Final Decision on Proposed Revisions to the Access Arrangement for the Dampier to Bunbury Natural Gas Pipeline 2016 – 2020

Submitted by DBNGP (WA) Transmission Pty Limited

Appendix 4 Rate of Return

30 June 2016

Economic Regulation Authority
WESTERN AUSTRALIA

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Appendix 4 Rate of Return

1. This Appendix considers DBP's proposal for estimating the rate of return.

Regulatory Requirements

2. Rule 87 in the NGR sets out the requirements for the rate of return.

3. The overarching objective for the Authority's consideration of the rate of return proposed by DBP is provided by rule 87(3) of the NGR:

> The allowed rate of return objective is that the rate of return for a service provider is to be commensurate with the efficient financing costs of a benchmark efficient entity with a similar degree of risk as that which applies to the service provider in respect of the provision of reference services.

4. The allowed rate of return objective is intended to be consistent with the National Gas Objective:[1]

> Most importantly, the new rules allow the regulator (and the appeal body) to focus on whether the overall rate of return meets the allowed rate of return objective, which is intended to be consistent with the NEO, the NGO and the RPP.

5. Rule 87 includes a number of sub-rules which refer to matters the regulator is to have 'regard' to, when determining the allowed rate of return, including:

> 87. Rate of return
>
> …
>
> (5) In determining the allowed rate of return, regard must be had to:
>
> (a) relevant estimation methods, financial models, market data and other evidence;
>
> (b) the desirability of using an approach that leads to the consistent application of any estimates of financial parameters that are relevant to the estimates of, and that are common to, the return on equity and the return on debt; and
>
> (c) any interrelationships between estimates of financial parameters that are relevant to the estimates of the return on equity and the return on debt.
>
> …
>
> (7) In estimating the return on equity under subrule (6), regard must be had to the prevailing conditions in the market for equity funds.
>
> …
>
> (11) In estimating the return on debt under subrule (8), regard must be had to the following factors:
>
> (a) the desirability of minimising any difference between the return on debt and the return on debt of a benchmark efficient entity referred to in the allowed rate of return objective ;
>
> (b) the interrelationship between the return on equity and the return on debt;

[1] Australian Energy Market Commission, Rule Determination: National Electricity Amendment (Economic Regulation of Network Service Providers) Rule 2012: National Gas Amendment (Price and Revenue Regulation of Gas Services) Rule 2012, 29 November 2012, p. 23.

(c) the incentives that the return on debt may provide in relation to capital expenditure over the access arrangement period, including as to the timing of any capital expenditure; and

(d) any impacts (including in relation to the costs of servicing debt across access arrangement periods) on a benchmark efficient entity referred to in the allowed rate of return objective that could arise as a result of changing the methodology that is used to estimate the return on debt from one access arrangement period to the next.

6. In addition, rule 87 of the NGR sets out a number of additional requirements for the allowed rate of return, including that it:

- is to be determined such that it achieves the allowed rate of return objective (NGR 87(2));
- subject to NGR 87(2) and therefore also NGR 87(3), the allowed rate of return for a regulatory year is to be:
  - a weighted average of the return on equity for the access arrangement period in which the regulatory year occurs and the return on debt for that regulatory year (new NGR 87(4)(a));
  - determined on a nominal vanilla rate of return that is consistent with the estimate of the value of imputation credits (new NGR 87(4)(b));
- results in a return on debt for a regulatory year which contributes to the achievement of the allowed rate of return objective (NGR 87(8)) which is either the same in each year of the access arrangement period or which varies in each year through the application of an automatic formula (NGR 87(9) and NGR 87(12));
- incorporates a return on debt that would be required by debt investors over a relevant time period (whether shortly before the access arrangement decision, or on average over an historical period, or some combination of the two approaches) (NGR 87(10)).

DBP's Original Proposal

7. DBP's approach to estimating the rate of return was provided in the Supporting Information to the Proposed Revisions to the DBNGP Access Arrangement that was submitted by DBP to the Authority on 31 December 2014.[2]

8. DBP noted that its submission was developed using the following four guiding principles:[3]

- following the Authority's Rate of Return Guidelines wherever possible;
- keeping information "live" through the process for as long as possible so that final results are informed by all relevant information;
- empirical assessment and cross checking of all modelled parameters and model outputs and a generally data-driven process of analysis; and

[2] DBNGP Transmission Pty Ltd, Proposed Revisions DBNGP Access Arrangement 2016 – 2020, Rate of Return - Supporting Submission: 12, 31 December 2015.

[3] DBNGP Transmission Pty Ltd, Proposed Revisions DBNGP Access Arrangement 2016 – 2020, Rate of Return - Supporting Submission: 12, 31 December 2015, p. ii.

- minimal use of judgment, restricted to the end-points of the analysis when no more can be learned by considering relevant data.

9. The following sub-sections provide more detail on DBP's initial proposal for the rate of return, with a particular emphasis on the proposed revisions which depart from the Authority's Rate of Return Guidelines.[4] DBP also responded to the Authority's position set out in the ATCO Gas Distribution System Draft Decision, which was released prior to DBP's submission of its proposed revisions.[5]

Benchmark efficient entity

10. DBP followed the Authority's position in the Guidelines in respect of the definition of the benchmark efficient entity, using:

- the set of energy firms to determine the return on equity:
  - Envestra;
  - APA;
  - DUET;
  - Hastings Diversified Utility Fund;
  - AusNet Services (previously, SP AusNet); and
  - Spark Infrastructure; and
- the set of BBB-rated debt (exclusive of finance firms, but including foreign bonds issued by Australian firms) to determine the return on debt.

Gearing

11. DBP proposed gearing of 60 per cent debt to regulated asset value, in line with the requirements set out in the Authority's Rate of Return Guidelines.

Averaging period

12. DBP's indicative estimates for its proposed revisions were based on the 40 trading days to 30 September 2014. DBP note the averaging period would be updated for the Final Decision.

Inflation

13. In relation to other matters, DBP advised that while it adopts the same approach in relation to the method for estimating inflation as set out in the Guidelines, it has used more than two bonds to undertake the linear interpolation (and adopts the same approach when it estimates the risk-free rate).[6]

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4 Economic Regulation Authority, Explanatory Statement for the Rate of Return Guidelines, 16 December 2013.

5 Economic Regulation Authority, Draft Decision on Proposed Revisions to the Access Arrangement for the Mid- West and South-West Gas Distribution System, 14 October 2014.

6 DBNGP Transmission Pty Ltd, Proposed Revisions DBNGP Access Arrangement 2016 – 2020, Rate of Return - Supporting Submission: 12, 31 December 2015, p. iii.

14. DBP submitted:[7]

> …the ERA has used an inflation rate that reflects the difference between the two bonds at the end of the period. This need not reflect inflation through the period. For example, if inflation were expected to surge for a period of time, and then return to the mean, this could be seen by applying a linear interpolation approach in each year of the access period, but would be hidden if only the final year were used. This could result in errors in inflation estimation.
>
> Our approach has therefore been to follow exactly the same approach as the ERA proposes in its Guidelines; making use of linear interpolation where the weights for each bond reflect the distance from the target date of that bond's maturity, and the Fischer equation to do the inflation calculation.
>
> The only differences are that we use all government bonds and not just the two maturing closest to the end of the access period (with progressively lower weights for those expiring further from the target date), and we do an inflation calculation quarterly (using the same linear interpolation approach and Fischer equation), not once for the whole five years.

15. That gives rise to an inflation estimate that differs for each forecast year. DBP suggested that its results are slightly smaller than those of the Authority, suggesting:[8]

> The differences arise because the market (as expressed by the difference in the relevant indexed and non-indexed bonds) clearly believes that inflation will be lower at the start of the next access period than at the end. By using only the one interpolation at the end of the access period, the ERA has slightly over-estimated the cost of inflation.

Risk free rate

16. DBP submitted that the Authority's use of the 5 year risk free rate is inappropriate, as:[9]

- the theoretical material by Lally used by the Authority to justify its position do not contain assumptions which are reflective of the real world; and
- the 5 year risk free rate does not meet the requirements of NGR 74(2), viz:[10]

> **74 Forecasts and estimates**
>
> (1) Information in the nature of a forecast or estimate must be supported by a statement of the basis of the forecast or estimate.
>
> (2) A forecast or estimate:
>
> (a) must be arrived at on a reasonable basis; and
>
> (b) must represent the best forecast or estimate possible in the circumstances;

7 DBNGP Transmission Pty Ltd, Proposed Revisions DBNGP Access Arrangement 2016 – 2020, Rate of Return - Supporting Submission: 12, 31 December 2015, p. 96.

8 DBNGP Transmission Pty Ltd, Proposed Revisions DBNGP Access Arrangement 2016 – 2020, Rate of Return - Supporting Submission: 12, 31 December 2015, p. 97.

9 DBNGP Transmission Pty Ltd, Proposed Revisions DBNGP Access Arrangement 2016 – 2020, Rate of Return - Supporting Submission: 12, 31 December 2015, p. 14.

10 NGR 74.

stating that:[11]

> If the requirement in the NGR to reflect relevant market information is to be adhered to, it seems difficult to understand how the ERA could note, and then discard, such information, in favour of a theoretical model. …We conclude with DBP's preferred [10 year rate] approach to the tenor of the risk-free rate matches that which has become the norm in other regulatory jurisdictions.

17. With regard to estimating the risk free rate, DBP proposed to utilise a different approach to that set out in the Guidelines:[12]

> We follow the ERA's approach of using linear interpolation, but instead of using just two bonds straddling the terminal date (ten years in our case) we use all bonds, with decreasing weights the further a bond is from the target date. We understand this approach is consistent with that used by firms regulated by the AER, and it produces no difference in the number for the risk free rate in our data compared to using only two bonds. We use multiple bonds because each bond contains potentially different information, and it does not seem appropriate to discard information from particular bonds. The ERA follows a similar philosophy in respect of the debt risk premium, where it uses a wide range of bonds and not just the ones closest to the target tenor.

18. DBP's indicative estimate of the risk free rate was 3.54 per cent.[13] DBP advised that this was 'a single market value based on a single 40-day estimating period', and as such does not have a confidence interval.

Return on Equity

19. DBP proposed the following departures from the Authority's Rate of Return Guidelines in relation to the return on equity.[14]

- *First*, at Stage One, DBP considered that if models are to have a role in empirical estimation of the return on equity, they must not only have a theoretical grounding, they must also be capable of being shown to be empirically relevant. DBP argued that the Authority has undertaken only a theoretical assessment of models at this Stage, but has not undertaken an empirical assessment of model outcomes to assess their relevance.
  - DBP submitted its "model adequacy test" so as to allow such an empirical assessment. DBP argued that this test is based upon the notion that when model predictions are compared with actual subsequent outcomes, the predictions should not exhibit any statistically significant upward or downward bias.
- *Second*, at Stage Two and Three, DBP noted that two departures from the Guidelines have been made: (i) ranges, rather than point estimates (as set out in the Guidelines), are used to report the output of each relevant model; and (ii) a ten-year term is used for estimating the risk free rate in all models for the return on equity, rather than the five-year term used by the Authority in the Guidelines.

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11 DBNGP Transmission Pty Ltd, Proposed Revisions DBNGP Access Arrangement 2016 – 2020, Rate of Return - Supporting Submission: 12, 31 December 2015, p. 14.

12 DBNGP Transmission Pty Ltd, Proposed Revisions DBNGP Access Arrangement 2016 – 2020, Rate of Return - Supporting Submission: 12, 31 December 2015, p. 80.

13 DBNGP Transmission Pty Ltd, Proposed Revisions DBNGP Access Arrangement 2016 – 2020, Rate of Return - Supporting Submission: 12, 31 December 2015, p. 80.

14 DBNGP Transmission Pty Ltd, Proposed Revisions DBNGP Access Arrangement 2016 – 2020, Rate of Return - Supporting Submission: 12, 31 December 2015, p. iii.

- *Third*, at Stage Four, DBP compared the results from models used to calculate the return on equity at Stage Two and Stage Three of the Authority's five-stage process with a series of cross checks. DBP argued that the Authority appears to have reservations in its Guidelines concerning the cross checks it proposes and that the Authority only used them sparingly, with a focus only on elements of the SL-CAPM, rather than the overall return on equity.
- *Fourth*, DBP argued that the cross check should be operationalised. DBP submitted this can be done using the insight first identified by Merton (1974) – that debt and equity are options on the same underlying asset, and can thus be priced as options.

20. In relation to the return on equity, DBP in its submission highlighted three key areas:[15]

- *First*, DBP's key departures from the Guidelines, including a "model adequacy test" which serves to illustrate more clearly the different roles that different models of the return on equity ought to play.
- *Second*, a discussion of the data used in the implementation of DBP's model adequacy test, as applied to each of the relevant models it assesses.
- *Third*, discussion of DBP's calculation of the return on equity, and tests of the parameters of the relevant models used.

21. DBP's approach focused on an empirical test which is applied to all models. DBP extracts, from the model results, ranges of outcomes which it considers can be shown, empirically, to be statistically unbiased and thus meet the Allowed Rate of Return Objective (**ARORO**). DBP submitted that the resulting range of outcomes for the return on equity that can be shown to be statistically unbiased and thus meet the ARORO. DBP then narrowed the range by using the range of outcomes which arise from its consistency test between debt and equity, so that the outcome is both unbiased and consistent with the calculated cost of debt. The final estimate for the return on equity was taken as the mid-point of the narrowed range.

22. DBP conducted an assessment to consider whether each of the models, including the SL-CAPM, the Black CAPM, the Fama-French model, and the Dividend Growth Model, are relevant in theory and in principle for determining a return on equity consistent with the ARORO. DBP noted that the Dividend Growth Model is not subject to DBP's model adequacy test because it is difficult to obtain a long time series of relevant variables for this model.[16]

23. Based on a report by CEG, DBP submitted that the Black CAPM and Fama French models are both relevant models, at least from a theoretical and principled perspective, and therefore should be considered to provide relevant information. In addition, DBP argued that a wide range of studies suggest that empirical estimations from the SL-CAPM are unlikely to explain stock market returns.[17] DBP then argued that reliance on a model which has theoretical support, buttressed by an ad-hoc adjustment to beta to address known problems of bias without ever testing the

[15] DBNGP Transmission Pty Ltd, Proposed Revisions DBNGP Access Arrangement 2016 – 2020, Rate of Return - Supporting Submission: 12, 31 December 2015, p. 42.

[16] DBNGP Transmission Pty Ltd, Proposed Revisions DBNGP Access Arrangement 2016 – 2020, Rate of Return - Supporting Submission: 12, 31 December 2014, p. 47.

[17] DBNGP Transmission Pty Ltd, Proposed Revisions DBNGP Access Arrangement 2016 – 2020, Rate of Return - Supporting Submission: 12, 31 December 2014, p. 48.

efficacy of this adjustment is unlikely to provide estimates of the return on equity which can be shown to meet the ARORO.[18]

24. DBP submitted that it has developed a step in the process (known as *the model adequacy test*) which involves taking each of the models that are relevant as a matter of theory and principle (i.e., SL-CAPM, the Black CAPM, and the Fama-French model), using them to forecast different points in time in the past, and comparing those forecasts to actual data. DBP submitted that a model which, statistically, is shown not to be reliable in predicting actual outcomes (using historical data) seems unlikely to be appropriate as the sole relevant model going forward.[19]

DBP's Model Adequacy Test

25. DBP's model adequacy test proceeds as follows.[20] *First*, DBP takes a financial model and parameterises it using data up to a point in time. *Second*, DBP uses it to make a prediction on future returns. *Third*, DBP compares predicted with actual returns and records any error. *Fourth*, having done that, DBP then compares the errors over many periods and many different portfolios to understand whether they are, on average, zero.

26. Based on the above findings from its model adequacy test, DBP concluded that the Fama French model is not an adequate model to use in Stages Two and Three. DBP considered that this model (in addition to the SL-CAPM, which is also found not relevant) might play a role as cross checks, but should not play a role in the estimation of the return on equity in Stages Two and Three of the Authority's process.[21]

27. On the basis of its so-called "model adequacy test" (to test the predictive capacity of the models), DBP submitted that only Black CAPM passes this test such that the model then becomes relevant for the purpose of estimating a return on equity.

28. DBP submitted that the Black CAPM, as implemented through its own betastar model, is relevant given its model adequacy test, and is therefore used for calculating the permissible ranges of the return on equity in stages two and three of the Authority's process.

Consistency between debt and equity

29. DBP submitted that achieving the ARORO requires a consideration of the interrelationship between the return on debt and the return on equity.[22] DBP considered that, at the very least, each of NGR 87(5)(b) and (c), suggest some degree of consistency or similarity of approach to estimating the return on equity and the return on debt.

