p. 30.

70 McKenzie, Partington, *Estimation of equity beta*, April 2012, p. 11; McKenzie and Partington, *Report to the AER, Part A: Return on equity*, October 2014, p. 11; Partington, *Report to the AER: Return on equity (Updated)*, April 2015, p. 31.

depending on a firm's actual leverage, the de-levering and re-levering process can yield estimates that may be biased up or down.[71]

We also note the inter-relationships between the benchmark gearing, equity beta, return on equity and the overall rate of return. The table below provides a simplified example of how a change in benchmark gearing may impact the equity beta and overall rate of return. This example does not consider the effect (or the materiality of the effect) on the cost of debt, credit rating or tax-related impact from a change in gearing. It would be expected that the cost of debt would likely increase from an increase in gearing however it is unclear if this would entirely offset the change in the rate of return shown below.

Table 2 Sensitivity analysis of change in benchmark gearing

Benchmark gearing	Equity beta	Return on equity	Return on debt	Overall rate of return
60%	0.7	7%	5%	5.8%
50%	0.66	6.72%	5%	5.86%
70%	0.74	7.28%	5%	5.69%

Note: This analysis assumes that the return on debt does not change when gearing changes

Gearing adjustments

We de-lever a firm's raw equity beta estimates (using a firm's actual gearing). For firms that hold a minority interest (less than 50 per cent ownership) in an asset or company, their debt and hence gearing may be understated. This is because the investments may be reported using the equity accounting method, which does not require firms to report debt held by those assets on its balance sheet.[72]

We would need to make adjustments to ensure a firm's gearing appropriately reflects the level of debt held by itself and its assets.

Such an instance arises with Spark Infrastructure (SKI) which holds a minority interest in regulated energy networks (SAPN, CitiPower, Powercor and TransGrid). Its share of debt held by those networks is not reported in its public financial reports due to the use of the equity accounting method.

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[71] Partington and Satchell, Report to the AER: Issues in re-levering beta and testing for structural breaks, 21 September 2017, p. 8–9.

[72] The equity method is used for reporting investments in an associate or a joint venture where the investments is initially recognised at cost and the carrying amount is increased or decreased to recognise the investor's share of the profit or loss of the investee. Essentially firms report their share of profit and loss from investments but is not required to report its share of debt held by its assets. See: AASB Board Standard, Investments in associates and joint ventures, para 10–15. Available at: http://www.aasb.gov.au/admin/file/content105/c9/AASB128_08-15_COMPdec15_01-18.pdf

As a result, gearing information computed from its firm-level estimates would likely be under-stated. SKI also provides related party lending to those same networks.

To ensure gearing appropriately reflects all debt attributable to SKI, the look through method is used to incorporate the related party lending and SKI's share of the asset-level debt. This method is summarised in the following steps:

- Estimate SKI's share of its assets' borrowings (net of related party borrowings);
- This estimate is then combined with related party borrowings and other borrowings to arrive at total debt, which is then used to derive overall gearing in combination with market value of equity.[73]

However, information previously used to make this adjustment are no longer publicly available. For example, SAPN appears to no longer publish its financial reports and financial reports from 2013 to 2015 are only accessible to certain debt holders.[74]

Due to these changes, we estimated gearing to 2015 for SKI in our Gearing Discussion Paper. However, our June 2017 equity beta update has used 2016 liabilities data to estimate gearing for SKI to derive the most up-to-date estimates.[75]

In Section 7, we seek views on the use of borrowings versus liabilities for adjusting gearing estimates.

3.2 Conceptual analysis

Systematic risk

As part of the 2013 Guideline process, we reviewed and considered how conceptual analysis may be used for informing the systematic risk (and equity beta) of a benchmark efficient entity.

We have noted submissions disagreeing with our use of conceptual analysis:

- APA submitted that conceptual analysis could not support a low value for beta or a value below 1.0. It explained that conceptual analysis does not lead far and we must hold recourse to empirical evidence.[76]
- APIA was not supportive of the use of conceptual analysis for anything other than forming priories to be empirically tested.[77]

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73 This is consistent with the approach in Henry's study where debt and equity are used to estimate a firm's gearing level.

74 https://www.sapowernetworks.com.au/centric/corporate/corporate_information/annual_reports.jsp.

75 A liabilities-based gearing estimate is likely to be higher than a borrowings-based estimate. This is because liabilities would include borrowings and other items.

76 APA, *Submission on beta issues paper*, October 2013, p. 20.

77 APIA, *Submission to beta issues paper*, October 2013, p. 4.

- The Energy Networks Association (ENA) submitted that if the use of conceptual analysis continues to supports an equity beta of less than 1.0, then the guideline should clearly set out the quantitative basis for its 0.4 to 0.7 range.[78]
- The ENA submitted that our conceptual analysis is inconclusive as it implies a benchmark efficient entity has below average operating risk and above average finance risk.[79] Consequently, the ENA submitted this provides no basis to conclude that beta would be less than 1.0, as the low operating risk may have a smaller impact than the high financial risk.

Having considered the submissions and available evidence, we were able to conclude that the risk faced by a benchmark efficient entity in the supply of regulated energy network services is low. We noted that two key types of systematic risk were relevant for conceptual analysis: business risk and financial risk.

Our assessment of business risk for the benchmark efficient entity concluded that it would be low, and reduce systematic risk for the following reasons:[80]

- There are a number of inherent characteristics of an energy transportation network that lead to low systematic risk exposure. For example, operation of a natural monopoly and provision of an essential service with low price elasticity of demand.
- The structure of the current regulatory regime insulates service providers from systematic risk. For example, the current regime provides for revenue cap regulation, tariff variation mechanisms and cost pass through mechanisms. It also provides for tariff structures that include fixed charges and protection from asset write downs.

We also considered the high financial leverage of the benchmark efficient entity (relative to the market average) and concluded that it does not necessarily correspond to an equivalently high exposure to financial risk. This was because given a revenue cap mechanism, the implied earnings before interest and tax (EBIT) are relatively more stable compared to those of other unregulated firms. The relative stability in the EBIT provides the efficient entities a reasonable buffer to meet their obligations of interest payments and principal repayments. In addition, a structure of staggered debt profile which on average matches with a revenue cap for a regulatory control period also provides another buffer for the efficient entity to meet its obligation of interest payments and principal repayments.

Therefore, on the basis of this information, we considered there were reasonable conceptual grounds to expect the overall systematic risk for the benchmark efficient

78 ENA, *Submission to beta issues paper*, October 2013, p. 25.

79 ENA, *Submission to beta issues paper*, October 2013, p. 20.

80 AER, *Explanatory statement to the rate of return guideline (appendices)*, December 2013, pp. 40–41. Also see: Frontier Economics, *Assessing risk for regulated energy networks*, July 2013; McKenzie and Partington, *Estimation of equity beta*, April 2012, p. 6.

entity to be below that of the market average firm. This led to our expectation that the equity beta of the benchmark efficient entity will be below 1.0.

However, we were not able to arrive at a quantitative measure because the conceptual analysis cannot give a numerical value on the systematic risk of a benchmark efficient entity in the provision of regulated energy network services. As a result conceptual analysis was allocated a role to cross-check against the empirically derived range.[81]

Our regulatory decisions have maintained this view from the 2013 Guideline.[82] We noted that a business with a similar degree of risk as a service provider in providing regulated energy network services would be expected to have low business risk exposure (relative to the market average). The high financial leverage of a benchmark efficient entity also does not necessarily correspond to an equivalently high exposure to financial risk.[83]

Comparative systematic risks of different networks

An issue raised in the 2013 Guideline was whether the comparative systematic risks differed between different networks.

Stakeholders have indicated two main areas where there may be differences in the risk exposure between gas and electricity businesses—demand risk and competition risk.[84]

We considered the characteristics of different types of networks and observed the following: [85]

- Both gas and electricity service providers face limited competition risk by virtue of being regulated natural monopolies. Generally, competition risks for regulated networks are low. Such networks are usually regulated because they are natural monopolies.
- The regulatory framework for gas and electricity service providers are similar. Differences in demand risk are mitigated by the regulatory regime through the revenue or price setting mechanism (form of control).
- To the extent that there are genuine risks of extreme changes in demand for specific service providers which present the potential for stranded assets, the

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81 AER, *Explanatory statement to the rate of return guideline (appendices)*, December 2013, pp. 43

82 For example, see: AER, Final decision APA VTS gas access arrangement 2018 to 2022 Attachment 3–Rate of return, November 2017, pp. 24–26.

83 For example, see: AER, Final decision APA VTS gas access arrangement 2018 to 2022 Attachment 3–Rate of return, November 2017, pp. 285–286.

84 Envestra, *Response to the consultation paper*, June 2013, p. 10; APIA, *Response to Issues Paper: The Australian Energy Regulator's development of Rate of Return Guidelines*, 20 February 2013, Schedule 3, p. 1 (APIA, *Response to the issues paper*, February 2013); APA Group, *Submission responding to AER Rate of Return Guidelines Consultation Paper*, 21 June 2013, p. 5.

85 AER, *Explanatory statement to the rate of return guideline*, December 2013, p. 33; For example, see: AER, Final decision APA VTS gas access arrangement 2018 to 2022 Attachment 3–Rate of return, November 2017, pp. 27–28.

regulatory regime for gas and electricity can mitigate this risk by providing prudent discount and accelerated depreciation provisions.[86]

- Our Australian empirical analysis is based on a comparator set which includes gas service providers. Therefore, if there are differences in the systematic risks of electricity and gas service providers, this may be captured in our Australian empirical estimates of equity beta.