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18 DBNGP Transmission Pty Ltd, Proposed Revisions DBNGP Access Arrangement 2016 – 2020, Rate of Return - Supporting Submission: 12, 31 December 2014, p. 48.

19 DBNGP Transmission Pty Ltd, Proposed Revisions DBNGP Access Arrangement 2016 – 2020, Rate of Return - Supporting Submission: 12, 31 December 2014, p. 49.

20 DBNGP Transmission Pty Ltd, Proposed Revisions DBNGP Access Arrangement 2016 – 2020, Rate of Return - Supporting Submission: 12, 31 December 2014, p. 51.

21 DBNGP Transmission Pty Ltd, Proposed Revisions DBNGP Access Arrangement 2016 – 2020, Rate of Return - Supporting Submission: 12, 31 December 2014, p. 66.

22 DBNGP Transmission Pty Ltd, Proposed Revisions DBNGP Access Arrangement 2016 – 2020, Rate of Return - Supporting Submission: 12, 31 December 2014, p. 85.

30. DBP engaged SFG to provide expert advice in relation to the relationship between the cost of debt and the return on equity. SFG argues that the linkage between the required return on debt and equity to the benchmark firm appears to be central to the NGR 87(5) requirements to have regard to all relevant evidence, consistency, and interrelationships between parameters for equity and debt.[23]

31. Based on its analysis, DBP ascribes to SFG's conclusion that, given the debt risk premium, internal consistency requires that the equity risk premium must be at least 6.0 per cent.[24]

32. SFG noted that it was instructed by DBP that its proposed total cost of debt is within the range of 5.66 per cent to 5.77 per cent (net of any new issue premium and the 15 basis points for debt issuance costs).

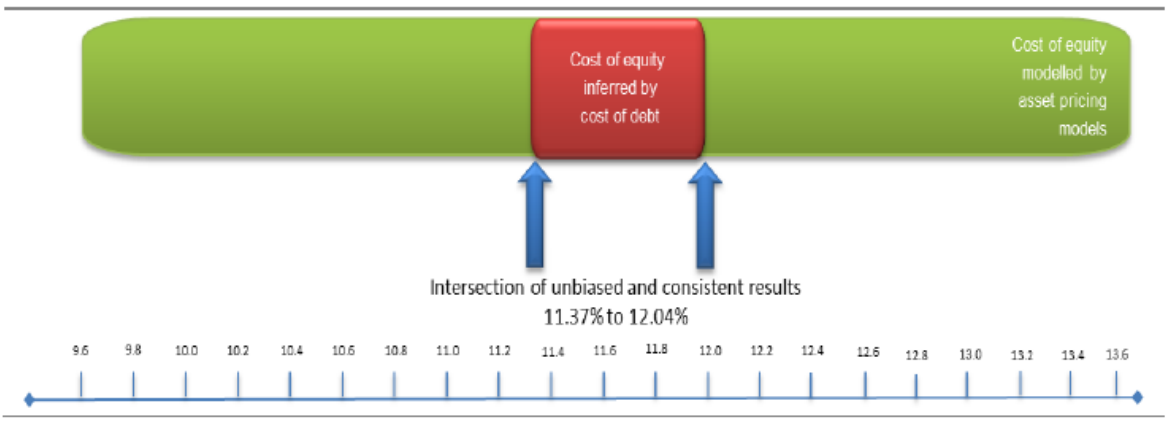
33. Using the risk free rate of 3.54 per cent, the above range of the equity risk premium of 7.86 per cent to 8.52 per cent, SFG inferred that the range of return on equity for DBP must be 11.4 per cent and 12.06 per cent.

34. DBP contended that its analyses indicate that the range of unbiased model outcomes of the return on equity is from 9.67 to 13.72 per cent. In addition, DBP suggested that the allowed return on debt ranges from 5.66 to 5.77 per cent (without the premium for debt issuance and hedging or the new issue premium), which translates into an expected debt risk premium of between 131 and 142 bps once the risk free rate (3.54 per cent) and default premium (82 bps) are subtracted.[25]

35. DBP concluded that this intersection, as represented below in Figure 1, represents the range of estimates of the return on equity that are both unbiased and consistent with the return on debt.[26]

Figure 1 DBP's Return on equity from unbiased asset pricing models and inferred from return on debt

36.



Source: Figure 10, DBP's Proposed Revisions DBNGP Access Arrangement, page 89.

23 DBNGP Transmission Pty Ltd, Proposed Revisions DBNGP Access Arrangement 2016 – 2020, Rate of Return - Supporting Submission: 12, 31 December 2014, Appendix L, p. 1.

24 DBNGP Transmission Pty Ltd, Proposed Revisions DBNGP Access Arrangement 2016 – 2020, Rate of Return - Supporting Submission: 12, 31 December 2014, Appendix L, p. 18.

25 DBNGP Transmission Pty Ltd, Proposed Revisions DBNGP Access Arrangement 2016 – 2020, Rate of Return - Supporting Submission: 12, 31 December 2014, p. 89.

26 DBNGP Transmission Pty Ltd, Proposed Revisions DBNGP Access Arrangement 2016 – 2020, Rate of Return - Supporting Submission: 12, 31 December 2014, p. 89.

37. DBP then concluded that:[27]

> The true return on equity, which is unbiased and consistent with the return on debt, lies in the portion of the [range] indicated by the arrows in Figure 10 [Figure 1 above]. One could choose any point in this range and, on the strength of the data alone, reach equally valid conclusion. We choose the mean, which leads to a point estimate for the return on equity that is both unbiased and consistent of 11.71 per cent.

Return on debt

38. In relation to the return on debt, DBP adopted the Authority's revised method for estimating the annual debt risk premium (**DRP**) which was set out in the ATCO GDS Draft Decision, with:

- the benchmark sample of bonds based on non-financial domestic and international bonds with a BBB-/BBB/BBB+ credit rating;
- the 10 year DRP estimate determined as the average of three yield curve methods (the Gaussian Kernel, Nelson Siegel and Nelson Siegel Svennson methods).

39. However, DBP diverged from the Authority's Rate of Return Guidelines (and the recent ATCO GDS decision) by:[28]

- using a ten-year risk free rate instead of the five-year rate;
- utilising a ten year trailing average for both the risk free rate and the DRP, which is annually updated;
  - with the annual updating approach based on the methodology outlined by the Australian Energy Regulator in its rate of return guidelines;
  - albeit, modified slightly such that, not only is there a ten-year transition period at the outset of the switch to this new approach, but every block of capital expenditure made in an access arrangement period in excess of a certain threshold (being a tenth of the capital base) itself has a ten-year transition period;
- adding 15 basis points for debt-raising and hedging costs;[29] although there is some apparent confusion here, as:
  - DBP suggests elsewhere that it does not require or include swaps costs, which are a key component in hedging, given that it is adopting a ten year term;[30]
  - DBP in its later submission on the Issues Paper then submits that it considers that 46.5 basis points is the appropriate value, based on advice from UBS:[31]

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27 DBNGP Transmission Pty Ltd, Proposed Revisions DBNGP Access Arrangement 2016 – 2020, Rate of Return - Supporting Submission: 12, 31 December 2014, p. 89.

28 DBNGP Transmission Pty Ltd, Proposed Revisions DBNGP Access Arrangement 2016 – 2020, Rate of Return - Supporting Submission: 12, 31 December 2015, p. 20.

29 DBNGP Transmission Pty Ltd, Proposed Revisions DBNGP Access Arrangement 2016 – 2020, Rate of Return - Supporting Submission: 12, 31 December 2014, p. iv.

30 DBNGP Transmission Pty Ltd, Proposed Revisions DBNGP Access Arrangement, 2016 – 2020, Response to ERA Issues Paper, Submission 26, 31 December 2014, p. 11.

31 DBNGP Transmission Pty Ltd, Proposed Revisions DBNGP Access Arrangement, 2016 – 2020, Response to ERA Issues Paper, Submission 26, 31 December 2014, p. 11.

The correct total, according to expert advice from UBS, is 60 to 63.9 basis points. If the return on debt data include conversion factors, then the true cost of debt, as distinct from the return on debt earned by investors, would be 46.5 basis points above the value determined from a yield curve model that uses Bloomberg or similar data as an input.

- adding a new issue premium of 27 basis points to the resulting annual return on debt.

40. The resulting quoted illustrative return on debt, as at the averaging period of 30 September 2014, is 6.13 per cent (nominal pre-tax – excluding the flagged change in hedging costs).[32]

Proposed rate of return

41. In revisions to the Access Arrangement, DBP proposed an allowed post tax nominal rate of return for the benchmark efficient entity of 8.36 per cent (as at 30 September 2014).

42. With debt gearing of 60 per cent, DBP's proposed nominal rate of return was a weighted average of:

- a return on equity of 11.71 per cent; and
- a return on debt of 6.13 per cent.

Draft Decision

43. This section summarises the Authority's position on the rate of return that was set out in the Draft Decision.[33]

Gearing

44. The Authority accepted DBP's proposed gearing of 60 per cent debt, 40 per cent equity, as it is consistent with assumptions in the Guidelines.

Inflation

45. The Authority in the Draft Decision did not depart from its method for estimating inflation set out in the Rate of Return Guidelines, thereby rejecting DBP's proposal for five unique inflation forecasts for each year of the regulatory period.

46. Specifically, the Authority disagreed with DBP's claim that a 5 year period annualised inflation rate 'need not reflect inflation through the period'. The Authority demonstrated mathematically that a surge in *expected* inflation in any one of the one year periods will be reflected in the 5 year annualised inflation rate.

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32 DBNGP Transmission Pty Ltd, Proposed Revisions DBNGP Access Arrangement 2016 – 2020, Rate of Return - Supporting Submission: 12, 31 December 2014, p. ii.

33 Economic Regulation Authority, Draft Decision on Proposed Revisions to the Access Arrangement for the Dampier to Bunbury Natural Gas Pipeline, 22 December 2016, Appendix 4.

Risk free rate

47. The Authority rejected DBP's view that the term of the risk free rate should be set at 10 years. The Authority maintained its view – set out in the Rate of Return Guidelines – that the appropriate term should be commensurate with the term of the regulatory period. That term is 5 years.

Return on equity

48. In relation to the estimate of the return on equity for DBNGP, the Authority concluded the following.

DBP's Model Adequacy Test

49. The Authority considered both the conceptual and empirical elements of DBP's model adequacy test in its Draft Decision. Based on its considerations, the Authority was of the view that DBP's model adequacy test does not properly compare the prediction performance of the Authority's method. DBP's analysis is fundamentally flawed and its approach is unable to produce any sensible estimates.

50. DBP's model adequacy test therefore fails conceptually and in empirical application. As such, the Authority considered that the analysis is not fit for the purpose of estimating equity beta.

Relevant models for the estimates of return on equity for DBNGP

51. The following conclusions were reached in relation to the approach for estimating the return on equity in the Draft Decision for DBP:

- The SL-CAPM should be utilised to estimate the return on equity.
- The Fama French three factor model is not relevant and as such, this model should not be used for the purpose of estimating a return on equity.
- The Black CAPM is relevant for the purpose of estimating a return on equity. However, given it is not reliable and practical to estimate a robust return on equity using this model, the model will not be used directly, but only to inform the point estimate of the equity beta from within its range for input to the SL-CAPM.
- The DGM is a relevant model for informing the market return on equity and also the forward looking MRP.
- Other information such as historical data on equity risk premium; surveys of market risk and other equity analysts' estimates are also relevant for the purpose of estimating the MRP and the market return on equity. This other material should be used as a cross check for the return on equity.

52. Given that the only robust model for estimating the return on equity in the Australian context is the SL-CAPM, the Authority did not see any current need for data sourced from the SIRCA SPPR database, as suggested by DBP.[34] The SPPR database was required by DBP to form long time series of predictions for the model adequacy

[34] DBNGP Transmission Pty Ltd, Proposed Revisions DBNGP Access Arrangement, 2016 – 2020, Rate of Return, Supporting Submission: 12, 31 December 2014, p. 55.

test.[35] As need for the model adequacy test was rejected, then so too was need for the SPPR database.

53. The Authority remained of the view that its reasons for adopting the SL-CAPM are sound. The Authority considered that its application of the SL-CAPM meets the requirements of the NGR, and the allowed rate of return objective.

- The Authority did not agree with DBP's submission that it had not taken all of the relevant information into consideration with respect to its estimate of the return on equity. The Authority was of the view that all of the issues raised by DBP and its consultants were considered in the Draft Decision.
- The Authority also disagreed with DBP's estimates of the rate of return on equity. The Authority conducted significant research into the rate of return and cross checked its estimate across various sources. The Authority's estimate for the rate of return was in line with other industry estimates.
- The Authority considered that the estimated return on equity adopted in the Draft Decision was commensurate with the equity costs incurred by a benchmark efficient entity with a similar degree of risk as DBP with respect to the provision of reference services. The Authority therefore considered that the estimated rate of return meets the allowed rate of return objective and the requirements of the NGR and NGL.

Consistency between debt and equity

54. The Authority noted DBP's argument that the return on debt can be used as a quantitative cross check for the return on equity, while giving form to the consistency requirements of NGR 87(5) and NGR 87(11).[36] DBP based its position on advice from SFG with regard to the relationship between the cost of debt and the return on equity.

55. In particular, SFG argued that Merton (1974) concluded that equity and debt are contingent claims over the assets of the same firm. Both become less valuable as the assets of the firm decline in value and both become more valuable as the assets of the firm rise in value. Both are linked to the value of the assets of the firm. Thus, if there are certain factors that drive changes in the value of the assets of the firm, those same factors will drive the returns to debt and equity in that firm. SFG argued that this means that there is a positive relationship between the return on debt and the return on equity in the same firm.[37]

56. Based on its analysis, SFG concluded that, given the debt risk premium, internal consistency requires that the equity risk premium must be at least 6.0 per cent.[38]

57. The Authority noted that SFG's proposed approach does not follow any standard finance theory. The approach is not well established and is untested. In addition,

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35 This need for a long time series was considered one of the weaknesses of the model adequacy test (Appendix 4B), one which can be circumnavigated by various approaches to cross-validation (Appendix 4Bi).

36 DBP, Proposed Revisions DBNGP Access Arrangement, 2016 – 2020 Regulatory Period, Rate of Return, Supporting Submission: 12, 31 December 2014, p. 84.

37 DBP, Proposed Revisions DBNGP Access Arrangement, 2016 – 2020 Regulatory Period, Rate of Return, Supporting Submission: 12, 31 December 2014, Appendix L, p. 2.

38 DBP, Proposed Revisions DBNGP Access Arrangement, 2016 – 2020 Regulatory Period, Rate of Return, Supporting Submission: 12, 31 December 2014, Appendix L, p. 18.

based on the Authority's sensitivity analyses, there are fundamental issues attached to the SFG's proposed approach, setting aside its failure on theoretical grounds.

58. In summary, the Authority was of the view that evidence presented in SFG's analysis to support the relationship between the cost of debt and the return on equity is inconclusive and that the link between the two markets is not robustly established. As a result, this approach should not be adopted.

59. Therefore, SFG's proposed approach, which stated that the return on equity can be directly derived from the observed cost of debt, is not relevant for the purpose of a cross check for the return on equity.

Return on debt

Debt raising and hedging costs

60. The Authority in the Draft Decision determined that:[39]

- Its estimate of 12.5 bppa for debt raising costs – estimated for the 2013 gas Rate of Return Guidelines – was reasonable. The Authority observed that the estimate was consistent with or exceeded debt raising costs estimated in a range of other studies, including by the ACCC, the Allen Consulting Group in 2004 and PwC in 2011.[40]
    - With regard to debt raising costs, the Authority did not accept the estimates for liquidity or deferral costs proposed by DBP. The Authority's discussions with finance providers suggest the costs associated with these aspects are small, approaching as little as 1 basis point under normal liquidity conditions – provided that debt requirements are packaged efficiently. On that basis, the Authority was not convinced that Incenta's bottom up analysis would be borne out in reality.
- Hedging costs of 11.4 bppa be awarded, based on:
    - 5 year swap floating for fixed for the full amount of debt = 4 bppa x 100 per cent = 4.0 bppa; plus
    - 10 year cross currency swaps for (100 – 65 =) 35 per cent of debt issuance = 14 bppa x 35 per cent = 4.9 bppa; plus
    - 10-year fixed-float AUD swaps for (65 – 24=) 41 per cent of debt issuance = 6 bppa x 41 per cent = 2.5 bppa.
- There is insufficient evidence that a new issue premium exists. DBP's proposed new issue premium of newly issued corporate bonds was not considered to have been demonstrated for the benchmark efficient sample. In addition, the Authority was of the view that there is no robust evidence to confirm that the allowed cost of debt is underestimated. As a result, the Authority was of the view that a new issue premium should not be included in the cost of debt for regulated businesses.

[39] Economic Regulation Authority, Draft Decision on Proposed Revisions to the Access Arrangement for the Dampier to Bunbury Natural Gas Pipeline, 22 December 2016, Appendix 4, p. 132.

[40] Economic Regulation Authority, Explanatory Statement for the Rate of Return Guidelines, 16 December 2013, pp. 199 – 205.

DBP's response to the draft decision

Gearing

61. As noted above, DBP proposed gearing of 60 per cent debt in its initial proposal, which was accepted by the Authority.

Inflation

62. DBP accepted the Authority's position on inflation set out in the Draft Decision.[41]

Risk free rate

63. DBP's response to the Authority's Draft Decision on the risk free rate is in two parts.

64. First, regarding the risk free rate component of the return on debt, DBP accepts the Authority's approach. That approach entails the use of the five year bank bill swap rate as the proxy for the risk free rate within the hybrid trailing average.[42]

65. Second, with regard to the return on equity, DBP does not adopt the *five year* Commonwealth Government Security as the proxy for the risk free rate for the purpose of estimating the return on equity. DBP states:[43]

> In respect of the return on equity, the ERA has relied upon a theoretical construct based upon numerous papers by Lally which assumes, at its core, that the only risk facing regulated firms in respect of pricing is interest rate risk. Whilst it might be appropriate to set the tenor to five years (or whatever the regulatory period is) in this imaginary scenario, it is not appropriate in the real-world environment where regulated firms face a host of risks from a wide variety of sources. A far more suitable approach is to recognise the long-run nature of this risk and to use the long run risk-free rate that is widely used by other regulators.

66. DBP notes that the Authority and Lally recognise that firms face a variety of risks. DBP observes that the Authority dismisses this concern by stating that these risks are reflected in equity and debt risk premia. In this context, DBP contends that it would be almost impossible to calculate an adequate compensation for these risks in debt and equity. DBP concludes that 'for this reason, recognising the long run risk taken by equity holders in infrastructure, we continue to believe that the ten-year tenor for the risk free rate is appropriate'.[44]

67. DBP notes that its proposed use of the 10 year term will lower the return on equity – as compared to using a risk free rate with a five year term – when beta is greater than 1, and raise it, when beta is less than one. DBP avers then that its proposal is

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41 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 29.

42 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 28.

43 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 29.

44 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 29.

made on principle.[45] It results in a lower return on equity for DBP with its proposed (mean) beta of 1.15.[46]

Averaging period

68. DBP now proposes a 20 day averaging period for the course of the AA4 period.[47]

Return on equity

69. In response to the Draft Decision, DBP submits only a slightly amended approach to estimating the return on equity, as compared to that put forward in its initial proposal.

70. *First*, DBP updates its range of outcomes for the return on equity from its model adequacy test. This delivers a so-called 'unbiased' betastar range of 1.00 (25th percentile) to 1.70 (99th percentile), around a mean of 1.15.[48]

71. *Second*, the resulting range for the return on equity, when the betastar range is applied within the SL-CAPM, is between 9.9 per cent and 14.82 per cent. This result builds on DBP's estimate of the 10 year risk free rate, of 2.87 per cent, and its estimate of the Market Risk Premium (**MRP**) of 7.03 per cent.

72. *Third*, DBP also utilises information from the return on debt to derive the final range of the return on equity, drawing on the insights of Merton. DBP considers that this ensures consistency between the return on debt and the return on equity. Based on its analysis, DBP argues that the range of the return on equity should be between 10.61 per cent and 11.06 per cent. This range is narrower, lying entirely within the range given by the betastar estimates. DBP then takes the midpoint estimate of the narrower range, which is 10.84 per cent, to be the best estimate of the return on equity.[49]

73. In arriving at this position, DBP considers that two issues are central to the differences between DBP and the Authority, which are reflected in their respective approaches to the return on equity.[50]

74. *First*, DBP is of the view that the Authority has not made a proper assessment of its betastar approach. DBP contends that the Authority had based its conclusions on

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45 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 68.

46 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 98.

47 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 30,

48 DBP have revised slightly the betastar estimates to reflect a change in the benchmark efficient entity sample set. The revised sample set reflects the omission of Envestra and HDF, which are now both delisted from the ASX DBP states (DBP, *Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56*, 24 February 2016, p. 97):

We note in Appendix 4A(ii) that the ERA has dropped Envestra and HDF from its original sample set as they are now dead stocks. We are unclear as to why it did not do this at its last estimation; Envestra was trading until September 2014, but HDF ceased trading in November 2012, a year before the ERA undertook the beta calculations in its Guidelines. The ERA has not explained this change in stance.

49 Ibid. p. iii

50 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 81.

superficial reasoning and irrelevant evidence, while ignoring relevant evidence. DBP submits that the Authority fails to make a proper application of the evidence which itself had produced in relation to the identification or quantification of bias within the SL-CAPM.

75. *Second*, DBP argues that the Authority did not test whether the outcome of its SL-CAPM approach to estimating the return on equity meets Rule 87(5).[51] DBP, on the other hand, considers that it does this through the use of its model adequacy test. DBP also contends that the need to test outcomes as well as inputs is a fundamental aspect of the regulatory framework in the NGL and NGR.

76. DBP maintains substantially the same approach to determining the return on equity in its initial Access Arrangement Proposal; that is, the application of its 'model adequacy test'. DBP considers that this tests the outputs of models, and whether they give rise to a range of unbiased outcomes; such that the model results then neither systematically overstate nor understate actual returns.[52]

77. DBP notes that one of the amendments from the Authority requires the DBP to implement the SL-CAPM using the five-year risk-free rate and a beta of 0.7, along with the estimate of the MRP. DBP argues that the first two could be done, but not the third. This problem arises because the Authority's estimate of the MRP changes at each regulatory decision, based upon how it interprets a number of "forward looking" indicator variables. DBP considers that the Draft Decision fails to outline the ERA's methodology for quantifying the correlation between changes in these variables and the change in the MRP.[53]

DBP's reasons for rejecting the Authority's views on relevant asset valuation models

78. DBP submits that the Authority accepts that the Black CAPM, dividend growth model (DGM) and SL-CAPM are relevant in principle, as it does. However, a key difference arises with respect to the Fama-French model (**FFM**); DBP considers it to be relevant in-principle (based on the advice of CEG) but the Authority does not.[54]

Is the SL-CAPM relevant?

79. DBP submits that the Authority overstated the empirical robustness of the SL-CAPM and this assessment is different to the AER's assessment.[55]

Is the Black CAPM relevant?

80. DBP considers that the Authority appeared to have missed considerable relevant information in deciding that the Black CAPM is not relevant. DBP argued that the

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51 NGR 87(5) refers to the requirement to have regard for relevant estimation methods, financial models etc.

52 Ibid. p. ii

53 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 31.

54 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 32.

55 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 32.

model has widespread use and the central finding of a flatter security market line is still taught, because it is still true, in mainstream finance textbooks.[56]

81. DBP also argues that the Authority appeared to have missed a great deal of US evidence as to the use of the Black CAPM. DBP quotes Malko's (2015) study to confirm its view that the Black CAPM, which is also known as the empirical CAPM, has been widely used by the US regulators both at the federal and states levels.[57]

DBP's reasons for maintaining a model adequacy test

82. In respect of its model adequacy test, DBP submits that it has many fundamental issues with the Authority's view in the Draft Decision. These issues are discussed in turn below.

The model adequacy test's conclusions are confirmed by the established literature

83. DBP submits that the notion that the SL-CAPM is biased downwards is hardly a new finding, noting that the Authority accepts that this downward bias exists when it chooses 0.7 for beta, while specifically acknowledging that it is doing so in order to address the issue of bias. As such, DBP is of the view that DBP's model adequacy test is not somehow unique and new. DBP disagrees the model adequacy test produces results found by nobody else, suggesting that the Authority's view is contrary to more than 40 years of empirical finance.[58]

The Authority ignores its own evidence about bias

84. DBP submits that in ignoring the empirical information relating to the zero-beta premium, the Authority misses an important implication of its own research. DBP considers that although the Authority's estimates of the zero-beta premium are indeed varied, they are all more than zero.[59] To illustrate, DBP contends that the Authority's smallest estimate of the ratio of the zero-beta premium to the market risk premium – the ratio applies the DBP betastar algebra – implies a bias-adjusted estimate of beta of 0.88, not the value of 0.7 the Authority proposed to use.[60]

85. On that basis, DBP is of the view that there is thus a clear inconsistency between the "theoretical implications" the Authority used to inform its judgement about the bias adjustment implied by the Black CAPM and the smallest adjustment it would have made for bias using its own empirical calculations of the same model.[61]

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56 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 32.

57 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 33.

58 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 35.

59 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 35.

60 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 35.

61 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 36.

Need for an empirical test of outputs

86. DBP submits that:[62]

> Neither the SL-CAPM nor the Black CAPM represent "the truth"; they are both models. The inconsistency between the "theoretical implications" of the Black CAPM the ERA purports to be considering and the smallest empirical result that it fails to consider can be considered as a necessary condition to move away from no consideration of any empirical evidence from the Black CAPM whatsoever, but cannot be considered as a necessary condition for being able to claim that the "right" bias adjustment has now been found.

87. DBP considers that the Authority appears to be in two minds about this.[63] On the one hand, the Authority has come up with an appropriate estimate of the return on equity, despite none of its cross checks containing any kind of meaningful examination of outputs and despite the evidence of its own estimation of the Black CAPM. On the other hand, the Authority has not applied its cross validation testing to any model.

88. DBP confirmed that it is not irrevocably wedded to its model adequacy test as the only way in which model outputs can be assessed; provided an alternative test is applied which is suitably robust. To that end, DBP also implemented the cross validation test the Authority proposed.[64]

Unfounded basis for the Authority's rejection of the model adequacy test

89. DBP submits that its over-arching concern in relation to the Authority's assessment of DBP's model adequacy test is the superficial nature of the assessment.[65] DBP responds to the Authority's conclusions in the Draft Decision in respect of the DBP's model adequacy test in the following terms.

The Authority's "conceptual" issues and DBP's new Method C

90. DBP notes that its model adequacy test was rejected by the Authority on conceptual grounds, on the basis that DBP was not testing the model that the Authority used for determining the MRP. DBP argued that there are two errors in this decision.

91. *First*, with regard to the rejection on conceptual grounds, DBP argues that the SL-CAPM is not a model of the MRP. Specifically, the MRP relates to the movement of the market, and the SL-CAPM is not a model of the movement of the market, but is rather a model of the movement of a stock (or portfolio) with the market; or in other words, its covariance. DBP considers that its 'Method B' uses the actual MRP each period, rather than an estimate of it. This was done because much of the variation in the return of a stock is due to variation in the return to the market, which the SL-CAPM does not seek to explain, and this noise reduces the power of the

62 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 36.

63 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 36.

64 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 36.

65 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 36.

tests.[66] DBP contends that Method B of DBP's model adequacy test does not require that DBP replicate the approach that the Authority used in assessing the MRP.[67]

92. *Second,* DBP argues that a second issue arises as a matter of timing.[68] DBP submitted that:[69]

> DBP made its Original AA Proposal in December 2014, shortly after the ATCO Draft Decision. Our formulation of the MRP in the model adequacy test was based upon the ATCO Draft Decision as being the most recent example of the ERA's approach. There, the ERA chose a fixed band of five to 7.5 percent, and then several conditioning variables within that band. Since the fixing of the band was based on the ERA's assessment of information roughly contemporaneous with the present, DBP could not know whether the same band would have been used through more than 40 years had the regulator been regulating gas pipelines for all that time, let alone where in that band it would have chosen based on conditioning variables with only one observation of how it proposed to do so, because its decision involved regulatory judgement. This was the reason for the choice of the historical average at that time.

93. DBP then notes that the Authority subsequently changed its approach to the estimation of the MRP. As such, DBP could not have been able to predict the Authority's MRP estimate in formulating its testing. DBP nonetheless argues that, given that the new model maintains a large measure of regulatory judgement, it is impossible to reflect exactly what the Authority would do under any situation over the past 50 years.[70]

> Thus, Method C assumes in the first instance that the upper bound for the MRP is that determined by the Wright method.[56] However, since the DGM result is currently around ten percent higher than that for the Wright method and since the Wright method result might not always be particularly high (we have no way of knowing what the ERA would do under these, or indeed any circumstances other than those at the ATCO Final Decision), we also allow variants of Method C whereby the MRP is five, ten, 15 and 20 percent higher than the estimate formed by the Wright CAPM. This gives rise to five variants of Method C.

94. However, DBP considers that, having regard to the Authority's new approach for the estimation of MRP, it is possible to create a 'Method C' which better reflects this new model for determining MRP.

95. DBP implemented several versions of Method C. Those versions recognise the bounds for the Authority's MRP given by the Ibbotson and Wright approaches to evaluating the historical data, and by the DGM. To encompass the latter, DBP tested an MRP based on the Wright approach, plus 5, 10, 15 and 20 per cent.

96. However, DBP argues that in all cases, the version of the SL-CAPM using an MRP formed via Method C fails to pass the model adequacy test. That is, DBP considers that even adopting the Authority's new approach to MRP and testing that approach

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66 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 38.

67 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 39.

68 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 39.

69 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 39.

70 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 39.

using the most reasonable assumptions available, the conclusions from its Original AA Proposal remain.[71]

97. DBP concludes that since the results indicate that Method C is biased downwards, the only reasonable conclusion is that the Authority's actual approach would have delivered a result which is more biased downwards.[72]

Variance in estimates of the zero-beta premium and robustness of the Black CAPM in Australia

98. DBP contends that the Authority's focus on variation in estimates of the zero beta premium has caused the Authority to ignore important evidence about the minimum value of the variable, which assists to quantify the bias associated with the SL-CAPM and overcome the difficulty in assessing that bias.[73] DBP considers that variation in the estimation of a particular parameter, like the zero-beta premium is not a problem when considered from the perspective of the model adequacy test. DBP concludes that, quite the opposite; it is a problem which the model adequacy test seeks to overcome.[74]

99. DBP also argues that the zero beta rate should lie between the risk-free borrowing and lending rates, and the borrowing rate should be below the return to the market portfolio of all risky assets. As such, DBP submits that the zero beta premium should thus lie between zero and the market risk premium.[75]

100. DBP disagrees with the Authority's view in relation to the amount of variation found in estimates of the zero-beta premium and the degree to which these estimates are or are not robust enough to use. DBP does not dispute that there is some variation, but based on advice from HoustonKemp, DBP is of the view that the problem is not nearly as large as the Authority suggests; it is not that much larger than the variation in estimates of the market risk premium.[76]

101. DBP notes that the Authority relied on two pieces of evidence with regard to the properties of the zero beta premium: (i) the Authority's own estimates of the zero beta premium; and (ii) the opinions of various experts.

102. In response, *first,* DBP notes its expert advice from HoustonKemp's report which suggests that the Authority's own estimates of the zero beta premium may be subject to a number of important flaws:[77]

- The Authority incorrectly computed the returns to stocks on the days following ex-dividend days. The Authority incorrectly presumed that a purchaser of a

71 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 40.

72 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 40.

73 The zero beta premium is given by the difference between the zero beta return and the risk free rate.

74 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 41.

75 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 41.

76 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 41.

77 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, pp. 41-2.

share of stock on the ex-dividend day will pay the sum of the price at the close of business and the dividend distributed.

- There is no sign in the Authority's code that it takes steps to ensure that dividends and prices are denominated in the same currency. When dividends and prices are denominated in different currencies returns can be very badly mismeasured.
- The Authority selected stocks based on whether they are currently members of the All Ordinaries and so, because membership of the All Ordinaries is determined by market capitalisation, on their current market capitalisations. It is likely, therefore, that the Authority's results suffer from survivorship bias.
- Rather than setting the return to a stock on a day when it does not trade – or over a week or a month when it does not trade – to missing [sic], the Authority set the return to zero if a price has previously been recorded. Treating missing returns as zero returns can lead to estimates of the beta of a stock that are biased towards zero.
- In computing an estimate of the zero-beta premium, the only restriction that the Authority placed on the number of observations required to compute a past estimate of beta is that there be at least two observations. Some of the estimates on which the Authority relies will be constructed using very few observations and will thus be imprecise.

103. Overall, the DBP was of the view that:[78]

> These empirical issues may have a significant effect on the ERA's empirical estimates, and suggest that at the very least that the ERA's empirical work be subject to the same kinds of independent audit as DBP submitted its own work to.