The Australian Pipeline Industry Association (APIA) and Envestra have submitted that gas service providers face greater risk than electricity service providers because gas faces greater competition.[87] However, we observed that gas service providers are able to mitigate competition from other pipelines through long term contracts with consumers—typically between 10 to 15 years.[88] Gas distribution service providers also often undertake pipeline extensions when they are underwritten by government or developer contributions.[89] Further, the regulatory regime and the limited scope for competition between pipelines mitigates the potential theoretical reasons for gas service providers being somewhat riskier than the average electricity service provider. This view is shared by Frontier, which stated that:[90]

> Based on this analysis, we were able to conclude that systematic risks between gas, electricity, transmission and distribution networks are sufficiently similar as to justify one benchmark (and estimate).[91]

Our regulation decisions since the 2013Guideline have maintained this view.[92]

Disruptive technologies

In subsequent application of the 2013Guideline, we recognised that disruptive technologies such as solar panels, smart technology and power storage may be changing the way consumers produce and consume electricity.[93] We also recognised this could have an effect on how consumers make use of network infrastructure and may increase some risks faced by service providers. However, in determining whether this increased risk needs to be accounted for in the equity beta (or the rate of return generally), we have considered whether the risk is systematic.

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86 For prudent discounts, see NER, cl. 6A.26, NGR r. 96; for accelerated depreciation provisions see NER, cll. 6.5.5(b)(1), 6A.6.3(b)(1); NGR, r.89(1).

87 APIA, *Response to the issues paper,* February 2013, Schedule 3, p. 1; Envestra, *Response to the consultation paper*, June 2013.

88 Energy Quest, *ESAA Domestic Gas Study Stage 2*, 10 March 2011, p. 69.

89 For example, Victorian government contributions via the 'Energy to the Regions' program have enabled gas distribution expansion.

90 Frontier, *Assessing risk for regulated energy networks*, July 2013, p. 5.

91 AER, *Explanatory statement to the rate of return guideline (appendices)*, December 2013, p. 38

92 For example, see: AER, Final decision APA VTS gas access arrangement 2018 to 2022 Attachment 3–Rate of return, November 2017, p. 24.

93 For example, AER, Final decision SA Power Networks determination 2015–16 to 2019–20, October 2015, p. 447.

Submissions from service providers have noted that we have not adequately accounted for the recent risks arising from disruptive technologies.[94] These service providers submitted that developments in distributed generation, smart technology and power storage may allow consumers to disconnect from the grid, which could threaten the role of energy networks. They referred to a number of articles describing various disruptive technologies and their impact on the energy sector.

Systematic risk is risk which affects the market as a whole (such as macroeconomic conditions and interest rate risk). We considered that the development of disruptive technologies in the Australian energy sector may create some non-systematic risk to the cash flows of energy network businesses.[95] This is because these technologies (distributed generation, smart technology and power storage) are unlikely to have significant effects outside the energy sector.

Therefore, we did not consider the risk arising from disruptive technologies can be reasonably classified as systematic risk[96] and be accounted for in the equity beta (or the rate of return generally) for a benchmark efficient entity.[97]

3.3 Theory of the Black CAPM

The Black CAPM is an alternative model to the Sharpe-Lintner CAPM. The key theoretical difference between the Black CAPM and the Sharpe-Lintner CAPM relates to borrowing and lending assumptions.[98]

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94 See, for example, ActewAGL, *Access arrangement information for the 2016-21 ACT, Queanbeyan and Palerang access arrangement: Appendix 8.02—Return on equity detailed proposal*, June 2015, p. 34; AGN, *2016/17 to 2020/21 access arrangement information: Attachment 10.1—Rate of return*, July 2015, pp. 29–30; AusNet Services, *Regulatory proposal 2016-20*, 30 April 2015, p. 316; United Energy, *2016 to 2020 regulatory proposal:* April 2015, section 2; CitiPower, *Regulatory proposal 2016-2020*, April 2015, section 12.2 (Powercor's regulatory proposal on the return on equity appears to be identical in substance to CitiPower's); Jemena Electricity Networks, *2016-20 electricity distribution price review regulatory proposal: Attachment 9-2—Rate of return proposal,* April 2015, section 2; Ergon Energy, *Submission to the AER on its Preliminary Determination: Rate of return—Cost of equity*, July 2015, pp. 11–14; SAPN, *Revised regulatory proposal*, July 2015, pp. 337, 344–347.

95 For example, AER, Final decision SA Power Networks determination 2015–16 to 2019–20, October 2015, pp. 447–448;

96 For example, AER, Final decision SA Power Networks determination 2015–16 to 2019–20, October 2015, pp. 447–448;

97 In our April/June 2015 final and preliminary decisions, we considered that, 'Even if the risk arising from disruptive technologies has increased the systematic risk of the benchmark efficient entity, we consider this will be captured in our empirical equity beta estimates to the extent that investors are aware of the risk' (see, for example, AER, *Jemena Gas Networks final decision 2015-20: Attachment 3—Rate of return*, June 2015, p. 406). We do not consider the risk arising from disruptive technologies can be reasonably classified as systematic risk. As Partington and Satchell stated in their October 2015 report, 'Since we do not consider the impact of disruptive technology to be a systematic risk we do not consider that it would be captured by estimates of beta, however recent they are' (see Partington and Satchell, *Report to the AER: Analysis of criticism of 2015 determinations*, October 2015, p. 39).

98 The Sharpe-Lintner CAPM assumes that investors can access unlimited borrowing and lending at the risk free rate. The Black CAPM relaxes this assumption, and instead assumes that investors can access unlimited short selling of stocks, with the proceeds immediately available for investment. Either of these assumptions might correctly be criticised as being unrealistic, and it is not clear which assumption is preferable.

As a result of slightly different starting assumptions, the Black CAPM predicts a slope of estimated returns that can be flatter than for the Sharpe-Lintner CAPM.[99] For firms with an equity beta below 1.0, the Black CAPM may predict a higher expected return on equity than the Sharpe-Lintner CAPM.

Some service providers submitted that the evidence from the Black CAPM suggests the appropriate beta estimate is 1.0, for all firms in the market (including the benchmark firm).[100] This is countered by several stakeholders commenting that the theoretical analysis of the Black CAPM identified such shortcomings in this approach that it should not be used to inform the equity beta point estimate.[101] PIAC stated that it was unreasonable for the AER to use theoretical analysis based on the Black CAPM to influence the selection of the equity beta point estimate.[102]

After assessing all the evidence available on the Black CAPM, we concluded that it should not be used to directly determine the equity beta range or point estimate for the benchmark efficient entity due to a range of limitations, such as empirical instability and implementation.[103] This is because while the direction of its effect may be known, the magnitude is much more difficult to ascertain.

However, we did not ignore the information provided by the Black CAPM. We acknowledged that it can provide some information in selecting the equity beta point estimate towards the upper end of our empirical range.[104] Therefore, the theory of the Black CAPM is used to select a point estimate towards the upper bound of our empirical range in the 2013 Guideline and regulatory decisions since its publication.[105]

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99 Fischer Black's 1972 paper on the Black CAPM develops two model specifications. The base specification assumes no risk free asset exists (no risk free borrowing or lending). The second specification assumes that the representative investor can lend but not borrow at the risk free rate. In the base specification, the return on the zero beta portfolio can be above the risk free rate. In the second specification, the return on the zero beta portfolio must be above the risk free rate. See: Black, *Capital market equilibrium with restricted borrowing*, Journal of Business 45(3), July 1972, pp. 452–454.

100 ActewAGL, *Response to beta issues paper*, October 2013, p. 3; ENA, *Submission to beta issues paper*, October 2013, pp. 22–23.

101 See for example COSBOA, Return on equity issues paper, Comments, October 2013, p. 3.

102 PIAC, *Better equity, submission to the AER's equity beta issues paper*, 28 October 2013, pp. 28–29.

103 AER, Better Regulation Explanatory Statement Rate of Return Guideline (appendices), December 2013, pp. 71-72.

104 In the Guideline we performed a rough assessment of the reasonableness of the option to select a point estimate towards the upper end of the equity beta range (to reflect the differing predictions of the Black CAPM relative to the SLCAPM). We noted for clarity that we do not consider the possible zero beta premiums presented in table C.11 of the explanatory statement to the Guideline are accurate or reliable as empirical estimates because we do not consider that there is any reliable empirical estimate for this parameter. However, in light of the available evidence, if the Black CAPM captured the 'true' state of the world better than any other asset pricing model (although we are not implying that it does), selecting a point estimate towards the upper end of the equity beta range appeared open to us. See: AER, *Explanatory statement to the rate of return guideline (appendices)*, December 2013, pp. 70–71.

105 For example, see: AER, Final decision APA VTS gas access arrangement 2018 to 2022 Attachment 3–Rate of return, November 2017, pp. 64–73;

3.4 International empirical estimates

We considered the role of international empirical estimates as part of the 2013 Guideline. There were competing views from stakeholders on the role of international comparators during the 2013 Guideline process:

- Consumer groups submitted that less weight should be placed on the international data.[106] APA also submitted that international evidence should not be considered for beta estimation.[107]
- CEG examined the correlation between industry betas in Australia and the US. It suggested that the US sample provides a relevant proxy for regulated Australian energy network as the industry betas are positively correlated.[108]

Having reviewed the evidence available, we considered that international comparators are less aligned with the benchmark efficient entity, compared to Australian comparators.[109]

We noted that it would difficult to use this information in accordance with good practice because it is difficult to adjust for these differences. These differences include, but are not limited to: differences in regulatory regimes, economic conditions and market structures. In addition, estimated betas drawn from international empirical studies are best employed within the framework of an international CAPM version which is effectively involved with, together with these estimated betas, an international risk free rate and an international market risk premium.

Therefore, we did not use international empirical estimates to directly estimate the equity beta and considered that it may be used to inform a point estimate within our empirical range.

Our regulatory decisions since the Guideline continue to have regard to international empirical estimates and use it to inform a point estimate within our empirical range.[110]

3.5 Application of our approach to date

Applying our approach, we estimated a range of 0.4–0.7 for the equity beta. We consider the equity beta of a benchmark efficient entity is in this range as:

- Conceptual analysis supports that the equity beta of a benchmark efficient entity would be low and below 1.0.
- Our conceptual and empirical analysis suggested systematic risks are sufficiently similar between the different sectors of the energy market to warrant one estimate.

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[106] AER, *Explanatory statement to the rate of return guideline (appendices),* December 2013, p. 60.

[107] APA, *Submission on beta issues paper*, October 2013, p .9 and pp.16–17.

[108] CEG, E*quity beta from US companies,* June 2013, pp. 37–41.

[109] AER, *Explanatory statement to the rate of return guideline*, December 2013, p. 85

[110] For example, see: AER, Final decision SA Power Networks determination 2015–16 to 2019–20 Attachment 3–Rate of return, October 2015, pp. 94, 129.

We used Henry's study to inform Australian empirical estimates of equity beta.[111] This empirical evidence for Australian electricity and gas networks supports an equity beta of between 0.4 and 0.7 for the benchmark efficient entity. Our update using data up to April 2017 also continued to support this range.[112]

Our point estimate is at the upper end of our 0.4–0.7 range. We have chosen this point estimate because:

- Theoretical principles underpinning the Black CAPM suggest the standard Sharpe–Lintner CAPM may underestimate the return on equity for firms with equity betas below 1.0. Although it is difficult to ascertain the magnitude (or materiality) of this effect, selecting a point estimate towards the higher end of the range is an appropriate approach to allow for the theoretical differences between the models.
- We have used overseas energy networks to inform our point estimate. The pattern of overseas results is not consistent and there are inherent uncertainties when relating foreign estimates to Australian conditions. However, these results make up the bundle of evidence before us that we considered in selecting a point estimate towards the upper end of our range.

The estimate of 0.7 is a decrease from the 0.8 in our 2009 WACC review.[113] This was because of greater confidence in our empirical estimates (which supported a range of 0.4-0.7) for the following reasons:[114]

- Increase in the length of the time series of the data set; and
- Additional data from pre-global financial crises (GFC) and post-GFC periods suggested that the equity beta for the benchmark efficient entity was relatively stable across time, even when there were major fluctuations in the business cycle.

[111] Henry, *Estimating β: an update*, April 2014.

[112] AER, AER staff beta update, June 2017

[113] AER, Final Decision Electricity transmission and distribution network service providers review of the weighted average cost of capital (WACC) parameters, May 2009, p. v.

[114] AER, Better Regulation Explanatory Statement Rate of Return Guideline, December 2013, pp. 84–85.

4 Independent expert views

In this section, we do not aim to exhaustively cover all the views put to us by independent experts, but rather highlight some of the key considerations to facilitate discussion.

We also suggest some questions for further discussion in section 7.

4.1 Conceptual analysis

Systematic risk

McKenzie and Partington have previously stated that the systematic risk for a business with a similar degree of risk as a service provider in the provision of regulated energy network services to be below that of the market average firm. They noted that:[115]

> Taken together, the previous conceptual discussion clearly provides evidence to suggest that the theoretical beta of the benchmark firm is very low. While it is difficult to provide a point estimate of beta, based on these considerations, it is hard to think of an industry that is more insulated from the business cycle due to inelastic demand and a fixed component to their pricing structure. In this case, one would expect the beta to be among the lowest possible and this conclusion would apply equally irrespective as to whether the benchmark firm is a regulated energy network or a regulated gas transmission pipeline.

In their 2014 (and 2015) report, McKenzie and Partington reviewed the available evidence and confirmed the continued validity of their conclusions made on their conceptual assessment of equity beta outlined in their 2012 report.[116]

However, other experts have disagreed with our conceptual analysis. For example:

- SFG considered there are a number of problems with our conceptual analysis in a 2014 report, including:[117]
    - It is an empirical (not conceptual) analysis, as McKenzie and Partington consider empirical literature to support their conclusions. SFG considered an

115 McKenzie and Partington, *Estimation of equity beta*, April 2012, p. 15.

116 McKenzie and Partington, *Report to the AER, Part A: Return on equity*, October 2014, pp. 11–12; Partington, *Report to the AER: Return on equity (Updated)*, April 2015, pp. 31–32.

117 SFG, *Equity beta*, May 2014, p. 18; SFG, *Estimating the required return on equity: Report for Energex*, 28 August 2014, p. 60. SFG summarises and directly references SFG's 2014 equity beta report in SFG, *The required return on equity for regulated gas and electricity network businesses: Report for Jemena Gas Networks, ActewAGL Distribution, Ergon and Transend*, 27 May 2014, pp. 84–85 (SFG, *The required return on equity for regulated gas and electricity network businesses*, 27 May 2014). Therefore, any references we make to SFG, *Equity beta*, May 2014 also apply to the service providers who submitted SFG, *The required return on equity for regulated gas and electricity network businesses*, 27 May 2014 (including SAPN).

empirical analysis cannot be used to form a conceptual view. Frontier, in its June 2015 report, expressed a similar view.[118]

  - It implies the effect of leverage on equity beta is weaker than (and inconsistent with) that implied by the formula the AER uses to de-lever and re-lever its raw equity beta estimates.
  - It is wrong, because the empirical evidence and expert reports relied upon by the AER have been misinterpreted.

- SFG's 2015 report also disagreed with our analysis, noting that if the benchmark efficient entity has an equity beta less than 1.0, then, according to the Brealey–Myers formula, its business risk would have to be less than 0.4. There is no conceptual way to determine if this is the case.[119]
- Frontier also submitted that our conceptual analysis of systematic risk is likely to be counterproductive to good regulatory decisions.[120]

Disruptive technologies

Partington has stated that the risk arising from disruptive technologies can be reasonably classified as systematic risk.[121]

Partington and Satchell added that:[122]

> A systematic risk is one that investors cannot diversify away. The impact of disruptive technology on the returns to the regulated businesses can clearly be seen to be diversifiable. A simple diversification strategy would be for investors to invest in disruptive technology firms and/or the physical assets, and more generally invest in stocks that have a positive covariance of returns with respect to the returns of disruptive technology investments.

Partington also agreed with this view, stating that:[123]

> The appropriate way to adjust to for disruptive technology is therefore to adjust the cash flow. To the extent that the result of disruptive technology is stranded assets, then the effective economic life of the asset is reduced and/or its residual value is less than originally assumed. Consequently, one way to allow for the impact on cash flow is to increase the regulatory depreciation allowance.

Partington and Satchell have reiterated this view in their 2015 report:[124]

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118 Frontier, *Review of the AER's conceptual analysis for equity beta*, June 2015, p. 6.

119 SFG, *Beta and the Black capital asset pricing model*, 13 February 2015, pp. 41–45 (appendix 3).

120 Frontier, *Review of the AER's conceptual analysis for equity beta*, June 2015, p. 7.

121 Partington, *Report to the AER: Return on equity (Updated)*, April 2015, pp. 77–78.

122 Partington and Satchell, *Report to the AER: Analysis of criticism of 2015 determinations*, October 2015, p. 39.

123 Partington, *Report to the AER: Return on equity (Updated)*, April 2015, p. 77.

124 Partington and Satchell, *Report to the AER: Analysis of criticism of 2015 determinations*, October 2015, p. 39.

> We agree with the AER, that any adjustment for the impact of disruptive technology should be made by adjustment to the cash flows, for example by increasing the depreciation allowance. We suggest that this could be done if and when there is some more substantive evidence of the impact, such as companies making announcements to shareholders about asset value impairment, writing down asset values and seeking to minimise new capital expenditures.

Frontier submitted that, 'the AER has neither attempted to estimate the effect of those risks, nor made any allowances for those risks, through the rate of return or through regulated cash flows'.[125] Frontier also submitted that, given recent developments, its assessment of the risk to service providers from disruptive technologies had increased since its 2013 report.[126]

4.2 Empirical studies

SFG has previously raised a number of issues with Henry's study, for example it:

- expressed concerns regarding the reliability of equity beta estimates based on a small comparator set of Australian energy network firms.[127] [128]
- proposed 'best empirical estimate of beta' should be based on averages of individual estimates for Australian energy network firms and US energy firms.[129]

Frontier and CEG have also submitted that extension of Henry's study suggesting increase in empirical estimates warrant a higher equity beta of 0.8.[130] More detail on the Frontier and CEG reports are in Section 6.1**Error! Reference source not found.**.

Comparator set

As noted above, concerns have been raised regarding the reliability of equity beta estimates from our comparator firms.[131] Some experts suggested that our comparator

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125 Frontier, *Review of the AER's conceptual analysis for equity beta*, June 2015, p. 26.

126 Frontier, *Review of the AER's conceptual analysis for equity beta*, June 2015, p. 23.

127 SFG, *Equity beta*, May 2014, pp. 2–3; SFG, *Estimating the required return on equity: Report for Energex*, 28 August 2014, pp. 68–71.