104. *Second,* DBP submitted that Authority appeared to be endorsing the views of experts, who have been engaged by the AER and not the Authority, as being supportive of its own view that estimates of the zero-beta premium are likely to be highly variable and potentially not very robust. However, DBP considered that, based on HoustonKemp's expert advice, there are various issues involved with the Authority's assessment, as outlined in the following quote.[79]

    - Partington & Satchell (2015) are incorrect to conclude that zero-beta estimates are "virtually worthless" due to their sensitivity to extreme values, when in fact there are no extreme values in the estimates that NERA, and subsequently HoustonKemp, provide. Additionally, the stability of NERA and subsequently HoustonKemp estimates of the zero-beta premium through time suggests that they are clearly not "worthless" – the fact that they are stable and lie significantly above zero illustrates that the SL-CAPM is not consistent with the data.
    - Partington & Satchell (2015) are incorrect to conclude that an estimate of the zero-beta cannot be current because it requires almost 20-years of data to estimate robustly. The argument ignores the fact that DBP, and HoustonKemp, estimate a zero-beta premium which is added to the current risk-free rate to produce a current zero-beta rate.
    - The discussion on the technical issues in respect of the zero-beta premium, raised in the paper by Beaulieu, Dufour and Khalaf (2012), pertain primarily to situations where the beta of a stock is very close to one or the betas of a group of stocks are close to one, and this is not the case for the large set of ASX stocks used by NERA

[78] DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 42.

[79] DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 42.

and HoustonKemp in estimating the zero-beta premium. Moreover, the evidence of instability through time that Beaulieu, Dufour and Khalaf provide pertains to the zero beta rate (risk-free rate plus premium) and not the zero-beta premium. It is thus of limited relevance.

- The findings of the work of Ray, Savin and Tiwari (2009) have been addressed in NERA (2015); the issue of asymptotic distributions is not an issue for DBP because we used simulations to correct for issues with the asymptotic distribution which might influence critical values.
- The work of Da, Guo and Jagannathan (2012) about the use of the SL-CAPM in respect of projects does conclude that it is still valid, but only if one adjusts all betas for the growth options that some firms hold, which neither the Authority nor the AER do; it is not a finding in respect of the SL-CAPM as actually used by regulators.
- The paper by Kan, Robotti and Shanken (2013) suggests that, when portfolios are formed a certain way, the superiority of the FFM over the SL-CAPM vanishes, but the authors do not say that the SL-CAPM is superior, and overall they find that the inter-temporal CAPM performs best, followed by the FFM.

105. DBP then concluded that:[80]

> Much of the evidence regulators collect in respect of the Black CAPM, leading to the conclusion it is not robust, has been misinterpreted. Variation in estimates of the zero-beta premium is an issue whose importance is overstated, the ERA overlooks key information by ignoring other aspects of the zero-beta premium estimates it produces (like them all being greater than zero) and there are, in any case, serious doubts about the reliability of the regulator's estimates. In conclusion, from examining the ERA's empirical evidence and the views of the AER's experts, the case against the Black CAPM is, in DBP's submission, weak.

Nonsensical results from applying the model adequacy test

106. DBP argues that the Authority's view that DBP's model adequacy test produces nonsensical results was not based upon any assessment of the empirical work DBP had undertaken, or the uncovering of any flaws in its calculations.[81]

107. DBP submits that its model adequacy test shows that when one models the return on equity in the way that the Authority does, the results are both statistically and economically lower, significantly, than the actual returns made by firms with similar levels of systematic risk. DBP argues that this means that the empirical fact is substantially different from model prediction, and that the model adequacy test simply reflects the empirical reality. DBP argues this is not a nonsensical result.[82]

108. DBP takes issue the Authority's two examples used to confirm that DBP's model adequacy test produces a nonsensical result.

109. *First,* DBP takes issue with the Authority's view that the systematic risk of an energy firm is less than one. DBP notes that this view is supported by McKenzie and Partington, who consider that energy firms, which are relatively insulated from

80 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 43.

81 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 43.

82 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 43.

business risk and face inelastic demand, ought to have low systematic risk.[83] However, DBP does not agree that such a view is entirely borne out by reality. DBP is of the view that the evidence is mixed.

110. *Second,* DBP disputes the Authority's view that the results produced from DBP's model adequacy test must be nonsensical because it suggests a return on equity lower than the return on debt.[84] DBP considers that equity returns can be negative for long periods of time. DBP then concludes that:[85]

> This is not to say that debt is somehow a better investment than equity, and that one ought to expect that debt will out-perform equity in any particular period. Rather, it is to point out that the ERA's "impossibility" finding in relation to the relative returns of debt and equity is incorrect; if periods can be found where debt out-performed equity, then it is not automatically nonsense that Portfolio Nine has lower actual returns for equity than what the ERA believes are promised debt returns, particularly when Portfolio Nine is one of the riskiest portfolios we examine.

Other statistical issues

111. DBP noted the Authority's list of statistical issues in relation to DBP's model adequacy test.[86] DBP engaged Houston Kemp (Appendix G) and DAA (Appendix K) to respond to issues raised in the Authority's Draft Decision.[87]

112. In its report prepared for DBP, DAA concluded that:[88]

> In summary, I have found statistical shortcomings in both the Submission and the Draft Decision. However the shortcomings of the Submission do not, in my opinion, materially affect the reliability of predictions of excess returns and hence appear to provide a reasonable basis for setting a risk premium. The shortcomings of the Draft Decision appear to have, from a statistical viewpoint, a high likelihood of poor predictions of returns and subsequently inappropriate estimates of risk premiums.

Data issues

113. DBP notes the Authority's two comments in respect of the data which DBP uses for the model adequacy test.[89]

114. *First,* with regard to the dataset used by DBP for its model adequacy test, DBP contends that:[90]

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83 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 43.

84 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 45.

85 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 46.

86 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 46.

87 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, Appendix G and Appendix K.

88 Data Analysis Australia, *Review of Statistical Aspects of Capital Asset Pricing Model,* a report prepared for DBP, February 2016, p. 32.

89 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 48.

90 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 48.

> There is nothing inherent in the model adequacy test which requires us to use the SPPR dataset. We could have equally used Bloomberg, Thomson Reuters, Morgan Stanley or any other source of data to undertake our model adequacy test. We use the SPPR data because it is the longest database of stock returns available in Australia and it is highly regarded in Australia.

115. DBP is of the view that – consistent with best practice – any test ought to be undertaken using long datasets. DBP also considers that failure to use a long dataset, particularly when working with noisy finance data, leads to results with very low power, making it difficult to draw robust conclusions.[91]

116. DBP submits that:[92]

> This is particularly an issue for the cross validation the ERA proposes to use. As pointed out in paragraphs 11.14 11.15 (see also Appendix I), the error structure induced by overlapping time series means that cross validation cannot be used for these series and instead monthly results must be aggregated to annual results, or some other less frequent set of data. Unless the ERA uses a long time series, this means that it cannot implement cross validation robustly; if anything the ERA will need more data to do cross validation robustly.

117. *Second,* DBP contends that concerns relating to its choice of data are "ungrounded", because the zero-beta premium estimates come from NERA, the HML factors come from Ken French's website and the remainder of the data come from the SPPR database.[93] DBP argues that:[94]

> We note finally that any data issues which might arise from using two different sources make no difference to our results; although two data sources are used for the FFM, meaning our rejection of the FFM in the model adequacy test may be incorrect based upon the ERA's concerns about different assumptions underpinning different data sources, only one is used for the SL-CAPM and Black CAPM. Thus, any differences in data-sources are irrelevant in respect of the findings which bear directly upon the choice of model we eventually use.

Bias in the SL-CAPM and the "theory" of the Black CAPM

118. DBP disagrees with the Authority's view that there is some downward bias in equity beta estimates that are less than one and upward bias in equity beta estimates that are greater than one. Instead, DBP is of the view that it is not bias in the estimates of beta per se that is the issue, but rather it is the case that the SL-CAPM as a model produces results which are biased downwards for low beta stocks and biased upwards for high beta stocks. DBP considers that it is bias in the model, not bias in the estimation of beta per se.[95]

119. DBP argues that the Authority's decision to adopt the estimated beta from the upper end of range is inappropriate, because the theoretical change from the SL-CAPM to the Black CAPM is unrelated to beta, it is a shift of the intercept. In addition, DBP

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91 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 49.

92 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 49.

93 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 49.

94 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 49.

95 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 50.

considered that there is no way to generalise from the particular adjustment the Authority makes to any other stock, or indeed to a situation where energy stocks have a different beta.[96] DBP argues that the Authority's adjustment to beta is both arbitrary and unrelated to the theory of the Black CAPM, and further is instead a much less elegant response than Black, Brennan and others to the empirical observation that low beta stocks tend to have actual returns higher than predicted.

120. DBP then concludes that:[97]

> By contrast, betastar is an algebraic manipulation of the Black CAPM such that the effect of the higher intercept (the sole change in theory between the SL-CAPM and Black CAPM) is loaded into beta(star). It thus reflects the "theoretical insights" of the Black CAPM directly, through this algebraic manipulation; essentially doing exactly the same thing as the Black CAPM model does. This means, in turn, that there is no ambiguity about what to do for stocks with different betas; the adjustment is exactly the same as for the Black CAPM itself, where low beta stocks have higher returns predicted by the betastar model compared to the SL-CAPM, except that the change comes through an adjustment to beta (compare Original AA Proposal Submission 12 Tables 6 and 10, with Table 11) which is exactly consistent with the "theory" of the Black CAPM.

The results of the DAA audit

121. DBP submits an independent viewpoint from Data Analysis Australia (**DAA**) as to the statistical validity of the model adequacy work it has undertaken, to ascertain whether it represents "best practice". DBP was of the view that:[98]

> Overall, DAA endorse DBP's approach, and agree with our conclusions in respect of which models are biased and which are not, suggesting that DBP's work provides reasonable estimates of the appropriate risk premia, performing substantially better than the ERA's approach.

The Authority's proposed model adequacy test

122. DBP submits that it has no intrinsic opposition to the use of cross validation or indeed any potentially robust form of testing model outputs. However, DBP is of the view that the more common approach used by DBP and by Henry (2009, 2014) is to make use of an expanding window or to make use of the process set out by Hyndman & Athanasopoulos (2014). DBP contends its approach is essentially the same.[99]

123. With regard to the cross-validation method, DBP states:[100]

> That is not to say cross validation can have no place, but its results need to be interpreted with care. Since it is impossible to predict using information from the future, the use of cross-validation is not really a "predictive" test at all, but is rather a more complicated way of doing in-sample testing of how well the different models fit the

96 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 51.

97 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 50.

98 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 50.

99 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 54.

100 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 54.

> data. This is a valid thing to do, and its use is widespread in finance. Indeed, NERA (2015a) do both out-of-sample and in-sample tests in a version of the model adequacy test prepared for several East Coast service providers and presented to the AER. However, if one is seeking to ask the question "how well will these models predict future returns?", which is what the model adequacy test is seeking to do, it is not clear whether cross validation is the correct approach.

Reasons for maintaining betastar

124. DBP considers that the Authority's approach, given a finding of downward bias for low beta stocks in the SL-CAPM, is completely irrational. DBP argues that:[101]

> … the ERA is acknowledging that bias exists, acknowledging that different models can supply information which might help overcome the bias, but then explicitly rejecting any information from those models in order to solve the bias problem in order to satisfy itself that it is not deviating from the SL-CAPM in any material way.

125. DBP is of the view that its betastar adjustment is transparent and can be easily followed by any observer.[102]

126. DBP agrees with the Authority's view that there are no literature or empirical studies which use a betastar approach. DBP accepts that it fails to provide a single reference to support its view that betastar is well established, or at least follows any standard economic or statistical theories. However, DBP argues that:[103]

> This, however, is not surprising; in the ordinary course of events, if the Black CAPM passed a test like the model adequacy test but the SL-CAPM did not, one would simply have used the Black CAPM. However, betastar was adopted so as to minimise departure from the Guidelines.

Reasons for maintaining the Merton consistency test and rejecting the Authority's cross checks

127. DBP submits that – given the importance of checking overall returns – it is insufficient for a regulator to undertake only one check of the overall return on equity and, in that check, provide no reasoning whatsoever as to how it obtained its conclusion of "reasonableness".[104]

128. Furthermore, DBP is of the view that its consistency check – which is based upon Merton's (1974) insights regarding the relationship between debt and equity – provides the most important cross-check. It is therefore given most weight by DBP.[105]

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101 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 55.

102 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 55.

103 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 55.

104 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 57.

105 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 58.

129. DBP disagrees with the Authority's conclusion that the Merton consistency test does not follow 'standard finance theory'. DBP argues that:[106]

> The approach is an application of options pricing, which is a well-established body of work within the finance field. The *Journal of Finance* has on its website a list of the top 50 articles (in terms of numbers of citations) it has published throughout its long history. The SL-CAPM, upon which the ERA places so much faith, sits at number two on that list, and Merton's (1974) paper, upon which SFG ultimately relies, sits at number 9.[71] As SFG point out (Original AA Proposal Submission 12 Appendix L, para 25) the paper also forms part of the portfolio of work which ultimately led to his Nobel Prize. It is unclear what basis the ERA has for asserting that SFG's approach "does not follow standard finance theory".

Issues with estimation of the MRP parameter in the SL-CAPM

130. DBP has issues with the Authority's estimates of the MRP and beta within the SL-CAPM, and the choices made for each.[107]

Market Risk Premium

131. DBP has two concerns regarding the MRP. The first is procedural and the second technical.[108]

132. *First,* DBP considers that it is impossible to know how the Authority's judgement with regard to the estimate of the MRP might change given different economic situations over time. DBP argued that:[109]

> For example, if VIX, spread and dividend growth data were all well above or well below their mean values, how much of a movement towards the upper end of the range of historical range (between the Ibbotson and Wright values) would the ERA contemplate, and how might the results from the DGM influence this? Additionally, where would the various results need to be before the ERA believed that the DGM evidence was sufficiently strong to warrant moving above the top end of the range formed by what the ERA terms its two "historical" measures?

133. *Second,* DBP expresses concerns in relation to the Authority's use of conditioning variables.[110] DBP considers that:[111]

> The key finding of ESQUANT was that none of the individual forward-looking indicators is cointegrated with either market returns or the MRP, and hence any relationship between them would be entirely spurious (see Original AA Proposal para 5.185). This means, effectively that each individual indicator is actually revealing nothing meaningful at all about the MRP, and the ERA's assessment from paragraph 321 to 336 (pp 70-4) which relies upon considering each indicator in turn (the ERA appears

106 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 59.

107 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 60.

108 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 60.

109 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 61.

110 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 62.

111 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 63.

> to have abandoned its approach of forming an index as per the ATCO Draft Decision; time-varying weights or no) of the Draft Decision is meaningless.

Beta

134. In its response to the Authority's Draft Decision in relation to the estimates of equity beta, DBP submitted that it has no issue with the *estimation* of beta as undertaken by the Authority.[112]

135. However, DBP considered that there are two issues in respect of the Authority's beta, including: (i) The *estimate* of beta the Authority has used of 0.7 produces a result which is not consistent with the approach it has used in the past, because it has failed to take into consideration the changes in its beta *estimation;* and (ii) a potential issue concerning the efficiency of the market portfolio.

136. *First,* DBP argued that as the confidence interval around beta has shifted upwards, the Authority's choice of beta has not changed.[113] DBP considered that systematic risk is measured relative to the market and one would expect change as either the actual risks facing the firm changed or risks in the market changed. DBP was of the view that a consistent regulator would also choose a point two basis points below the upper end of the same confidence interval to address the same bias issue. As such, DBP argued that doing so would require the Authority to adopt the estimate of equity beta of 0.79.[114]

137. *Second,* DBP submitted that if the market portfolio is inefficient, then the SL-CAPM fails to hold, and the conclusions the Authority has drawn in respect of beta are wrong. DBP argued that, more importantly, DBP concluded that:[115]

> DBP is to show that the predictions made by an SL-CAPM predicated on an inefficient market portfolio are downward-biased estimators of the actual returns made firms with (imperfectly measured) systematic risk similar to (likewise imperfectly measured) systematic risk exposure to the benchmark efficient firm, whilst the Black CAPM does not produce downward-biased estimators.

Return on debt

The method for developing the estimator of the DRP

138. DBP submits that it agrees with the DRP estimation methods and bond selection criteria employed in the Authority's revised bond yield approach.[116] DBP employed Esquant Statistical Consulting (**Esquant**) to apply and critique the revised bond yield approach. Esquant appears to have replicated the revised bond yield approach following the steps outlined in the Draft Decision, in so far that it produced similar

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112 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 63.

113 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 64.

114 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 64.

115 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 66.