128 SFG, *Beta and the Black capital asset pricing model*, 13 February 2015, pp. 10–11. SFG also submitted that our estimates are imprecise with wide standard errors. However, SFG did not provide analysis to support this submission. We did not consider increased statistical precision (or reduced dispersion) necessarily results in more reliable equity beta estimates. We also noted that Henry performed tests for thin trading and parameter instability in his analysis and concluded that there was no significant issue with thin trading or stability in his equity beta estimates.

129 SFG, *Regression-based estimates of risk parameters for the benchmark firm*, June 2013, pp. 2, 13.

130 Frontier, An equity beta estimate for Australian energy network businesses, December 2016; Frontier, An equity beta estimate for the benchmark efficient entity, January 2017; Frontier, Updated rate of return parameter estimates, August 2017; CEG, *Replication and extension of Henry's beta analysis*, September 2016.

131 SFG, *Equity beta*, May 2014, pp. 2–3, 31–34, 40; SFG, *Estimating the required return on equity: Report for Energex*, 28 August 2014, pp. 68–71, 71–74, 82.

firms should be complemented by international energy networks and Australian infrastructure firms.[132]

Partington and Satchell have cautioned against the inclusion of international energy network firms in our comparator set. Their reasoning include the following:[133]

- the trade-off is that additional comparators 'are likely to be an increasingly poor match'
- 'there needs to be a strong case for believing that the data is relevant to Australia and that the relevant betas and operating leverage are likely to be similar between the regulated network businesses and the additional comparators'
- there are 'serious problems involved if we plan to [add] US energy companies' to the comparator set and 'the US data not supply suitable comparators'.[134]

Partington and Satchell have also advised that they saw 'no need to drop [de-listed] firms from the set of comparators as they…are valuable looking backwards.'[135]

4.3 Theory of the Black CAPM

McKenzie and Partington have previously considered our role for the Black CAPM. They noted that while the empirical implementation of the Black CAPM is problematic, the theory underlying the Black CAPM may have a role in informing the equity beta estimate.[136] They submitted there is considerable uncertainty in how the Black CAPM theory should be applied to a Sharpe-Lintner CAPM equity beta estimate. However, they considered the theory underlying the Black CAPM does not necessarily support an uplift to the equity beta estimate used in the SLCAPM.[137]

SFG and NERA have submitted that in the Guideline we used the Black CAPM to apply a specific uplift to equity beta to correct for 'low beta bias', and that the uplift applied was insufficient.[138]

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[132] SFG, *Equity beta*, May 2014, pp. 2–3, 31–34, 40; SFG, *Estimating the required return on equity: Report for Energex*, 28 August 2014, pp. 68–71, 71–74, 82; Frontier, An equity beta estimate for Australian energy network businesses, December 2016; Frontier, An equity beta estimate for the benchmark efficient entity, January 2017; Frontier, Updated rate of return parameter estimates, August 2017.

[133] Partington and Satchell, Report to the AER: Discussion of comparator firms for estimating beta, June 2016, pp. 8–9.

[134] Partington and Satchell, Report to the AER: Discussion of comparator firms for estimating beta, June 2016, pp. 11–12.

[135] Partington and Satchell, Report to the AER: Discussion of comparator firms for estimating beta, June 2016, p. 9.

[136] McKenzie and Partington, *Report to the AER, Part A: Return on equity*, October 2014, pp. 24–25; Partington, *Report to the AER: Return on equity (Updated)*, April 2015, pp. 44–45.

[137] McKenzie and Partington, *Report to the AER, Part A: Return on equity*, October 2014, p. 24; Partington, *Report to the AER: Return on equity (Updated)*, April 2015, p. 44.

[138] NERA, *Return on capital of a regulated electricity network*, May 2014, pp. 44, 68, 89–91; SFG, *The required return on equity for regulated gas and electricity network businesses*, May 2014, pp. 92–95; SFG, *Estimating the required return on equity: Report for Energex*, 28 August 2014, pp. 76–79, 83. SFG and NERA considered the SLCAPM produces downward biased return on equity estimates for low beta stocks (stocks with an equity beta less than 1.0). This is what they refer to as 'low beta bias'.

SFG has also submitted that we have had regard to the Black CAPM in a convoluted manner. It submitted that we should have regard to the Black CAPM by either:[139]

- empirically estimating the Black CAPM in a multiple model approach to estimating the return on equity
- empirically estimating the Black CAPM return on equity and then inserting this into the SLCAPM to reverse engineer an equity beta estimate (SFG recommends an equity beta of 0.91 under this approach).

SFG noted that transparency requires us to empirically estimate the Black CAPM, and that we have essentially computed an unspecified estimate of the zero-beta premium.[140]

4.4 International empirical estimates

Partington and Satchell have considered the potential for including international empirical estimates and 'strongly [disagreed] with the use of international energy firms'.[141] They noted that 'beta estimates for utilities vary quite substantially across countries' which 'raises opportunities for cherry picking' and international firms may not represent 'the exposure of Australian network utility to the Australian market return'.[142]

Other experts have previously submitted that more regard should be given to international empirical estimates. For example, SFG acknowledged that international energy network firms are less comparable to the benchmark efficient entity than Australian energy network firms. But it considered our comparator set of Australian energy network firms was too small and produced unreliable equity beta estimates.[143] It made the following suggestions:[144]

1. The 56 US energy firms identified by CEG during the Guideline process are sufficiently comparable to the benchmark efficient entity. Therefore, they should be included in our comparator set for empirical analysis, albeit with less weight than the domestic comparators.
2. Including US energy firms in the comparator set for empirical analysis increases the reliability of the equity beta estimates.

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139 SFG, *Beta and the Black capital asset pricing model*, 13 February 2015, p. 23–24, 35; SFG, *The required return on equity: Initial review of the AER draft decisions*, 19 January 2015, pp. 16–17; SFG, *The required return on equity for the benchmark efficient entity*, 13 February 2015, p. 19.

140 SFG, *Beta and the Black capital asset pricing model*, 13 February 2015, pp. 23–24; SFG, *The required return on equity: Initial review of the AER draft decisions*, 19 January 2015, p. 17.

141 Partington and Satchell, Report to the AER: Discussion of comparator firms for estimating beta, June 2016, p. 14.

142 Partington and Satchell, Report to the AER: Discussion of comparator firms for estimating beta, June 2016, p. 11–12.

143 SFG, *Equity beta*, May 2014, p. 2; SFG, *Estimating the required return on equity: Report for Energex*, 28 August 2014, p. 82.

144 SFG, *Equity beta*, May 2014, pp. 31–34, 40; SFG, *Estimating the required return on equity: Report for Energex*, 28 August 2014, pp. 71–74, 82.

In its 2015 report for several service providers, CEG made similar submissions to SFG.[145]

4.5 Estimation method

SFG has previously submitted that the LAD estimation method produces systematically downward biased equity beta estimates and should not be used.[146] It also submitted LAD estimation is not used to estimate equity beta in academic research or in commercial practice.

4.6 Time period selection

Frontier and CEG have previously submitted that we should have greater regard to shorter time periods when estimating equity beta. Specifically, Frontier has previously focused on 5-year estimates when submitting for an increase in equity beta and CEG suggested that 1-year estimates should be given consideration.[147]

SFG has also submitted that equity beta estimates can vary materially depending on how the return interval is defined (in particular, what reference day is chosen to calculate weekly or monthly returns).[148] SFG referenced a report by CEG which was submitted to the ERA in 2013.[149] This report presented a diagram showing variation in equity beta estimates depending on which day of the week or month is used as the reference day of the return interval.[150]

145 CEG, *Estimating the cost of equity, equity beta and MRP*, January 2015, pp. 34–38

146 SFG, *Equity beta*, May 2014, p. 12.

147 CEG, Replication and extension of Henry's beta analysis, September 2016, p. 13; Frontier, An equity beta estimate for Australian energy network businesses, December 2016, pp. 19–20

148 SFG, *Equity beta*, May 2014, pp. 29–31; SFG, *Estimating the required return on equity: Report for Energex*, 28 August 2014, pp. 69–71.

149 CEG, *Regression estimates of equity beta*, September 2013, pp. 25–27.

150 CEG, *Regression estimates of equity beta*, September 2013, pp. 26, figure 3. The same diagram is presented in: SFG, *Equity beta*, May 2014, p. 30, figure 3 and SFG, *Estimating the required return on equity: Report for Energex*, 28 August 2014, p. 70, figure 8.

5 Updated Australian empirical estimates

Our 2013 Guideline used Henry's 2014 study to inform Australian empirical estimates of equity beta.

We also conducted an update of Professor Henry's study in 2017 following submissions from regulated businesses that Australian empirical estimates have been increasing since 2013 to warrant increasing the equity beta above 0.7.[151] This study extends the period of estimation to 30 April 2017. Our conclusion was that updated empirical estimates did not provide sufficient evidence to warrant moving from our range or point estimate.

We also recently undertook an estimation of industry-level equity betas for the utilities industry. This was in response to previous submissions that our sample comparator firms is too small and should be expanded to include additional firms.[152] This study covers all 11 Australian industries as classified by Bloomberg for the period of 10 years, from 1 January 2009 to 31 December 2017. The findings of our estimation indicate that the utilities sector has less systematic risk than the market average firm and has a beta within our current range of 0.4–0.7.

A summary of both exercises is provided below.

5.1 June 2017 update

We estimated equity betas for three scenarios using data up to 30 April 2017:

1. The longest possible period of data for the benchmark sample of nine Australian energy utility firms
2. The longest possible period of data for the benchmark sample after the tech boom (3 Jul 1998 to 30 October 2001) and *excluding* the GFC (5 September 2008 to 30 October 2009)
3. The most recent five years of data to 30 April 2017.

Analyses were conducted at the individual firm and portfolio levels. Both equally weighted and value weighted averages are employed at the portfolio level.

Estimates of equity beta across scenarios, methods and portfolios from this study can be presented in the following summaries.

151 AER, AER staff beta analysis, June 2017. Available at: https://www.aer.gov.au/networks-pipelines/guidelines-schemes-models-reviews/review-of-rate-of-return-guideline/initiation

152 For example, see: AER, Final decision APA VTS gas access arrangement 2018 to 2022 Attachment 3–Rate of return, November 2017, p. 270.

Table 3 A summary of re-levered beta at the individual firm level

Firm		AAN	AGL	APA	DUE	ENV	GAS	HDF	SKI	AST
Scenario 1										
	OLS	0.83	0.69	0.72	0.34	0.37	0.35	1.30	0.39	0.40
	LAD	0.64	0.71	0.73	0.27	0.32	0.28	0.77	0.44	0.52
Scenario 2										
	OLS	0.95	0.71	0.79	0.38	0.36	0.35	0.93	0.41	0.56
	LAD	0.69	0.51	0.73	0.30	0.30	0.28	0.71	0.55	0.57
Scenario 3										
	OLS			0.93	0.31				0.48	0.79
	LAD			0.94	0.39				0.54	0.79

Source: the AER's analysis

Table 4: A Summary of Re-levered Beta at the portfolio level

			Portfolio 1 (APA, ENV)	Portfolio 2 (AAN, AGL, APA, ENV, GAS)	Portfolio 3 (APA, DUE, ENV, HDF, AST)	Portfolio 4 (APA, DUE, ENV, HDF,SKI, AST	Portfolio 5 (APA, DUE, ENV, SKI, AST)	Portfolio 6 (APA, DUE, SKI, AST)[153]
Scenario 1								
	Equal							
		OLS	0.57	0.52	0.61	0.57	0.47	0.47
		LAD	0.58	0.39	0.55	0.56	0.51	0.55
	Value							
		OLS	0.58	0.53	0.53	0.51	0.47	0.49
		LAD	0.56	0.35	0.49	0.52	0.52	0.56
Scenario 2								
	Equal							
		OLS	0.59	0.52	0.60	0.58	0.52	0.55
		LAD	0.60	0.39	0.58	0.61	0.59	0.62
	Value							
		OLS	0.62	0.53	0.60	0.58	0.55	0.57
		LAD	0.56	0.35	0.55	0.61	0.58	0.61
Scenario 3								
	Equal							
		OLS	0.81				0.60	0.61
		LAD	0.81				0.65	0.73
	Value							
		OLS	0.81				0.63	0.65
		LAD	0.80				0.71	0.72

Source: the AER's analysis

In accordance with Henry's 2014 analysis, tests on thin trading; stability and structural breaks have also been conducted. On balance, across all scenarios, methods, and portfolios, key findings from this study can be summarised as below.[154]

- At the individual firm level, the highest estimate of 1.3022 is for HDF and the lowest estimate of 0.2705 is for DUET. The mean value of estimated beta is 0.5754 whereas the median is 0.5424. It is noted that more than 50 per cent of the estimates are lower than the mean estimated value when all estimates from various scenarios are considered.
- At the portfolio level, across various scenarios and portfolios, the mean value of the estimated beta for portfolios is approximately 0.5744 which varies within the range of 0.3509 (LAD estimates on Scenario 1) and 0.8118 (OLS estimates on Scenario 3). The median for the estimated betas across various scenarios and portfolios is 0.5741 which is very close with the average value of 0.5744. However,

153 We note that portfolio 6 is not part of Henry's 2014 study. It includes all firms which were listed as at April 2017. DUET ceased trading in 1 May 2017 and was de-listed on 16 May 2017.

154 AER, AER staff beta analysis, June 2017.

it is noted that most of the estimates are clustered around 0.6. More than two thirds of the estimates (42 out of 60) are below 0.6.

- There is no strong evidence of thin trading in this analysis at both individual firms and portfolio levels. As such, the estimated betas from this study are robust and can be used for the regulatory purpose.
- No sensible evidence of a structural break in the estimates of beta is found at both individual firm and portfolio levels. There is no theoretical justification for any “break” found on the empirical ground. As a result, the two-step approach should be considered for any possible break of the estimates of equity beta: (i) a major event during a period is examined to consider a possible structural break in the data; and (ii) structural break tests such as a very popular Chow’s test and the others are conducted to examine realised data to confirm if the structural break did occur during the period as anticipated.
- A stability of estimated parameter is conducted in this study. It is concluded that there is no strong evidence to support instability of the estimated parameter and that the range of 0.4 to 0.7 is supported from this analysis.

On balance, when each of the above estimates is considered independently, two thirds of the above estimates are less than 0.6. In addition, the mean and median values of the estimated betas across scenarios, methods, and portfolios are also less than 0.6.

5.2 February 2018 industry equity betas

We have also estimated the industry/sector beta for various Australian sectors/industries in 2018. The relevant market indices for all eleven Australia industries as classified by Bloomberg are used. These industries include:

- Industrials;
- Consumer Discretionary;
- Consumer Staples;
- Financials;
- Materials;
- Health;
- Energy;
- Utilities;
- Telecommunication;
- Information Technology; and
- Real estates.

The exercise covers a period of 10 years, from 1 January 2008 to 31 December 2017. The standard econometric techniques of OLS and LAD were used in this analysis.

The composition of the industry indices suggests that utilities would be the most comparable industry group. This is because the utilities index includes our comparator firms[155] which make up 3 of the top 5 firms in this index.[156] By contrast, the energy index is not a good comparator because it is mostly composed of firms in oil, gas and coal industries involved in exploration, development, operation and export of oil/gas fields and coal mines.

Key findings from this exercise can be summarised as below.

- Australian *Utilities* industry is among the lowest risk of all Australian industries for the period of 2008–2017. The *Utilities* industry is ranked third (Weekly data OLS) and second (weekly data, LAD) lowest risk in Australia.
- Estimated betas for Australian *Utilities* are 0.5647 (Weekly data, OLS) and 0.5995 (Weekly data, LAD). These estimates are averaged all estimates for the considered period of 2008–2017.
- The 95 per cent confidence intervals for these estimates are 0.42 – 0.71 (Weekly data, OLS); and 0.41 – 0.78 (Weekly data, LAD).

When each of the above estimates is considered independently, 16 estimated betas out of 20 (or 80 percent) are less than 0.7 – the current point estimate of equity beta. In addition, the mean values of the estimated betas across years are also less than 0.6, with the median of 0.6214 (LAD) and 0.5792 (OLS).

[155] The Bloomberg utilities index includes our comparator firms that remain listed (APA, AST and SKI).

[156] The top 5 firms in the utilities index make up the majority of the index: 3 of these firms are part of our comparator set (APA, AST and SKI).

Table 5: Australian Industry Beta, Weekly Data, OLS, 2008 - 2017

Weekly data - OLS	Industrials	Consumer Discretionary	Consumer Staples	Financials	Materials	Health Care	Energy	Utilities	Telecommunication	Information Technology	Real Estate
2008	0.90	0.76	0.73	0.93	1.31	0.65	1.51	0.68	0.50	0.69	1.16
2009	1.16	0.94	0.40	1.22	1.28	0.20	0.98	0.54	0.19	0.76	1.37
2010	0.97	0.74	0.65	1.11	1.25	0.53	1.17	0.56	0.38	0.93	0.61
2011	0.88	0.83	0.58	1.17	1.28	0.64	1.21	0.59	0.35	0.66	0.65
2012	1.18	0.85	0.57	0.91	1.61	0.57	1.45	0.13	0.25	0.88	0.41
2013	1.06	0.94	0.79	1.14	1.25	0.73	1.12	0.52	0.63	0.93	0.49
2014	0.98	1.07	0.96	1.04	1.25	0.75	1.17	0.66	0.85	1.34	0.73
2015	0.63	0.86	0.86	1.19	1.37	0.64	1.69	0.92	0.66	0.71	0.76
2016	0.69	0.75	0.89	1.39	1.34	0.64	1.14	0.40	0.45	1.01	0.42
2017	0.79	0.99	1.05	1.32	0.81	0.73	1.21	0.63	0.11	1.22	1.02
Average	**0.92**	**0.87**	**0.75**	**1.14**	**1.27**	**0.61**	**1.26**	**0.56**	**0.44**	**0.91**	**0.76**

Weekly data - LAD	Industrials	Consumer Discretionary	Consumer Staples	Financials	Materials	Health Care	Energy	Utilities	Telecommunication	Information Technology	Real Estate
2008	1.00	0.71	0.79	0.95	1.02	0.78	1.50	0.74	0.66	0.90	1.28
2009	1.09	0.97	0.53	1.21	1.33	0.37	1.04	0.60	0.33	0.61	1.24
2010	0.93	0.70	0.54	1.09	1.21	0.61	1.21	0.53	0.24	0.93	0.61
2011	0.85	0.84	0.64	1.14	1.29	0.80	1.15	0.63	0.28	0.60	0.69
2012	1.13	0.95	0.47	0.91	1.58	0.50	1.52	-0.01	0.22	0.87	0.50
2013	1.11	0.90	0.86	1.08	1.36	0.81	1.08	0.61	0.65	0.70	0.73
2014	0.99	1.19	0.94	0.98	1.26	0.71	0.97	0.64	0.79	1.20	0.77
2015	0.63	0.87	0.79	1.21	1.12	0.66	1.67	1.02	0.67	0.52	0.76
2016	0.75	0.86	0.85	1.47	1.34	0.52	1.10	0.49	0.62	0.84	0.52
2017	0.72	0.94	1.09	1.42	0.49	0.85	1.02	0.73	0.28	1.31	0.87