116 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 73.

results to that it derived from an implementation in R statistical software. Its view was that the revised bond yield approach has two substantial weaknesses:

- it does not control for the effects of different credit ratings of bonds within the BBB band; and
- the Nelson-Siegel-Svensson curve is over-parameterised and so, is difficult to fit and suffers from multi-collinearity. [117]

139. DBP highlights that it proposes to apply the Authority's revised bond yield approach in using different software (R instead of Excel) and different data (Thomson-Reuters instead of Bloomberg) in order to check the Authority's DRP estimates.[118]

Hedging costs, debt raising costs and the new issue premium

140. DBP considers that the Authority's allowance of 12.5 bppa for the costs of issuing debt is too high, proposing an alternative figure of 9.0 bppa.

141. In addition, DBP also considers that debt raising costs should include allowances for the costs of meeting the following requirements of Standard & Poor's investment grade credit ratings:[119]

- establish and maintain bank facilities to meet the liquidity requirements condition; and
- re-finance debt three months ahead of the re-financing date.[120]

142. Overall, DBP considers that these three debt transactions costs, combined, should be around 18 bppa. DBP proposes that these figures be re-calculated each time the risk free rate is re-estimated.[121]

143. As to hedging costs, DBP considers that the Authority's allowance of 11.4 bppa is too low, suggesting a figure of 14.8 bps instead.[122]

144. With the regard to the New Issue Premium, DBP suggests that the Authority makes theoretical arguments which are in error.[123] Further, DBP also considers that the Authority's observations on the empirical findings are not germane. DBP considers that if a New Issue Premium exists, it is incumbent on the Authority to estimate it.

Automatic updating formulas for the return on debt

145. DBP raises a number of administrative issues in relation to the DRP estimate and subsequent annual updates. It submits that the Authority's checking mechanism is ill-defined in terms of timeframes and proposes that the Authority be required to provide its estimate of the cost of debt to be updated, along with relevant supporting

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117 Esquant Statistical Consulting, *drpr package*, 22 February 2016, pp. 7-8.

118 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 73.

119 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 81.

120 DBP states that it targets re-finance six months ahead in order to reduce re-finance risk.

121 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. iv.

122 Ibid.

123 Ibid.

information within a maximum of five working days following the end of each averaging period. It also submitted that supporting information should include the same information as at Appendix 4E of the Draft Decision, with the addition of the relevant ISIN codes for the bonds, rather than just their Bloomberg tickers. It reasons that the existing checking mechanism would potentially leave little time to check and respond in order that the tariff variation mechanism be deployed prior to the first of January in the following year.[124]

Further Submissions

146. Two public submissions were received in response to the Rate of Return issues set out in the Authority's DBNGP Draft Decision.

147. Wesfarmers Chemicals, Energy & Fertilisers (**WesCEF**) supports the Authority's rate of return estimation method. In particular, WesCEF 'does not agree with DBP's reasoning for the selection of its costs of equity methodology and believes the Authority's methodology is more appropriate'.[125]

148. DBP submits additional supporting material relating to the recent Australian Competition Tribunal (**ACT**) PIAC/Ausgrid decisions.[126] DBP considers that there are three contextual issues of primary importance from the ACT's approach to the return on equity:[127]

- first, the ACT did not find sufficient evidence that moving to a multiple models approach would give a more 'correct' outcome that maintaining an approach based on the SL CAPM – DBP submits that its return on equity results:
  - are not driven by the multiple models approach, as its approach is not based on a weighted average of several models;
  - follow the Authority, utilising the SL CAPM, with an adjustment to the beta to account for the implications of the Black CAPM;
- second, the ACT accepted that the SL CAPM exhibits a downward bias and that the AER did not err in choosing a beta of 0.7 from the range based on Henry's work but this must be read in context:
  - the AER made its decision based on the evidence before it, which was accepted by the ACT, but that does not imply that a beta estimate of 0.7 is the best estimate;
- third, the ACT 'does not appear to have been called upon to decide as to the correctness of the AER's approach to checking whether the return on equity, derived from its application of the Foundation Model approach, contributed to achieving the ARORO for the purposes of Rule 87(5) NGR';
  - systematic testing of the model outcomes was not involved;

124 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, pp. 82-83.

125 Wesfarmers Chemicals, Energy & Fertilisers, *Public Submission – DBP Draft Decision*, 23 March 2016.

126 DBNGP (WA) Transmission Pty Ltd, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 60 Response to the Australian Competition Tribunal Decisions, 22 March 2016, p. 4.

127 Ibid.

- this compares to the case at hand for DBP, where 'rather than relying solely upon the arguments of experts in support of one flawed model or another, DBP tests the outputs of all models using an objective, transparent test. Should the ERA decide not to accept DBP's Amended AA Proposal and DBP apply for a review of that decision, the Tribunal would thus face a different task in assessing DBP's approach than it did in the recent challenge'.

149. DBP submits that the Authority needs to consider a range of different information as compared to that which informed the ACT's recent PIAC-Ausgrid decision,[128] specifically:[129]

- DBP's approach is not driven by the multiple models approach, rather, DBP follows the SL-CAPM;
- different information about the appropriate low beta bias adjustment within the SL-CAPM; and
- information about tests of model outputs (from DBP and suggested by the Authority itself).

150. DBP also notes the implication of the PIAC-Ausgrid decision for gamma, directing that it be a value of 0.25, given by the product of a distribution rate of 0.7 and a utilisation rate of 0.35. DBP notes that this has impact on other areas of the decision, specifically the value of the MRP. DBP contends that:[130]

> …the ERA's process of creating a range based upon a variety of sources of information and then choosing an answer from within that range by considering indicator variables which are not impacted by gamma, means that the relatively small change in gamma would have no appreciable effect on the ERA's estimate of MRP. Indeed, as Frontier point out (see Appendix A), when considering a point estimate of the MRP formed by an "Ibbotson Approach" (which the ERA uses only to form the lower bound of its range) in light of a much larger change in gamma than contemplated in the recent Tribunal decision, the AER determined that no change in MRP should be made. There would thus appear to be little reason to expect any change in the ERA's estimate of the MRP flowing from the recent Tribunal decision on gamma.

151. DBP also submitted further arguments in relation to the estimate of equity beta in response to the Australian Competition Tribunal decisions on 22 March 2016. Key arguments are summarised as follows.[131]

152. *First*, 0.5 is not the "median" or "best estimate" for beta. Further, the Authority's approach to calculating its average artificially lowers the range for beta and does not accord with the Henry approach considered by the Tribunal.[132]

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128 Australian Competition Tribunal, *Applications by Public Interest Advocacy Centre Ltd and Ausgrid*, [2016] ACompT 1, 26 February 2016.

129 DBNGP (WA) Transmission Pty Ltd, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 60 Response to the Australian Competition Tribunal Decisions, 22 March 2016, p. 5.

130 DBNGP (WA) Transmission Pty Ltd, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 60 Response to the Australian Competition Tribunal Decisions, 22 March 2016, p. 12.

131 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Regulatory Period Supporting Submission: 60 Response to Australian Competition Tribunal Decisions, 22 March 2016, p. 6.

132 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Regulatory Period Supporting Submission: 60 Response to Australian Competition Tribunal Decisions, 22 March 2016, p. 7.

153. *Second*, new evidence indicates that, based on three-year beta estimates, the value for beta should be 0.95 (before any adjustment for bias). DBP submitted that the three-year timeframe is not arbitrary, but is supported by the statistical properties of the data used to calculate beta. DBP argued that data from before three years ago appears to reflect a different "state of the world" compared to the present, which in statistics is known as a "structural break".[133]

154. *Third,* the Authority's approach to selecting beta based on confidence intervals is flawed. DBP argued that:[134]

> In essence, confidence intervals tell one something about the precision of a parameter estimate (such as of beta) within a given model. However, it tells one nothing about the performance of that model itself. A model can perform very poorly but still have very precisely estimated parameters. The issue of low-beta bias is not a problem in the estimation of beta per-se. As DAA point out, that can be improved simply by increasing sample size. The issue is rather that the outputs of the model produce results which are systematically wrong; too low where the beta of a stock is below one and too high when the beta of a stock is above one.

155. *Fourth*, the Authority has not considered the ramifications of its own Black CAPM calculations on required bias adjustments, when it ought to have done so. DBP argued that an approach of estimating a return on equity based on the zero beta premium represent potentially the most useful information. DBP considered that using the algebra for the betastar transformation is the mathematically correct way to transform empirical information from the Black CAPM into an SL-CAPM framework. In addition, on the basis of CEG's advice, DBP argued that doing so is no different to adjusting beta within an SL-CAPM framework using the "theoretical implications" of the Black CAPM, except that it is more transparent.[135]

156. *Fifth*, the meaningful testing of model outputs is required. DBP considered that DBP's model adequacy test only shows which model results to reject, and does not provide a final answer. DBP maintained its view that the final answer is a matter for regulatory judgement. However, DBP argued that before judgement is exercised, it is possible to narrow the range of suitable estimates still further by considering information from the cost of debt.[136]

Considerations of the Authority

157. The Authority does not accept DBP's proposed approach for estimating the rate of return, as it does not comply with the regulatory requirements for the rate of return as specified in the NGL and NGR.[137] The Authority's reasoning for this position is based on its evaluation of DBP's proposal. That evaluation draws on previous

133 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Regulatory Period Supporting Submission: 60 Response to Australian Competition Tribunal Decisions, 22 March 2016, p. 8.

134 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Regulatory Period Supporting Submission: 60 Response to Australian Competition Tribunal Decisions, 22 March 2016, pp. 8-9.

135 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Regulatory Period Supporting Submission: 60 Response to Australian Competition Tribunal Decisions, 22 March 2016, p. 10.

136 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Regulatory Period Supporting Submission: 60 Response to Australian Competition Tribunal Decisions, 22 March 2016, p. 10.

137 These requirements include the National Gas Objective and the requirements under NGR 87, which includes the allowed rate of return objective.

positions set out in the Rate of Return Guidelines,[138] prior decisions,[139] the Draft Decision, and DBP's response to the Draft Decision, summarised above.

158. The following sections outline the Authority's considerations with regard to DBP's approach to estimating the rate of return, with specific regard to its estimates of:

- gearing
- the risk free rate;
- the return on equity;
  - beta
  - the market risk premium; and
- the return on debt;
  - estimating the debt risk premium;
  - hedging and other transactions costs.

Gearing

159. The Authority accepts DBP's proposed gearing of 60 per cent debt, 40 per cent equity, as it is consistent with the requirement set out in the Guidelines.

Inflation

160. The expected rate of inflation for the coming 5 year regulatory period is estimated using the procedure outlined in the Rate of Return Guidelines over the nominated averaging period.[140]

161. The expected inflation rate is estimated using the Treasury bond implied inflation approach. The approach uses the Fisher equation (shown in equation 12 below) and the observed yields of 5-year Commonwealth Government Securities (**CGS**) (which reflect a market based estimate of the nominal risk free rate) and 5-year indexed Treasury bonds (which incorporate a market based estimate of a real risk free rate). Linear interpolation is used to derive the daily point estimates of both the nominal 5-year risk free rate and the real 5-year risk free rate, for use in the Fisher equation.

$$1+i=(1+r)(1+\pi^{e}) \quad (12)$$

162. DBP initially proposed that five unique inflation forecasts for each year should be used in place of a single five year estimate that remains constant over each year in the financial model. Each of these forecasts use all Treasury bonds for forecasting

138 Economic Regulation Authority, *Rate of Return Guidelines*, 16 December 2013.

139 Economic Regulatory Authority, Final Decision on Final Decision on Proposed Revisions to the Access Arrangement for the Mid-West and South-West Gas Distribution Systems, as amended 10 September 2015.

140 Economic Regulation Authority, *Rate of Return Guidelines*, 16 December 2013, pp. 32-33.

within the access arrangement period instead of just the two bonds that straddle the date marking the end of the access arrangement period.[141]

163. DBP was of the view that the Authority's current approach, which uses just the two bonds straddling the date marking the end of the access arrangement period, 'artificially narrows' its bond selection and that it does not reflect inflation through the period. It outlined an example which stated that a surge in inflation within the period would not be reflected in the Authority's approach if inflation returned to the mean thereafter, within the period.[142]

Expectations Theory

164. Expectations theory predicts that the 5 year annualised inflation rate expected to prevail from today (5 year 'spot' inflation rate) will be equal to the geometric average (compounded) forward rates.

$$\pi_{0,5} = \left[(1+\pi_{0,1})(1+\pi_{1,1})(1+\pi_{2,1})(1+\pi_{3,1})(1+\pi_{4,1})\right]^{\frac{1}{5}} - 1 \quad (1)$$

Where:

$\pi_{0,5}$ is the 5 year annualised inflation rate expected to prevail from today (or 'spot' inflation rate);

$\pi_{0,1}$ is the 1 year annualised 'spot' inflation rate;

$\pi_{1,1}$ is the 1 year annualised inflation rate expected to prevail from 1 year later (1 year forward inflation rate);

$\pi_{2,1}$ is the 1 year annualised forward inflation rate expected to prevail from 2 years later;

$\pi_{3,1}$ is the 1 year annualised forward inflation rate expected to prevail from 3 years later; and;

$\pi_{4,1}$ is the 1 year annualised forward inflation rate expected to prevail from 4 years later.

165. If this relationship does not hold arbitrage opportunities exist where riskless profits can be made. Assuming the market for Treasury bonds and Treasury indexed bonds is efficient and no trading frictions – such as transaction costs – exist, the 5 year annualised inflation rate expected to prevail from today will be the same as the geometric average of the 1 year spot inflation rate and forward rates.

166. The Authority thereby demonstrates that the 5 year annualised inflation rate reflects inflation through the period.[143] As shown in equation (1), a surge in expected

[141] DBNGP Transmission Pty Ltd, Proposed Revisions DBNGP Access Arrangement 2016 – 2020, Rate of Return - Supporting Submission: 12, 31 December 2015, pp. 96-97.

[142] DBNGP Transmission Pty Ltd, Proposed Revisions DBNGP Access Arrangement 2016 – 2020, Rate of Return - Supporting Submission: 12, 31 December 2015, pp. 96-97.

[143] DBNGP Transmission Pty Ltd, Proposed Revisions DBNGP Access Arrangement 2016 – 2020, Rate of Return - Supporting Submission: 12, 31 December 2015, p. 96.

inflation in any one of the one year periods will be reflected in the 5 year annualised inflation rate.

167. The Authority is not aware of any evidence of inequality in the equation, such that the right hand side becomes a better measure of expectations than the 5 year spot rate on the left (due to factors such as transaction costs). The Authority has no reason to expect that the 5 year spot rate and component forward rates on the right hand side of the equation will not align at any point in time.

168. DBP's originally proposed method also is unconventional in proposing to use a weighting mechanism on bonds that gives less weight to those expiring further from the target date.[144]

169. In light of these arguments, the Authority was not convinced in the Draft Decision to depart from its method for estimating inflation set out in the Rate of Return Guidelines.

170. As noted above, DBP in its response to the Draft Decision accepted the Authority's decision on inflation.

171. In line with the foregoing method, the resulting estimate of inflation over the course of the regulatory period for this Final Decision is 1.43 per cent.

Risk free rate

172. The risk free rate contributes to estimates of the return on debt and the return on equity.

173. The key issues for the estimate of the risk free rate are:

- the term of the estimate;
- the method of estimating the risk free rate; and
- the averaging period.

174. It is convenient to deal first with the risk free rate to be used for estimating the return on debt. DBP now generally accepts the Authority's approach set out in the Draft Decision, including the application of the hybrid trailing average. As part of that, DBP accepts the use of the five year bank bill swap (**BBSW**) rate as the proxy for the risk free rate within the hybrid trailing average.[145] Accordingly, that issue is resolved, and is not considered further.

175. However, with regard to the return on equity, DBP does not accept the Authority's requirement in the Draft Decision that it use the *five year* Commonwealth Government Security for the risk free rate.[146] This is considered in the following section.

144 DBNGP Transmission Pty Ltd, Proposed Revisions DBNGP Access Arrangement 2016 – 2020, Rate of Return - Supporting Submission: 12, 31 December 2015, p. 96.

145 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 28.

146 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 29.

Term of the risk free rate for the return on equity

176. The Authority's requirement for a five year term for the risk free rate was based primarily on the NPV = 0 principle (or the **present value** principle), whereby the appropriate term in the current regulatory setting should be concomitant with the term of the access arrangement. Targeting that requirement assists in meeting the requirements of the NGL and NGR, as:

- consumers are not paying more than necessary, which is in their long term interests, consistent with the requirements of the NGO;
- gas pipeline service providers have reasonable opportunity to recover their efficient costs, which is consistent with the requirements of the Revenue and Pricing Principles (**RPP**);[147] and
- the rate of return will be commensurate with the efficient financing costs of a benchmark efficient entity with a similar degree of risk as that which applies to the service provider in respect of the provision of reference services, which is consistent with the requirements of the allowed rate of return objective.[148]

177. The Authority's detailed consideration of the present value condition was set out in the Rate of Return Guidelines.[149] The Authority's conclusions with regard to the term were based on the work of Lally and Davis.