Average	**0.92**	**0.89**	**0.75**	**1.15**	**1.20**	**0.66**	**1.22**	**0.60**	**0.47**	**0.85**	**0.80**

Figure 1 Australian Industry Beta, Weekly Data, OLS, 2008 - 2017

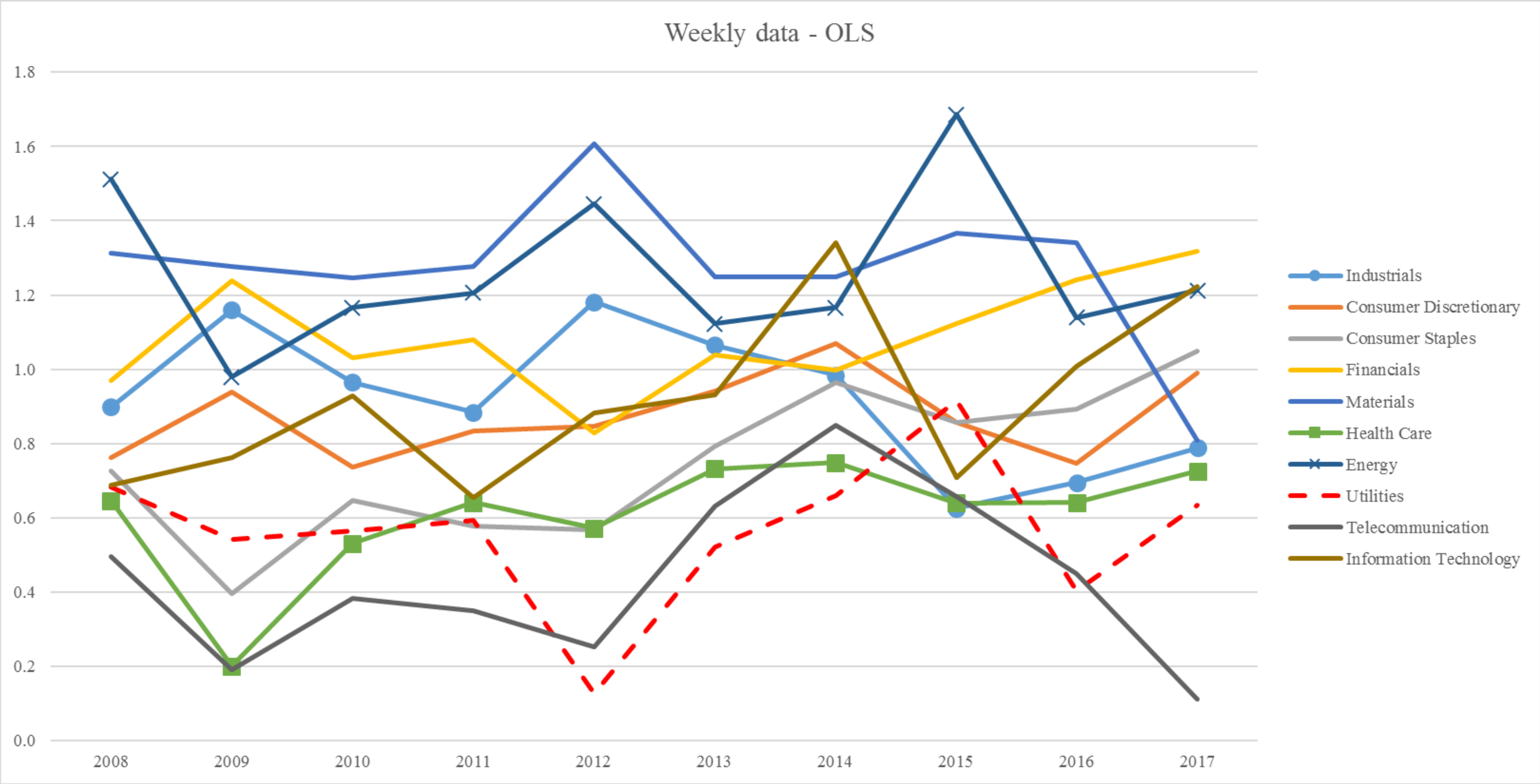


Figure 2 Australian Industry Beta, Weekly Data, LAD, 2008 - 2017

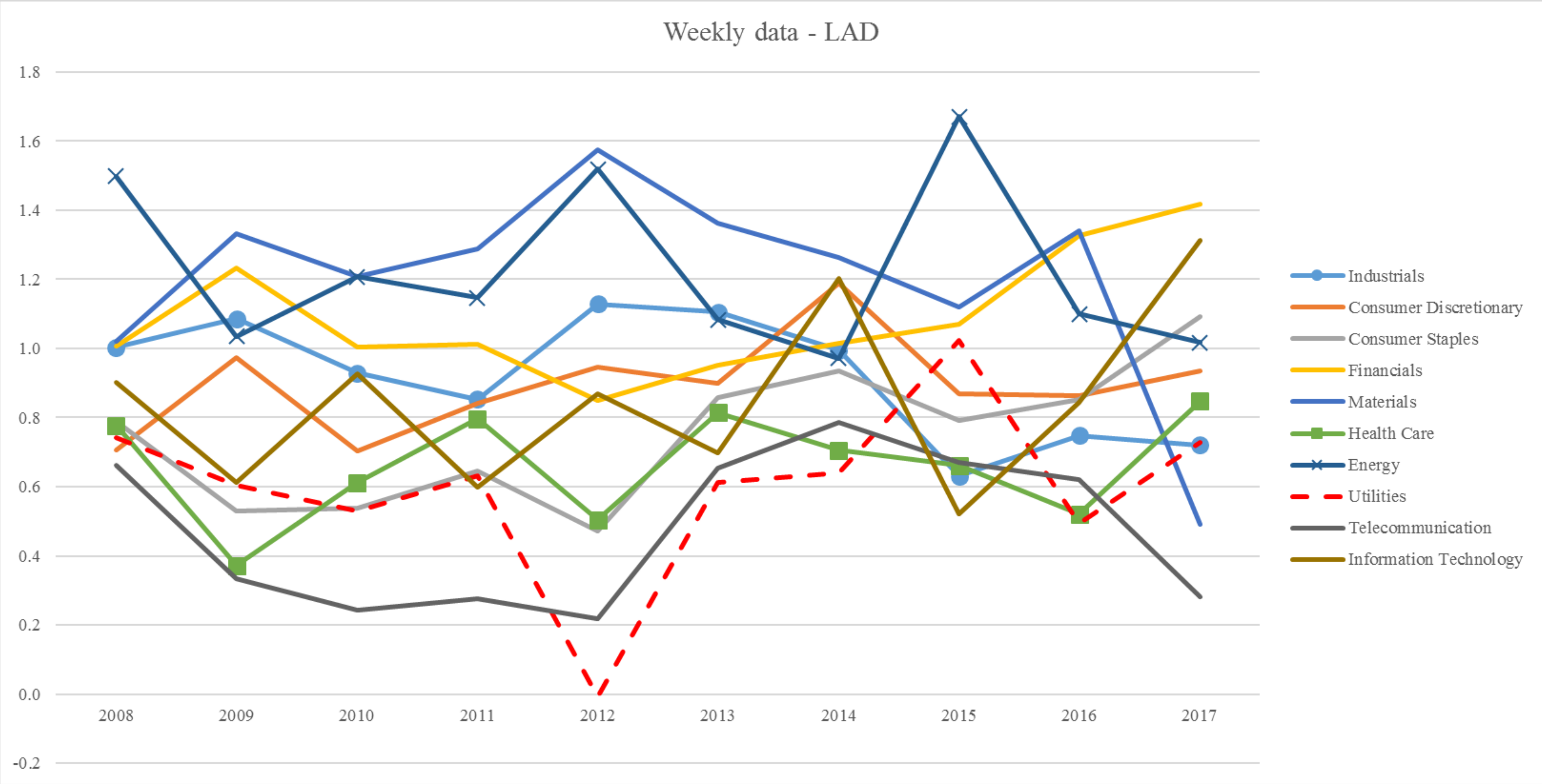


Figure 3 Ranking of Systematic Risk of Australian Industries, 2008-2017, Assumed Risk-free rate of 2.5 Percent & Market return of 8 Percent, Weekly Data, OLS

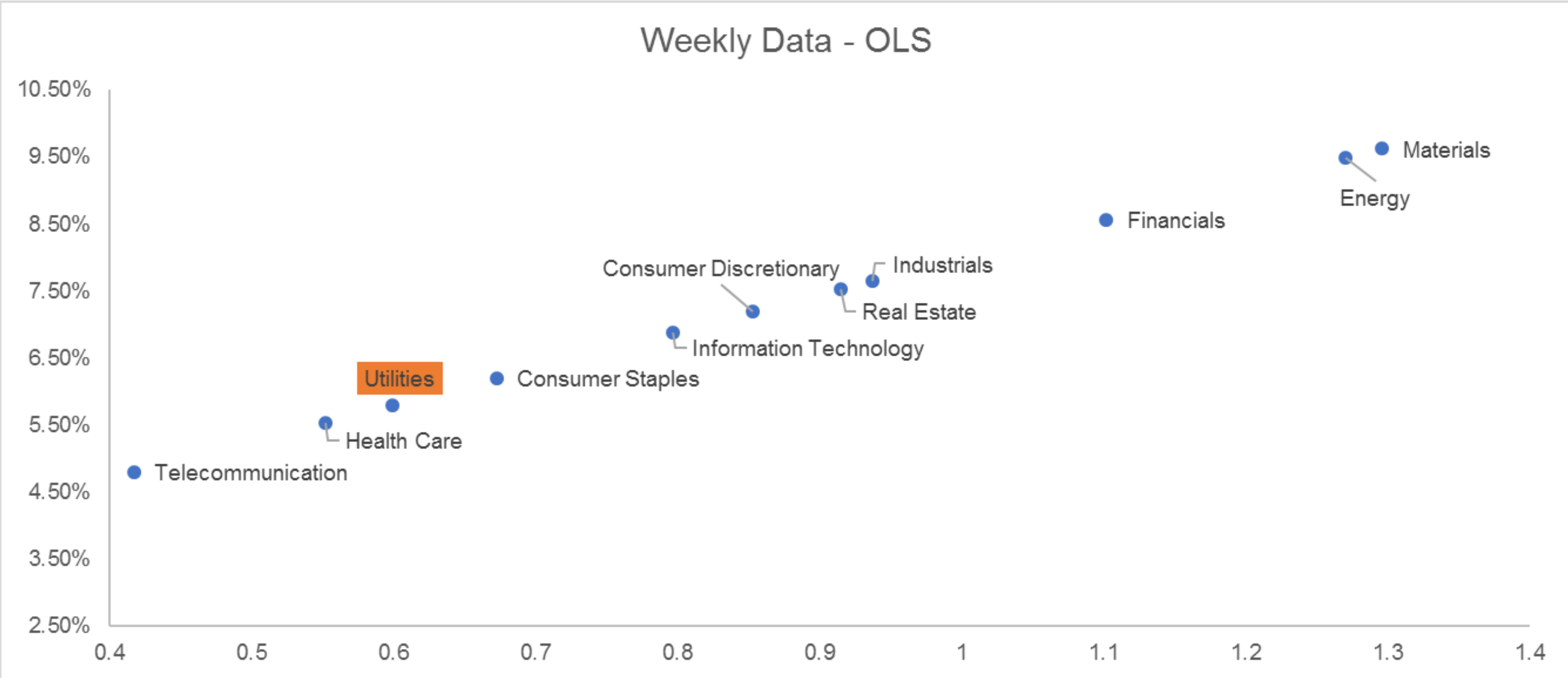
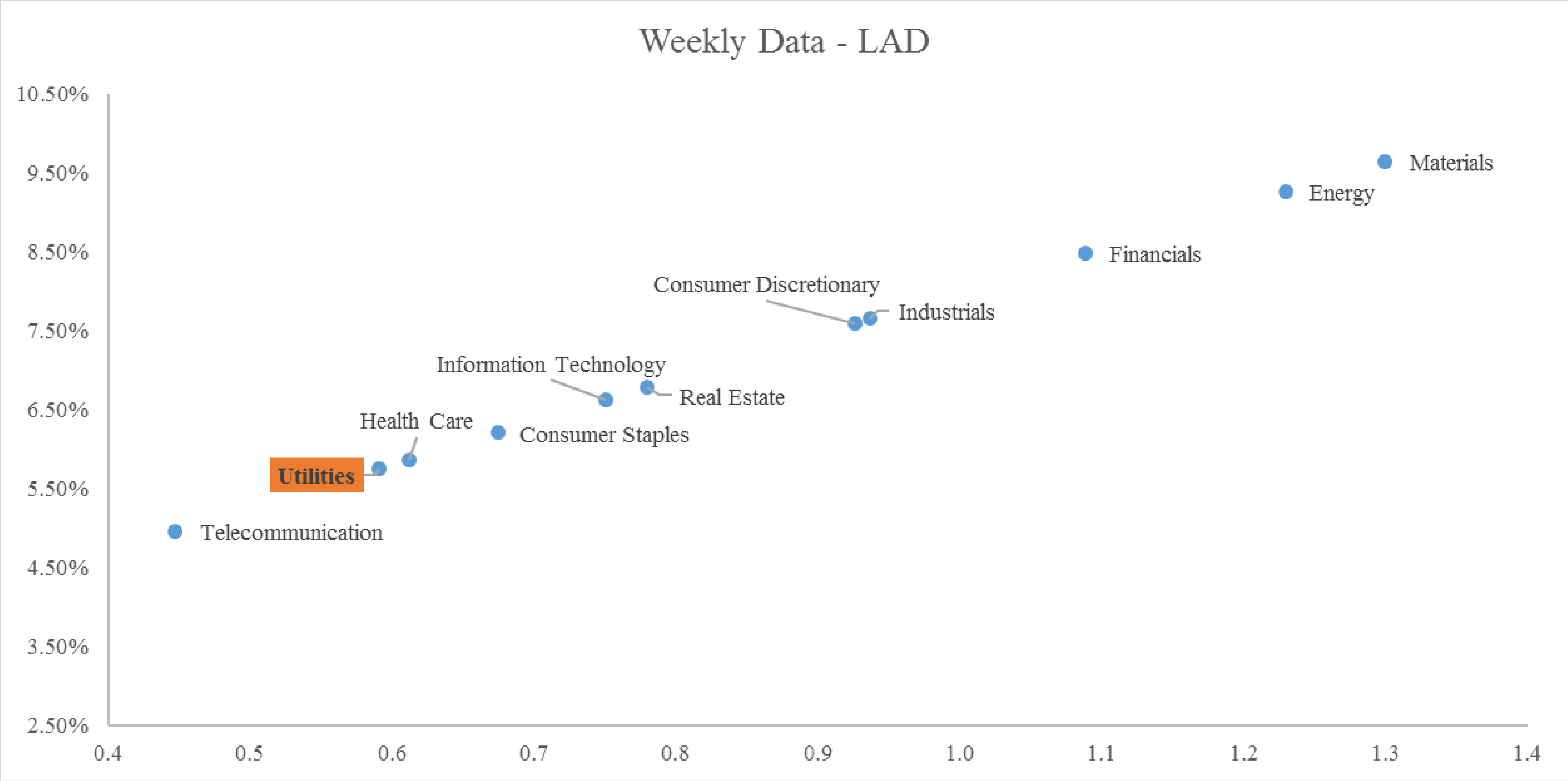


Figure 4 Ranking of Systematic Risk of Australian Industries, 2008-2017, Assumed Risk-free rate of 2.5 Percent & Market return of 8 Percent, Weekly Data, LAD



6 Empirical estimates studies

We have received a number of consultant studies on empirical equity beta estimates since publication of the current Guideline. A summary of the key Australian studies submitted to us since 2008 is set out in the table below.

Table 6 Equity beta estimates for Australian energy network firms

Source	Time period	Individual firm averages	Fixed portfolios	Varying portfolios[(a)]	Summary of regression permutations
Frontier (2017a/2018)	2007–2017	0.513–0.83	0.55–1.2	n/a	weekly/monthly return intervals, multiple estimation period, OLS regression, fixed portfolios, average portfolios, raw/re-levered estimates, 4 comparators
Frontier 2016a/2017	2006–2016	0.48–0.63	0.52-1.03	n/a	weekly/monthly return intervals, multiple estimation period, OLS regression, fixed portfolios, average portfolios, raw/re-levered estimates, 4 comparators
CEG 2016a	1992–2016	0.6–0.69	0.45–0.78	n/a	weekly return intervals, multiple estimation periods, OLS regression, fixed portfolios, average/median varying portfolios, raw/re-levered estimates, 9 comparators
CEG 2016	1992 - 2016	0.6–0.77	0.44–0.76	n/a	weekly and monthly return intervals, multiple estimation period, OLS regression, time varying portfolios, average/median varying portfolios, raw/re-levered estimates, 9 comparators
ERA 2016	2011-2016	0.54–0.6	0.64–0.78	n/a	weekly return intervals, 5 years (June 2011 to May 2016) for individual firms and portfolios, OLS/LAD/MM/T-S/ARIMAX/GARCH regressions, equal weight fixed/value weighted portfolios raw estimates, 4 comparators
Frontier 2016	1997–2015	0.49–0.63	n/a	n/a	Weekly/monthly return intervals, multiple estimation period, OLS regression, raw/re-levered estimates, 9 comparators
ERA 2015	2010–2015	0.55–0.59	0.65–0.79	n/a	weekly return intervals, 5 years for individual firms and portfolios, start November 2010 to October 2015, OLS/LAD/MM/T-S/ARIMAX/GARCH regressions, equal weight fixed/value weighted portfolios raw estimates, 4 comparators
SFG 2015	2002-2013	0.37-0.83	0.39-0.70	n/a	weekly return intervals, multiple estimation periods, OLS/LAD regressions, equal weight fixed portfolios raw/re-levered estimates, 9 comparators
Henry 2014	1992–2013	0.37–0.56	0.31–0.70[(b)]	0.39–0.53[(a)]	weekly/monthly return intervals, multiple estimation periods, OLS/LAD regressions, value/equal weight fixed portfolios, average/median varying portfolios, raw/re-