178. Crucially, in that analysis, a key consideration for the Authority, with regard to the term for the risk free rate, in the return on equity, was the mixed evidence on equity investors' investment horizons. The Authority took account of Lally's evidence that suggests that investors' horizons may be less than five years, based on data on the weighted average holding period of equity shares.[150] On that basis, ascribing a term of more than five years in the return on equity would be providing investors with a return that exceeded their requirement. That would not be consistent with the allowed rate of return objective.

179. The Authority notes that it also took account, in the final draft of the Rate of Return Guidelines, of an extensive critique by DBP and others on this material and the Authority's interpretation of it.[151]

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147 The RPP provide, among other things, that:

- a service provider should be provided with a reasonable opportunity to recover at least the efficient costs the operator incurs providing regulated services and complying with regulatory obligations (NGL 24(2));
- a service provider should be provided with effective incentives in order to promote economic efficiency with respect to the regulated services it provides (NGL 24(3)); and
- a price, charge or tariff for the provision of a regulated service should allow for a return commensurate with the regulatory and commercial risks involved in providing the regulated service (NGL 24(5)).

148 NGR 87.

149 Economic Regulation Authority, Appendices to the Explanatory Statement for the Rate of Return Guidelines, 16 December 2013, Appendix 2.

150 Economic Regulation Authority, Appendices to the Explanatory Statement for the Rate of Return Guidelines, 16 December 2013, Appendix 2, p. 29.

151 DBNGP (WA) Transmission Pty Ltd 2013, *ERA Draft Rate of Return Guidelines: DBP Response*, 23 September, pp. 36 – 39.

180. However, DBP in its access arrangement initial proposal took further issue with the same material. At the core of the DBP critique was the following:[152]

> The most important assumption in this respect is that which Lally makes about the terminal value of the asset. Like a government bond, he assumes that the value of the asset at the end of the AA period (two AA periods in his model) is known with certainty at the outset.[153] If this were true, Lally's model would hold, and this would justify the use of a tenor for determining the interest rate that matches the five-year AA period as the service provider would earn a "certain" (except for demand risk) revenue through the AA period and would then receive a certain terminal payment at the end of the access period, just as occurs with government bonds. However, if this assumption does not hold, then the NPV=0 condition is not met by using interest rates reflective of the five-year regulatory term, but requires the use of a longer-term rate that reflects the uncertainty of cashflows occurring after the conclusion of the current access period which affect the terminal value of the asset at the conclusion of this access period.

181. DBP engaged SFG Consulting to consider these matters. SFG's key points are as follows:[154]

- The present value principle only suggests that the term of the allowed return should be matched to the length of the regulatory period in the case where the market value of the regulated asset at the end of the regulatory period is known for sure from the outset. This is because the asset can be valued as the present value of cash flows over the regulatory period only (one of which is the known end-of-period market value of the asset).
- If the end-of-period market value of the asset is not known with certainty from the outset, the present value principle does not imply that the term of the allowed return should match the length of the regulatory period. This is because the asset cannot be valued as the present value of the cash flows over the regulatory period;
- Where the end-of-period market value of the asset is not known with certainty from the outset, the asset would be valued as the present value of the cash flows to be generated over the life of the asset. In this case a long-term discount rate would be used and therefore the allowed return should be set on the basis of a long-term rate;
- The dominant commercial practice is to use a long-term discount rate, even when valuing regulated infrastructure assets where the regulator sets allowed returns based on a shorter-term rate;
- The majority of regulated infrastructure assets in Australia have their allowed return set on the basis of a long-term (10-year) rate;
- The Authority argues that its (currently low) 5-year allowed return is consistent with the (currently higher) 10-year required return used by investors. The Authority argues that investors actually require a low return over the next five years (the same as what the Authority currently allows) and a much higher return on cash flows thereafter. However, there is no mechanism whereby the high future returns that the Authority says investors require can ever be delivered by the Authority's rate-setting process. The more likely outcome is that, at every determination, the Authority simply uses this term structure

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152 DBNGP Transmission Pty Ltd, Proposed Revisions DBNGP Access Arrangement 2016 – 2020, Rate of Return - Supporting Submission: 12, 31 December 2015, p. 14.

153 [DBP'S footnote] See Appendix B: for details of the numerous papers in which Lally confirms that this assumption is being made, including his original paper.

154 DBNGP Transmission Pty Ltd, Proposed Revisions DBNGP Access Arrangement 2016 – 2020, Rate of Return - Supporting Submission: 12, 31 December 2015, Appendix B, p. 1.

argument to explain why its current regulatory allowance is below the return that investors require; and

- If the Authority does adopt a 5-year risk-free rate, consistency requires that the same rate must be used in the two places it appears in the CAPM formula.

182. DBP also queried why the Authority adopts the 10 year term for its rail decisions, but not for its gas decisions.

183. The Authority subsequently engaged Lally to undertake a review of the conclusions it set out in the Rate of Return Guidelines and also the arguments made by SFG which were summarised by DBP in its initial proposal.[155] Lally noted a small number of relatively minor points with regard to the Authority's interpretation set out in the Rate of Return Guidelines, but otherwise concurred with the Authority's analysis. Lally also did not accept SFG's arguments summarised above.[156] The Authority in its Draft Decision agreed with Lally's views regarding SFG's further arguments.

184. Subsequently, in its response to the Authority's Draft Decision, DBP continues to reject the five year Commonwealth Government Security (**CGS**) as the proxy for the risk free rate for the purpose of estimating the return on equity. In its response, DBP re-proposes the 10 year CGS, stating:[157]

> In respect of the return on equity, the ERA has relied upon a theoretical construct based upon numerous papers by Lally which assumes, at its core, that the only risk facing regulated firms in respect of pricing is interest rate risk. Whilst it might be appropriate to set the tenor to five years (or whatever the regulatory period is) in this imaginary scenario, it is not appropriate in the real-world environment where regulated firms face a host of risks from a wide variety of sources. A far more suitable approach is to recognise the long-run nature of this risk and to use the long run risk-free rate that is widely used by other regulators.

185. DBP in this response draws on a further report by Frontier Economics (written by the same SFG Consulting personnel, now part of Frontier. This report evaluates the Authority's (and Lally's) position set out in the Draft Decision.[158] Frontier makes three further arguments in its report. Frontier (the following summary draws on that by Lally):[159]

- contends that regulation should seek to replicate the prices that would prevail in a comparable competitive market, given that;
  - comparable competitive businesses are capital intensive with long lived assets;
  - the comparable businesses' cost of capital reflects this, and therefore embodies the long-term (ten-year) risk-free rate;

155 M. Lally, Review of arguments on the term of the risk free rate, 20 November 2015, p. 3.

156 Ibid, p. 13.

157 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 29.

158 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, Appendix B.

159 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, Appendix B; paraphrasing here Lally's summary set out in M. Lally, Review of Arguments on the Equity Risk Premium and the Risk Free Rate, 30 April 2016, pp. 13 – 14.

- the same rate therefore should apply to the regulated situation; contending that:
  - the price resetting frequency does not affect risk, and in support of this claims that there is considerable variation in the price setting frequency in unregulated markets without consequent changes in the cost of capital;
- continues to contend that proofs (such as in Lally, 2004)[160] are only valid if the value of the regulatory assets at the end of the regulatory cycle is known with certainty (extending the points made in DBP's initial proposal);
  - noting that Lally, in his 2015 report for the Authority,[161] stated that this assumption does not underlie the proof in Lally (2004) and that any risks associated with the value of the regulatory assets at the end of the regulatory cycle should be addressed through an appropriate risk premium rather than by use of a longer-term risk-free rate;
  - acknowledging then the possibility that '...the equity risk premium increases to account for this risk...'[162] but argues that there is '…no reason to think that the Authority (2015) does incorporate any such risks over the asset base into the allowed return to equity holders or that the Authority could incorporate this risk into an equity beta estimate in the future';[163]
  - subsequently, stating that '… there is no realistic prospect that this consideration has taken place in the Authority's decision or that it could take place given the imprecision in estimation of risk to equity holders';[164]
  - concluding then that the ten-year risk-free rate should be used;
- argues that imposition of a five-year regulatory cycle raises the firm's refinancing risk, and hence its equity beta, believing that:[165]
  - this is not reflected in the Authority's estimate, and therefore the ten-year risk-free rate should be used in compensation;
  - the normal practice for a capital intensive business would be to issue debt with a long term to maturity, and subsequently identifies this as ten years;
  - unregulated firms act in this way in order to deal with refinancing risk;
  - regulatory resetting of prices at a particular frequency would prompt firms to borrow for that same period in order to hedge the interest rate risk;
  - firms would then be exposed to greater refinancing risk;

160 These demonstrate that satisfaction of the NPV = 0 principle implies that the appropriate risk-free rate to be used by a regulator in resetting prices every five years is the five-year rate, as with a floating rate bond in which the interest rate is reset every five years at the prevailing five-year rate. See for example Economic Regulation Authority, *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, pp. 29 - 30).

161 M. Lally, Review of Arguments on the Term of the Risk Free Rate, 20 November 2015, p. 18.

162 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, Appendix B, p. 13.

163 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, Appendix B, p. 21.

164 Ibid.

165 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, Appendix B, p. 18.

- the increased refinancing risk raises the equity beta, but this increase is not reflected in the Authority's beta estimate because estimates are imprecise.

186. Frontier further states in its report:[166]

> The key point we make is that the ERA's (2015) view in favour of the prior approach does not hold once we move outside a stylized model in which only interest rate risk matters, and into a real situation in which:
>
> a. investors are exposed to an array of risks, not just interest rate risk;
>
> b. businesses and investors have already worked out that an efficient financing structure is to finance with long term debt, and that taking on additional short term debt leads to an increase in refinancing risk; and
>
> c. given the quantitative metrics currently available to estimate the equity risk premium (beta and the market risk premium), there is no realistic way in which the regulator can make a trade-off between the average lower risk free rate by moving to a short term proxy, and the implied higher refinancing risk.

187. DBP stands with Frontier's position, noting that the Authority and Lally recognise that firms face a variety of risks. DBP observes that the Authority dismisses this concern by stating that these risks are reflected in equity and debt risk premia. DBP contends that it would be almost impossible to calculate an adequate compensation for these risks in debt and equity. DBP concludes that 'for this reason, recognising the long run risk taken by equity holders in infrastructure, we continue to believe that the ten-year tenor for the risk free rate is appropriate'.[167]

188. The Authority addresses each of the points from DBP – set out in both its initial proposal and revised proposal – in the following sections.

Value of the regulated asset

189. The Authority considers that SFG's contention – that the *market value* of the business at the end of the regulatory period must be known with certainty[168] – is a separate issue to the certainty of the Regulated Asset Base (**RAB**). Lally summarises why such a conflation is misleading, as follows:[169]

> …this proposition assumes that the resetting process at the end of each regulatory cycle (typically five years) must be such as to equate the market value of the firm's equity with its regulatory book value at that time, and this is not possible because share prices of regulated businesses are influenced by factors beyond the regulatory period. However [this seems] to be conflating the share price of a regulated business with the share price of the company that carries out the regulated activities, and only the latter exists. For example, suppose a company undertakes some regulated business and this is its only existing activity but it also possesses some growth options, i.e., potential opportunities to engage in NPV positive projects outside the regulated business at some future point. Its share price will reflect the value of these opportunities and will therefore change as the market's perception of those

166 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, Appendix B, p. 2.

167 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 29.

168 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 12, 31 December 2015, Appendix B, pp. 3 – 9.

169 M. Lally, Response to submissions on the risk-free rate and the MRP, 22 October 2013, p. 20.

> options changes. However, this has no bearing on the appropriate risk free rate for the regulated activities that it undertakes.[170]

190. With regard to the RAB, its certainty would only be applicable in the theoretical context where the only source of risk relates to changes in the risk free rate, which is the case in the analysis by Lally in his 2007 article.[171,172] As noted above, Lally had already dealt with the presence of an additional risk premium in his 2004 article, finding that even in the presence of a risk premium, it is appropriate to set the term of the risk free rate equal to the regulatory period.[173] The Authority covered this ground in depth in the Guidelines.[174] Lally reiterates the relevance of the 2004 article in his recent review of the matter:[175]

> SFG (2014, section 2) argues that the Present Value Principle is only valid if the value of the regulatory assets at the end of the regulatory cycle are known with certainty. However, certainty on this matter is not a necessary assumption, as demonstrated in Lally (2004)…

191. Except under highly stylised circumstances, the Authority acknowledges that the value of *any* asset at the end of the investment horizon cannot be known with full certainty. Risk premia generally apply.

192. As an analogy, consider the case of debt instruments. Here, credit risk factors impact the certainty of full and timely payment of the ending market value (for example the principal). Here the credit rating, and hence the debt risk premium, accounts for credit risk over the average term of finance issuance that stems from factors such as declaration of redundant assets, changing depreciation schedules, disallowance of forecast capital expenditure from being included in the asset base and disruptive technologies.

193. With regard to equity, an investor can diversify such risks away and to the extent they cannot, they are compensated through the equity risk premium via the weighting (equity beta) the premium is given.

194. Like the coupon rate for a vanilla bond, the regulatory cost of capital factors in credit or equity risk which, in turn, captures risks that can affect the value of the RAB. Like the face value of the bond at the end of 5 years, the RAB is subject to economic and financial market conditions that prevail and influence regulatory outcomes up until that time.

195. The credit spread in this analogy corresponds to the equity risk premium in the regulatory setting. It accounts for the uncertainty in the value of the RAB for equity

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170 [Lally's footnote] The market value of the regulated business may also differ from the RAB if the market's perception of expected costs (inclusive of any efficiency gains) differs from the costs allowed by the regulator.

171 The examples outlined in Lally's 2007 paper set out the NPV = 0 conditions (M Lally, Regulation and the Term of the Risk Free Rate: Implications for Corporate Debt, *Accounting and Research Journal,* Vol. 20, No.1, 2007). For the Authority's consideration of this paper, see Economic Regulation Authority, *Explanatory Statement for the Rate of Return Guidelines*, 16 December 2013, Appendix 2, pp. 20 – 23.

172 That said, the Authority noted in the Guidelines that the RAB is not re-valued periodically, implying a very low risk for the full return of the value of the RAB at the end of the regulatory period – generally investors know its value for regulatory purposes with a large degree of certainty (Economic Regulation Authority, *Explanatory Statement for the Rate of Return Guidelines*, 16 December 2013, p. 89).

173 M. Lally 2004, "Regulation and the Choice of the Risk Free Rate", *Accounting Research Journal*, Volume 17, No. 1, 2004, p. 19.

174 Economic Regulation Authority, *Explanatory Statement for the Rate of Return Guidelines*, 16 December 2013, Appendix 2, pp. 18 - 26.

175 M. Lally, Review of Arguments on the Term of the Risk Free Rate, 20 November 2015, p. 13.

investors. The Authority therefore does not accept DBP's point that the RAB at the end of the period is not known with certainty, thereby rendering its present value condition in error.

Commercial practice

196. While the Authority acknowledges that equity analysts use a long dated tenor for the risk free rate in discounting, it notes that the circumstances under which equity returns are determined differ to the drivers of those returns for non-regulated entities.

197. First, equity analysts generally are seeking to value the firm and therefore seek a discount rate to perpetuity, which is then applied to determine the present value of the expected cash flows over the life of the assets.

198. SFG quotes a report from Incenta as evidence that the dominant commercial practice is to use a 10 year rate when valuing regulatory businesses. Reference to the Incenta report makes clear that Incenta surveyed analysts about the rate they would use in the '*valuation* of the regulated business' [our italicised emphasis].[176]

199. Second, in contrast, the Authority considered in the Draft Decision that it is undertaking a different exercise when establishing the rate of return for the benchmark efficient entity; the Authority is not establishing the value of the regulated business based on the expected cash flows to perpetuity.[177] Rather, the regulator is seeking to establish the value of cash flows over the access arrangement period, consistent with the requirements of the NGR and NGL, based on the value of the regulated asset base, which is determined first.[178]

200. Regulated equity returns are afforded a degree of protection against interest rate risk over the medium term due the 5 yearly resets of the base rate, as discussed above. Therefore, the value of the firm in perpetuity from the next access arrangement forward – using the long term risk free rate expected to prevail at the start of the next access arrangement as the discounting factor – can be discounted back to the current present value, using a discount factor incorporating the 5 year risk free rate.[179]

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176 Incenta Economic Consulting, *Term of the risk free rate for the cost of equity*, June 2013, p. 26.