Source	Time period	Individual firm averages	Fixed portfolios	Varying portfolios[a]	Summary of regression permutations
					levered estimates, 9 comparators
Grant Samuel 2014	2009–2014[c]	0.42–0.64	n/a	n/a	weekly/monthly return intervals, multiple estimation periods, OLS regressions, Bloomberg adjusted betas, raw estimates, 5 comparators
ERA 2013	2002–2013	0.48–0.52	0.39–0.59	n/a	weekly return intervals, OLS/LAD/MM/TS regressions, value/equal weight fixed portfolios, multiple estimation periods, re-levered estimates, 6 comparators
SFG 2013	2002–2013	0.60	n/a	0.55[a]	OLS regressions, four weekly repeat sampling, Vasicek adjustment, re-levered estimates, 9 comparators
ERA 2012	2002–2011	0.44–0.60	n/a	n/a	weekly/monthly return intervals, OLS/LAD regressions, re-levered estimates, 9 comparators
Henry 2009	2002–2008	0.45–0.71	0.35–0.94[d]	0.41–0.78[a]	weekly/monthly return intervals, various estimation periods, OLS/LAD regressions, value/equal weight fixed portfolios, average/median varying portfolios, re-levered estimates, 9 comparators
ACG 2009[e]	1990–2008	0.50–0.58	n/a	0.69–0.91[a]	monthly return intervals, OLS/LAD regressions, multiple estimation periods, raw/re-levered estimates, average/median varying portfolios, 9 comparators
Henry 2008	2002–2008	0.35–0.67	0.31–0.77[f]	n/a	daily/weekly/monthly return intervals, discrete/continuous returns, various estimation periods, OLS/LAD regressions, value/equal weight portfolios, raw/re-levered estimates, no adjustment/Vasicek/Blume, 10 comparators

Source: AER analysis.[157]

[157] Based on the following reports: ACG, *Empirical evidence on proxy beta values for regulated gas transmission activities: final report*, July 2002, pp. 35, 39–40; Henry, *Econometric advice and beta estimation*, November 2008; ACG, *Australian Energy Regulator's draft conclusions on the weighted average cost of capital parameters: commentary on the AER's analysis of the equity beta*, January 2009, pp. 22, 25; Henry, *Estimating β*, April 2009; ERA, D*raft decision on proposed revisions to the access arrangement for the Western Power network*, March 2012, pp. 202, 204; SFG, *Regression-based estimates of risk parameters for the benchmark firm*, June 2013, pp. 12–15; ERA, *Explanatory statement for the rate of return guidelines*, December 2013, pp. 171, 173; Grant Samuel and Associates, *Envestra financial services guide and independent expert's report (appendix 3)*, March 2014, p. 6; Henry, *Estimating β: an update*, April 2014; SFG, *Beta and the Black capital asset pricing model*, 13 February, 2015; ERA, *Draft decision on proposed revisions to the Access Arrangement for the Dampier to Bunbury Natural Gas Pipeline 2016–2020: Appendix 4 Rate of Return*, 22 December 2015, p.192; ERA, *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 2016, p. 193; CEG, *Replication and extension of Henry's beta analysis*, September 2016; CEG, Replication and extension of Henry's beta analysis, November 2016; Frontier, An equity beta estimate for Australian energy network businesses, December 2016; Frontier, An equity beta estimate the benchmark efficient

(a) We place no material reliance on the estimates from time varying portfolios as they are not grounded in financial theory and are prone to measurement error. See: Henry, ***Estimating β: An update***, April 2014, p. 52.

(b) 0.31 is a raw LAD estimate, which we place less reliance on. The minimum re-levered LAD estimate is 0.38 and the minimum OLS estimate is 0.39.

(c) Grant Samuel uses equity beta estimates from the Australian Graduate School of Management (AGSM) and Bloomberg. This time period reflects AGSM's estimation, which uses a four year estimation period as at September 2013, and Bloomberg, which uses a four year estimation period as at February 2014.

(d) 0.94 is an LAD estimate based on a portfolio with only 18 monthly observations. If this portfolio is excluded the maximum estimate is 0.75, which is again an LAD estimate (which we place less reliance on). The maximum OLS estimate is 0.62.

(e) ACG did not make it clear what time period its data covered. However, it noted that equity beta estimates were only used where there were more than 20 observations.

(f) 0.31 is an LAD estimate, which we place less reliance on. The minimum OLS estimate is 0.42. 0.77 is a Blume–adjusted estimate, which we do not rely on. The maximum unadjusted estimate is 0.68, and the maximum OLS estimate is 0.66.

6.1 Studies since Tribunal's 2016 decision

The Australian Competition Tribunal upheld our Guideline approach for the return on equity (including the equity beta) in 2016.[158] Following this, consultant expert reports have focused on replicating and extending Professor Henry's report.[159]

These reports were from CEG and Frontier and submitted as part of regulatory proposals over 2016 to 2017. Although each consultant produced multiple reports, the content across reports were substantively similar for each consultant. Generally, they observed that empirical estimates of equity beta have increased since 2014 which warranted increasing the point estimate to above 0.7.

We have studied estimates from these reports and note that there are differences with our update in June 2017. A key driver would be these studies not adjusting for asset-level debt and related party transactions when estimating SKI's gearing.[160] We also note that differences may arise from the source of data–Frontier used Datastream while CEG used Bloomberg.[161]

A summary of the reports are provided below.

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entity, January 2017; Frontier, *Updated rate of return parameter estimates*, August 2017; Frontier, An equity beta estimate for Australian energy network businesses, January 2018.

158 *Networks (NSW) Ltd [2016] ACompT 5*, 3 March 2016, paras 47, 49, 95.

159 CEG, *Replication and extension of Henry's beta analysis*, September 2016; CEG, Replication and extension of Henry's beta analysis, November 2016; Frontier, An equity beta estimate for Australian energy network businesses, December 2016; Frontier, An equity beta estimate the benchmark efficient entity, January 2017; Frontier, *Updated rate of return parameter estimates*, August 2017; Frontier, An equity beta estimate for Australian energy network businesses, January 2018.

160 AER, Final decision APA VTS gas access arrangement 2018 to 2022 Attachment 3–Rate of return, November 2017, p. 253.

161 For example, see: CEG, *Replication and extension of Henry's beta analysis*, September 2016, p. 2; Frontier, An equity beta estimate for Australian energy network businesses, December 2016, p. 9.

Frontier

We received three reports from Frontier over 2016 to 2017 that we have assessed as part of regulatory decisions.[162] Frontier stated that empirical equity beta estimates have increased based on the following observations:

- 10-year estimates are generally lower than 5-year estimates which suggest that empirical estimates have increased
- Rolling 5-year estimates for portfolios display an upward trend over time
- 10-year estimates of unregulated transport infrastructure firms are materially above the AER's point estimate

CEG

We received two reports from CEG.[163] The key observations from the reports were:[164]

- CEG's extension of Henry's estimates suggest that empirical estimates of equity have increased since Henry's 2014 report
- CEG's more recent estimates for still listed firms indicate a more prominent increase in the equity beta since Henry's estimates
- The increase in beta is consistent with the observation from a February 2016 CEG report which observed a structural break in average rolling beta at 2014/15.

162 Frontier, An equity beta estimate for Australian energy network businesses, December 2016; Frontier, An equity beta estimate for the benchmark efficient entity, January 2017; Frontier, Updated rate of return parameter estimates, August 2017.

163 CEG, Replication and extension of Henry's beta analysis, September 2016; CEG, Replication and extension of Henry's beta analysis, November 2016.

164 For example, AER, Final decision APA VTS access arrangement 2018 to 2022 Attachment 3 – Rate of Return, November 2017, p. 251.

7 Questions

Approach to date

1. Does the approach to date remain appropriate for estimating equity beta including the roles allocated to relevant materials? What does the current evidence indicate?
2. What are the limitations of the current evidence?
3. How should the AER consider technological changes as part of its conceptual analysis? Are technological changes systematic risk that should be compensated for through the equity beta or are they risks that can be diversified away?

Comparator firms

4. Does the current Australian empirical data used by the AER remain sufficient for informing the equity beta of a benchmark efficient entity with a similar degree of risk as that which supplies regulated energy network services?
5. What weight should be given to data from de-listed firms when estimating equity beta?
6. If available Australian data is not considered sufficient, what might be done to augment this (use of international data, theory, etc.)? Will this augmentation improve the estimation?
   (a) What are the strengths and weaknesses of broadening comparator firms?
   (b) Should the AER's broaden its comparator firms to include international energy firms and/or other Australian infrastructure firm? Please explain the additional firms' comparability with the benchmark efficient entity with a similar degree of risk as that which applies to a service provider in respect of the provision of regulated energy network services.
   (c) What adjustments would be required to international energy firms and/or other Australian infrastructure firms to make them suitable comparators if we chose to consider their estimated betas?
   (d) Should Australian industry/sectors betas be considered to determine the equity beta?
   (e) If we include Australian industry/sectors betas, then how should they be considered to derive a point estimate?
   (f) Could the AER use regulated cash flows as opposed to market returns to estimate beta for networks businesses?

Empirical methodology

7. What length data should be used to estimate beta given the current regulatory regime and application, empirical evidence, and finance theory?
8. Do the AER's estimation periods remain appropriate?

9. When estimating gearing for firms with minority stakes in regulated energy networks, how should the AER arrive at an estimate that appropriately reflects the debt carried by the firm and its share of asset-level debt? Is the AER's look-through method appropriate for this adjustment?
10. Does it remain appropriate to use the look through method to adjust SKI's gearing estimate? Should the AER use 'borrowings' or 'labilities' to make this adjustment?

Range and selection of point estimate

11. Does theory support relatively stable regulated network equity beta estimates (at a given gearing) through time and over what time periods?
12. How do you pick a range and a point estimate? Do empirical studies around 'low beta bias' support an adjustment to beta estimates or imply judgement should be exercised differently?
13. Do empirical estimates of equity beta provide sufficient support to warrant departure from the current empirical range of 0.4–0.7?
14. Does the AER's current practice of selecting a point estimate from an empirical range remain appropriate?
15. Should the AER continue to have regard to the theory of the Black CAPM and the international beta estimates when estimating equity beta? How should the AER have regard to these materials?
16. What regard should be given to stakeholders' desire for certainty and stability?

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