177 Lally endorses exactly this view when he responds to similar arguments for the QCA in the context of the risk free rate (see M. Lally, *Response to submissions on the risk free rate and the MRP*, 22 October 2013, p. 24 and also paragraphs 189 - 190 above for the relevant quote).

178 The regulated asset base is the written down value of opening capital base, determined using depreciation from regulatory year to the next.

179 In this context, DBP claim (DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Regulatory Period Rate of Return Supporting Submission: 12, p. 15):

> The key question therefore concerns the certainty of the asset value at the conclusion of the current access period. The value of an asset reflects the NPV of expected future cashflows. As the ERA notes in the ATCO Draft Decision (see footnote 255, p146), in the regulatory sphere, this could be broken into a short term of the next access period, followed by the cashflows to perpetuity that the ERA suggests would be discounted at a different long-term rate. Clearly, if the asset is worth the NPV of a stream of discounted cashflows to perpetuity at the conclusion of the current access period, and these cashflows are discounted using a rate that is currently unknown (either because the parameters of a known model are unknown or because the future models used by regulators are currently unknown), then Lally's assumption of certain asset values at the termination of the AA period fails to hold.
>
> However, as noted above at paragraph 190, Lally does not assume certain asset values at the termination of the access arrangement period. Furthermore, the long term rate which might be expected (now) to apply at the conclusion of the access arrangement period will be consistent with the current

201. Lally's view is that the foregoing is 'reasonable for a valuation conducted on an unregulated business, but less so when it is conducted on a regulated business'.[180] In response to the Incenta evidence, Lally argues that:[181]

- the Incenta survey evidence does not support the use of the prevailing 10 year rate, rather, surveyed analysts appear to be using a rate in excess of the prevailing rate, looking 'through the cycle' – this does not support the application of the prevailing 10 year rate;
- even if the interviewees were using the prevailing ten-year rate for valuation purposes, it would not follow that they favoured use of the same rate by a regulator for setting output prices (RAV here corresponds to RAB):

  > If regulators set output prices correctly (so that the present value of future cash flows matched the contemporaneous RAV), regulated businesses were not expected to over or under perform the opex assumptions used by regulators, regulatory policy was not expected to change without appropriate compensation, and these businesses did not have any growth options, the valuation of a regulated businesses at any point in time would simply be the contemporaneous RAV.[6] Thus the value of a regulated business would be its RAV subject to correction for these additional issues. For example, if a regulated business was expected to have lower opex than that reflected in the prices allowed by the regulator, the value of the business would be its RAV plus the present value of this lower opex. Thus, when the analysts refer to using a ten-year risk free rate in the discounting process, they may be referring to the discounting for these additional issues. If so, this discount rate would have no relevance to the appropriate regulatory reset rate because the latter is reflected in the RAV component, i.e., in the WACC allowed by the regulator and applied to the RAV. Alternatively, if analysts are not acting in this way and are present valuing all cash flows (including those reflected in the RAV), then the use of the ten-year risk free rate within the discount rate would represent some sort of average over the rate that is relevant to the RAV (the five-year rate) and the rate that is relevant to the additional cash flows, and this average rate does not indicate the appropriate rate for the RAV component.

- there is no exploration by Incenta of any reasoning by the survey participants' for their responses – 'if their practices seem to be wrong, and they cannot supply a plausible explanation for them, it would not be sensible for a regulator to match their behaviour' – as a corollary, Lally notes that responses from the survey participants suggest that they do not understand why they apply the rate they do – one states it is 'the policy of the company', and further:[182]

  > …all of the interviewees claim that the appropriate risk-free rate for valuing regulated businesses (with five year cycles) is the same as that for unregulated businesses. Since regulated businesses subject to five-yearly price resets are similar to a very long-term bond with its coupon reset every five years, the belief on the part of all of these analysts that the appropriate risk-free rate for valuing regulated businesses (with five year cycles) is the same as that for unregulated businesses implies a belief that fixed rate bonds should be valued in the same way as floating rate bonds. This implicit failure to appreciate the difference between fixed-rate and floating-rate bonds undercuts the credibility of the interviewees.

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expectations of the 5 year rate, so it is not 'currently unknown'. Whether that long term rate is borne out in reality at the end of the access arrangement is another matter, as it would also be the expectations, now, for the 5 year rate to apply for the next access arrangement.

180 M. Lally, Review of Arguments on the Term of the Risk Free Rate, 20 November 2015, p. 16.

181 M. Lally, Review of Arguments on the Term of the Risk Free Rate, 20 November 2015, p. 16.

182 M. Lally, Review of Arguments on the Term of the Risk Free Rate, 20 November 2015, p. 18.

202. Based on the foregoing, the Authority is not convinced by SFG's or DBP's arguments with regard to the 10 year term for the risk free rate, or the cited evidence from Incenta's survey of analysts' practices.

203. The Authority considers that the need to establish the rate of return which meets the allowed rate of return objective does not involve valuation of the regulatory business; rather, it is to set a rate of return that is consistent with efficient financing costs of the benchmark efficient entity, which reflect the prevailing conditions in the market.

204. As noted above, a key consideration for the Authority, with regard to the term for the risk free rate in the return on equity, is the mixed evidence on equity investors' investment horizons. Lally provides evidence that suggests that investors' horizons may be less than five years, based on data on the weighted average holding period of equity shares.[183] On that basis, ascribing a term of more than five years in the return on equity would be providing investors with a return that exceeded their requirement. That would not be consistent with the allowed rate of return objective.

205. To that end, the Authority remains of the view that it is appropriate to apply a 5 year term for the risk free rate, as to do otherwise would violate the NPV=0 condition.

206. Additionally, the Authority notes that the approach to estimating the MRP has been adjusted since the Rate of Return Guidelines, such that the MRP is calculated using a 5 year risk free rate instead of a 10 year rate. The longer exposure of equity to risk is thus incorporated in the MRP, instead of the risk free rate. This is discussed in detail in paragraph 560 below.

Applying rates that prevail in a comparable competitive market

207. As noted above, Frontier contends that the price resetting frequency does not affect risk, and in support of this claims that there is considerable variation in the price setting frequency in unregulated markets without consequent changes in the cost of capital.

208. The Authority agrees with Lally that Frontier's argument has multiple shortcomings.[184]

209. In particular, nothing in it contests the importance of the present value principle or the analysis in Lally (2004) showing that this requires a regulatory risk-free rate term to match the regulatory cycle.

210. Furthermore, despite claiming that there is considerable variation in the price setting frequency in unregulated markets without consequent changes in the cost of capital, no empirical evidence is presented by Frontier in support of this claim. Furthermore, as noted by Lally, the allowance for risk in the cost of capital cannot be measured, only estimated almost certainly with error. Frontier recognises this.[185]

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183 Economic Regulation Authority, Appendices to the Explanatory Statement for the Rate of Return Guidelines, 16 December 2013, Appendix 2, p. 29.

184 M. Lally, Review of Arguments on the Equity Risk Premium and the Risk Free Rate, 30 April 2016, p. 13 – 14.

185 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, Appendix B, p. 12.

211. Lally suggests that consideration of two extreme and hypothetical cases is sufficient to demonstrate that the price setting frequency affects risk, and therefore must affect the cost of capital, as follows:[186]

> Suppose the output prices of a monopolist supplying an essential service were set once and never reset, demand subsequently changed dramatically and remained at that level indefinitely, and all costs were fixed with respect to output and time. The result would be that the cash flows of the firm would dramatically change and then remain at the new level. By contrast, with frequent resetting of the price to reflect prevailing demand, such uncertainty about future cash flows would be eliminated. Thus, the firm faces vastly more risk in the first scenario, due to the regulatory choice of the price resetting frequency. So long as the demand shock was systematic, the cost of capital in the first scenario would be higher than in the second. By contrast, customers would be protected from price shocks in the first scenario but not in the second. Of course, these cases are extreme and hypothetical but if risk differs significantly across these two cases it is plausible that it does so in less extreme cases where empirical assessment would be inconclusive.

212. The Authority notes in this context the view of the Australian Competition and Consumer Commission's (**ACCC**) Regulatory Development Branch, that '…when determining a new regulatory cost of debt approach, debt practices which are a product of the regulatory environment should be ignored. This is because these practices will change if the regulatory environment changes. If in setting a new regulatory framework, a regulator considers debt practices that are a result of businesses reacting to the existing regulatory framework, it may create a self-fulfilling method that may not necessarily be efficient'.[187] The Authority considers that if Frontier's views were borne out, the ACCC's view would be wrong. However, the Authority does not agree that is the case.

213. On that basis, the Authority agrees with Lally that the price resetting frequency does affect risk.

Issues regarding equity risk premia and the beta

214. The Authority does not consider that the certainty of the *value o*f the RAB at the end of the period is a requirement for proofs of the NPV=0 principle. As noted above, risks associated with that uncertainty will be compensated through equity risk premia.

215. Frontier acknowledges that an increased risk premium could address such risks, but disputes that there is evidence that the Authority incorporates such compensation:[188]

> In our view, investors project a set of expected cash flows and apply discount rates to those cash flows which reflect risks associated with those cash flows. The regulator adopts a number of processes, parameter estimates and judgements each period and investors form a view on all expected cash flows for the life of the asset... The cash flows are expected cash flows and so are not guaranteed. The contrasting situation is …[that] cash flows outside of year one are irrelevant for value because any increases or decreases in cash flows are perfectly offset by increases or decreases in discount rates…

186 M. Lally, Review of Arguments on the Equity Risk Premium and the Risk Free Rate, 30 April 2016, p. 14.

187 Goldfields Gas Transmission Pty Ltd, Goldfields Gas Pipeline, Access Arrangement Revision Proposal Response to ERA Draft Decision: Submission, January 2016, p. 91.

188 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, Appendix B, p. 13.

> Which of these views is correct depends upon the particular situation at hand. The view of the ERA (2015) and Lally (2015) holds if either:
>
> a. forward rates are an unbiased estimate of future spot rates; or
>
> b. there is no uncertainty about cash flows after the end of the regulatory period of a type that matters for the pricing of assets; or
>
> c. there is uncertainty about the asset base of a type that matters for the pricing of assets, but the equity risk premium increases to account for this risk. As we discuss in Section 4 there is no reason to think that the ERA (2015) does account for any risk of this type, or that the ERA could measure the different discount rates associated with the series of expected cash flows compared to the asset base.

216. As noted by Lally, Frontier makes the striking admission that regulatory use of the five-year risk-free rate is conceptually correct but that one should instead use the ten-year risk-free rate because the beta estimate somehow doesn't reflect the risks associated with the regulatory asset value at the end of the regulatory cycle:[189]

> This is a striking admission about the conceptual correctness of the five-year risk-free rate, contrary to all previous submissions by SFG on this question, and SFG is Frontier by an earlier name. For example, SFG (2012, section 3) argues that regulatory use of a five-year risk-free rate in a five-year regulatory scenario will only satisfy the NPV = 0 principle if the expectations hypothesis for the term structure of interest rates holds. Subsequently, SFG (2014c, section 2) argues that this result instead requires that the value of the regulatory assets at the end of the cycle is certain. Now, finally, Frontier accepts that the result will hold so long as any risks associated with the value of the regulatory assets at the end of the cycle are addressed through an appropriate risk premium. Furthermore, Frontier could not claim that the risk premium point is new, because it appears in Lally (2004).
>
> The problems with Frontier's argument are twofold. In particular, Frontier fails to explain why the beta estimates considered by the ERAWA, and obtained in the usual way through time-series regression, would not reflect these risks associated with the value of regulatory assets so long as the comparators are appropriately chosen and, if they are not, the solution to the problem lies there rather than in use of the ten-year risk-free rate. Frontier's uncontroversial claim that beta estimates are imprecise doesn't address this problem; if the risks associated with the cycle end asset values raise the true beta, the expected value of the estimate will rise. The actual estimate might be less than this, but it is equally likely to be higher, and this risk does not warrant use of a different risk-free rate. Similarly, MRP estimates are imprecise, but Frontier does not argue that a higher risk-free rate should be used in compensation for this. Furthermore, even if the beta estimate used by the ERAWA somehow failed to reflect this increased risk associated with the value of the regulatory assets at the end of the regulatory cycle, Frontier fails to quantify the beta impact of these risks so as to justify using a risk-free rate that is 0.50% larger than the conceptually correct five-year rate of 1.96%. For example, if the beta impact of these risks is 0.04 and the MRP is 6%, the appropriate increase in the cost of capital would be 0.24% rather than the 0.50% arising by using the ten-year risk-free rate.

217. The Authority agrees with Lally that the beta estimates will account for risks relating to the uncertainty of the value of the RAB.

218. On that basis, the Authority remains of the view that the appropriate term for the risk free rate is that which is concomitant with the term of the regulatory period.

[189] M. Lally, Review of Arguments on the Equity Risk Premium and the Risk Free Rate, 30 April 2016, p. 14.

Refinancing risk

219. Frontier's implied view is that the imposition of a five-year regulatory cycle will raise the firm's refinancing risk, and hence its equity beta, but that this is not reflected in the Authority's estimate. Therefore the ten-year risk-free rate should be used in compensation.[190]

220. However, the benchmark sample of private sector firms (from which the Authority estimates the beta), that have been subject to five-year regulatory cycles have not shortened their borrowing term to five years and aligned it with the regulatory cycle, because doing so would dramatically increase their refinancing risk. Instead, the evidence is clearly that they have adopted interest rate swap contracts in order to hedge the base rate component of the cost of debt. In this context Lally notes:[191]

> …the AER (2009, pp. 152-154) in summarizing submissions from private-sector entities concludes that such hedging is standard practice amongst private-sector firms, Citipower et al (2013, page 7) states that they do hedge in this way, AGN (2015, page 45) do likewise, and SFG (2015, footnotes 2 and 32) refers to SA Power Networks, Citipower, Powercor, JGN, JEN, and United Energy as practitioners of this method. In addition, SFG (2012b, page 24) claim that it is standard practice amongst small to medium sized businesses to hedge in this way, NERA (2014, page 22) make the same claim, and Jemena (2013, page 19) claims that it is standard practice amongst Network Service Providers in general. Furthermore, amongst these papers, the only references to the hedging being done at any level less than 100% are 80 – 100% by Envestra (AER, 2009, pp. 152-154), 98 – 100% by SP Ausnet (AER, 2009, pp. 152-154), and 80 – 100% by AGN (2015, page 45).

221. This evidence indicates that hedging at or close to 100 per cent is, and has been, the general practice in the private sector when the allowed cost of debt is periodically reset in accordance with the prevailing rate. The Authority notes that a portion of this evidence comes from SFG itself, which is now part of Frontier.

222. Lally further observes:[192]

> Remarkably, Frontier (2016c, para 81) seems to recognise that use of these derivative contracts is an alternative to aligning borrowing with the regulatory cycle, but immediately repeats the claim that refinancing risk would be raised by the imposition of a five-year regulatory cycle. However, if interest rate swap contracts were used, they would augment rather than displace the firm's existing 'physical' borrowing arrangements. Since the refinancing risk arises from the 'physical' borrowing arrangements, it would be unaffected by the use of the swap contracts. Thus, Frontier's recognition that derivatives could be used contradicts their belief that refinancing risk would still rise…
>
> These swaps would not change the firm's refinancing risk because the ten-year fixed-rate borrowing arrangements originally entered into by the firm would still be in force. So, given the adoption of swaps, there would be no increase in refinancing risk and therefore no increase in the equity beta arising from increased refinancing risk.

223. Given the foregoing, the Authority is not convinced that refinancing risk presents any issue for its approach.

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190 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, Appendix B, p. 21.

191 M. Lally, Review of Arguments on the Equity Risk Premium and the Risk Free Rate, 30 April 2016, p. 17.

192 M. Lally, Review of Arguments on the Equity Risk Premium and the Risk Free Rate, 30 April 2016, p. 17.

Gas versus rail decisions

224. DBP queried why the Authority adopts the 10 year term for its rail decisions, but not for its gas decisions.[193]

225. The Authority made clear in its rail decision that the effective term for its estimates is the 'economic life of the assets',[194] as this is the requirement under the rail Code:[195]

> The Authority notes that the longer term estimates developed for the rail WACC are not directly comparable to the five year forward looking estimate of the rate of return used for its gas decisions. The term of the gas rate of return is conditioned by the five year term of the regulatory period, which requires a five year term for the rate of return estimate in order to maintain the present value ("NPV=0") condition. In contrast, the term of the rail WACC is conditioned by the explicit requirement for a 'gross replacement value' annuity, which is paid over the 'economic life' of the rail assets. This is a different regulatory framework to that utilised for the Authority's gas pipeline regulation. As the weighted average life of typical rail infrastructure assets approaches 50 years or more, the WACC is long term.

226. The Authority therefore rejects DBP's view that the term of the risk free rate should be set at 10 years. The Authority maintains its view – clearly set out in the Rate of Return Guidelines – that the appropriate term should be commensurate with the term of the regulatory period. That term is 5 years.

Conclusions with regard to the term of the risk free rate for the return on equity

227. The Authority rejects DBP's view that the term of the risk free rate should be set at 10 years for the return on equity, for the reasons above. The Authority maintains its view – clearly set out in the Rate of Return Guidelines and the Draft Decision – that the appropriate term should be commensurate with the term of the regulatory period. That term is 5 years.

228. The Authority considers that a 5 year term for the risk free rate for the return on equity is consistent with the requirements of the NGL and NGR. Specifically, a 5 year term maintains the present value principle, which ensures that the return on equity is commensurate with the efficient financing costs of the benchmark efficient entity, thereby meeting the requirements of the allowed rate of return objective, ensuring that consumers of natural gas do not pay more for services than is necessary. It is also consistent with the Revenue and Pricing Principles, particularly the requirement in NGL 24(2) that the service provider has reasonable opportunity to recover at least the efficient costs the service provider incurs in providing reference services. It therefore meets the requirements of the National Gas Objective, and of the NGL and NGR more generally.

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193 DBNGP Transmission Pty Ltd, Proposed Revisions DBNGP Access Arrangement 2016 – 2020, Rate of Return - Supporting Submission: 12, 31 December 2015, p. 16.

194 *Railways (Access) Code 2000*, Schedule 4, Division 1, Clause 2.

195 Economic Regulation Authority, Review of the method for estimating the Weighted Average Cost of Capital for the Regulated Railway Networks – Final Decision, 18 September 2015, p. 55.

Proxy for the risk free rate

229. DBP proposes that the return on Commonwealth Government Securities (**CGS**) provides an acceptable proxy for the risk free rate for the return on equity.[196]

230. The Authority agrees that the return on CGS is a reasonable proxy for the risk free rate. The Authority therefore agrees that CGS may be used to estimate the risk free rate for the return on equity.

231. For the return on debt, the Authority set out in its Draft Decision that it would use estimates of the prevailing interest rate swaps of appropriate terms for estimating the return on debt. The swap rates incorporate a spread to the rate on Commonwealth Government Securities. Use of the swap rate is a convenience which simplifies the calculation of the DRP (the alternative would be to use the CGS and incorporate the spread to swap in the DRP). On that basis, the Authority considers that use of the swap rate is not inconsistent with the use of the CGS as the proxy for the risk free rate.

232. DBP has accepted the use of swap rates as the proxy for the risk free rate in the return on debt estimate.[197]

Averaging period

233. In the Rate of Return Guidelines, the Authority determined that the averaging period should be a 40 day period, for the purposes of removing day to day variation in the estimates.[198]

234. However, the Authority utilised an indicative 20 day averaging period in the Draft Decision, having moved to that for the ATCO GDS Final Decision. In that decision, the Authority recognised that any averaging period in the range 20 to 60 days could be adopted with little loss of predictive power.[199]

235. DBP now proposes a 20 day averaging period ending 10 June 2016.[200]

236. The Authority accepts DBP's proposal.

237. The Authority also requires that DBP nominate the averaging periods for the annual update of the DRP within 14 days of the release of this Final Decision. The requirements for the timing of these averaging periods are set out in the 'Return on debt' section below.

The estimate of the risk free rate

238. For this Final Decision, the average of the observed 20 days of the 5-year Commonwealth Government Securities (**CGS**) risk-free rate as at 10 June 2016 was

196 DBNGP Transmission Pty Ltd, Proposed Revisions DBNGP Access Arrangement 2016 – 2020, Rate of Return - Supporting Submission: 12, 31 December 2015, p. 19.

197 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 30.

198 Economic Regulation Authority, *Explanatory Statement for the Rate of Return Guidelines*, 16 December 2013, p. 86.

199 Economic Regulation Authority, Final Decision on Proposed Revisions to the Access Arrangement for the Mid-West and South-West Gas Distribution Systems, as amended 10 September 2015, p. 216.

200 DBNGP Transmission Pty Ltd, Proposed Revisions DBNGP Access Arrangement 2016 – 2020, Rate of Return - Supporting Submission: 12, 31 December 2015, p. 81.

1.80 per cent. This provides the point estimate for the risk free rate for the return on equity set out in this Final Decision.

239. The average of the observed 20 days of the 5-year swap rate (**BBSW**) as at 10 June 2016 was 2.10 per cent. This provides a point estimate for the risk free rate for the return on debt set out in this Final Decision.

Return on equity

240. In line with the requirements of NGR 87(5), the Authority evaluated the relevance of a broad range of material for estimating the return on equity in the Rate of Return Guidelines, covering relevant estimation methods, financial models, market data and other evidence.[201]

241. The Rate of Return Guidelines set out that the Authority will utilise a five step approach for estimating the return on equity.[202] The five steps are summarised in Figure 2 below.

242. In applying this approach, the Authority has assessed a wide range of material, and identified relevant models for the return on equity, as well as a range of other relevant information. For this Final Decision, the Authority has had regard to and given weight to relevant material, according to its merits, seeking to fully achieve the requirements of the allowed rate of return objective.[203]

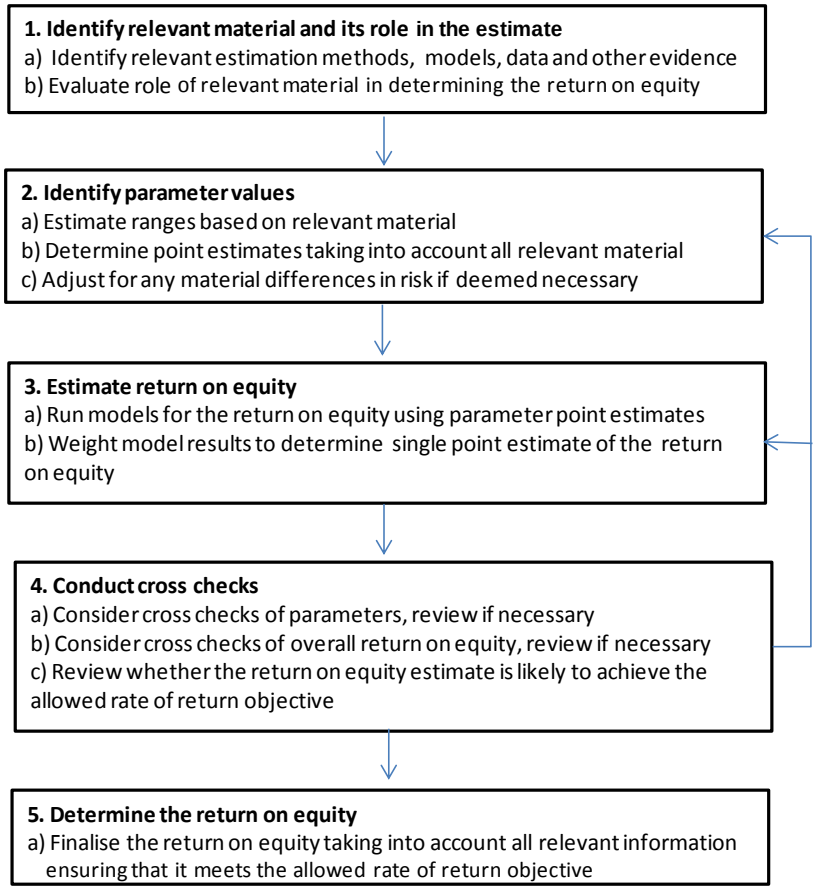
[201] Australian Energy Market Commission, Rule Determination: National Gas Amendment (Price and Revenue Regulation of Gas Services) Rule 2012, 29 November 2013, p. 36.

[202] Economic Regulation Authority, Rate of Return Guidelines: Meeting the requirements of the National Gas Rules, 16 December 2013, p. 22.

[203] The allowed rate of return objective is set out at NGR 87(3):

The allowed rate of return objective is that the rate of return for a service provider is to be commensurate with the efficient financing costs of a benchmark efficient entity with a similar degree of risk as that which applies to the service provider in respect of the provision of reference services.

Figure 2 Approach to estimating the return on equity [204]



Source: Economic Regulation Authority, Rate of Return Guidelines, 16 December 2013, p. 23.

243. The Authority in the Rate of Return Guidelines determined that only a subset of the material evaluated at that time could be considered relevant in the Australian context, given the allowed rate of return objective. The Authority remains of the view that:

> Rate of return estimate materials – the estimation methods, financial models, market data and other evidence – would need to be broadly consistent with the requirements of the NGL, the NGO, the NGR and the allowed rate of return objective to be considered relevant. Some estimation materials may perform better on some requirements and less well on others, and yet may still be considered relevant. Accordingly, the assessment is whether, on balance, estimation materials are consistent with the requirements of the NGL, the NGO, the NGR and the allowed rate of return objective.
>
> Nevertheless, estimation materials would need to pass a threshold of adequacy to be considered relevant. To the extent that estimation materials failed the adequacy

[204] The Authority considers that the term:

- 'approach' refers to the overall framework or method for estimating the return on equity, which combines the relevant estimation methods, financial models, market data and other evidence;
- 'estimation material' refers to any of the relevant estimation methods, financial models, market data and other evidence that contribute the 'approach'; and
- 'estimation method' relates primarily to the estimation of the parameters of financial models, or to the technique employed within that model to deliver an output.

threshold, then they would be rejected. This rejection would be consistent with the AEMC's purpose for the guidelines:[205]

> In order for the guidelines to have some purpose and value at the time of the regulatory determination or access arrangement process, they must have some weight to narrow the debate.

Once over the threshold for adequacy, then, as noted, any particular estimation material may meet the requirements of the NGL, the NGO, the NGR and the allowed rate of return objective to a greater or lesser degree. With this in mind, the criteria would then be used as a means to articulate the Authority's evaluation of the estimation materials, in terms of how they performed in meeting the requirements of the NGL, the NGO, the NGR and the allowed rate of return objective. In this way, the criteria are intended to assist transparency around its exercise of judgement. [206]

244. In that context, the following analysis provides the Authority's determination for this Final Decision of the return on equity for the DBNGP benchmark efficient entity. The Authority considers that the estimate is consistent with delivering an outcome that meets the allowed rate of return objective, as well as the NGL and NGR more broadly.[207]

Step 1: Identifying relevant material and its role in the estimate

The Guidelines

245. In the Rate of Return Guidelines, the Authority evaluated the relevance of the following models for estimating the return on equity, in terms of their ability to contribute to the achievement of the allowed rate of return objective:[208]

- the Sharpe Lintner Capital Asset Pricing Model (**SL CAPM**), as well as other asset pricing models in the CAPM 'family'; and
- an extensive range of other models and approaches which seek to estimate the return on equity.

246. The Authority concluded in the Guidelines that the SL-CAPM model is relevant for informing the Authority's estimation of the prevailing return on equity for the regulated firm at the current time.

247. However, the Authority determined that it would give weight to relevant outputs from the Dividend Growth Model (**DGM**) when estimating the market risk premium (**MRP**), which is an input to the SL-CAPM.[209]

248. The Authority also noted the empirical evidence provided by the Black and Empirical CAPM models, acknowledging the potential for bias in the estimates from the SL-

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205 Australian Energy Market Commission, Rule Determination, National Gas Amendment (Price and Revenue Regulation of Gas Services) Rule 2012, 29 November, p. 58.

206 Economic Regulation Authority, *Explanatory Statement for the Rate of Return Guidelines*, 16 December 2013, p. 12.

207 The allowed rate of return objective is set out at NGR 87(3):

The allowed rate of return objective is that the rate of return for a service provider is to be commensurate with the efficient financing costs of a benchmark efficient entity with a similar degree of risk as that which applies to the service provider in respect of the provision of reference services.

208 Economic Regulation Authority, Appendices to the Explanatory Statement for the Rate of Return Guidelines, 16 December 2013, Appendix 8.

209 Economic Regulation Authority, Appendices to the Explanatory Statement for the Rate of Return Guidelines, 16 December 2013, p. 78.

CAPM, and noted that it would take this relevant information into account when estimating the point estimate of the equity beta from within its estimated range.[210]

249. The Authority concluded that other models and approaches are not relevant within the Australian context, at the current time, without some new developments in terms of the theoretical foundations or in the empirical evidence. Generally, there are resulting shortcomings with regard to robustness in the Australian context. On this basis, the Authority considered that these other models are not 'fit for purpose' or able to be 'implemented in accordance with best practice'.[211]

250. The Authority considered that its approach in the Rate of Return Guidelines with regard to the determination of relevance – in terms of adopting approaches which

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210 Economic Regulation Authority, Appendices to the Explanatory Statement for the Rate of Return Guidelines, 16 December 2013, p. 67.

211 In its Rate of Return Guidelines, the Authority set out the criteria it would use to inform readers of the appropriateness of the proposed approach to be utilised for estimating the inputs of the rate of return, in terms of meeting the allowed rate of return objective (Economic Regulation Authority, *Rate of Return Guidelines*, 16 December 2013). The Authority considers that the criteria are consistent with the requirements of the NGL, the NGO, the NGR and the allowed rate of return objective. The requirements of the NGL, the NGO, the NGR and the allowed rate of return objective have primacy at all times. The criteria allow the Authority to articulate its interpretation of these requirements set out in the NGL and the NGR. The Authority considers it desirable if the proposed rate of return methods are:

- driven by economic principles;
  - based on a strong theoretical foundation, informed by empirical analysis;
- fit for purpose;
  - able to perform well in estimating the cost of debt and the return on equity over the regulatory years of the access arrangement period;
  - implemented in accordance with best practice;
- supported by robust, transparent and replicable analysis that is derived from available, credible datasets;
  - based on quantitative modelling that is sufficiently robust as to not be unduly sensitive to small changes in the input data;
  - based on quantitative modelling which avoids arbitrary filtering or adjustment of data, which does not have a sound rationale;
- capable of reflecting changes in market conditions and able to incorporate new information as it becomes available;
- supportive of specific regulatory aims; and thereby:
  - recognise the desirability of consistent approaches to regulation across industries, so as to promote economic efficiency;
  - seek to achieve rates of return that would be consistent with the outcomes of efficient, effectively competitive markets;
  - as far as possible, ensure that the net present value of returns is sufficient to cover a service provider's efficient expenditures (the 'NPV=0' condition);
  - provide incentives to finance efficiently;
  - promote simple approaches to estimating the rate of return over complex approaches where appropriate;
  - promote reasoned, predictable and transparent decision making;
  - enhance the credibility and acceptability of a decision.

The Authority does not accept DBP's claim (DBP, *Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 12*, 31 December 2015, p. 46) that the criteria do not account for the empirical prediction performance of the relevant models – the second and fourth criteria clearly address this issue.

best meet the allowed rate of return objective – was consistent with the stated intent of the AEMC:[212,213]

> … In general the final rules give the regulator greater discretion than it has currently. The objectives and factors show the regulator what it must bear in mind when it exercises that discretion.
>
> The role of the objective is to indicate what the regulator should be *seeking* to achieve in the exercise of its discretion. Some stakeholders appear to have understood the objectives as imposing on the regulator a requirement and that failure to comply with this would mean the regulator is in breach of the rules. This is not the case. Although the language of an obligation is used in some objectives, it is not necessarily expected that the substance of the objective will always be fully achieved, but rather the regulator should be striving to achieve the objective as fully as possible. Where it is used in rate of return and capital expenditure incentives, the objective has primacy over other matters which the regulator is directed to consider.
>
> These other matters include factors which the regulator is directed to consider. The rules use language such as "have regard to" and "take into account" to direct the regulator to consider certain factors. Throughout this rule change process there has been discussion over the respective meanings of these phrases. The Commission's approach is that these phrases mean the same thing and nothing is implied by the use of one rather than the other. The Johnson Winter & Slattery advice attached to the Australian Pipeline Industry Association (**APIA**) submission[214] includes a useful guide to how the phrases should be interpreted. The regulator must actively turn its mind to the factors listed, but it is up to the regulator to determine how the factors should influence its decision. It may, indeed, consider all of them and decide none should influence its decision. It is not intended that the regulator's decision is solely dependent on how it applies any or all of those factors. The intention is that where the rules require the regulator to consider certain factors in conjunction with an overall objective, it should explain its decision including how it has had regard to those factors in making a decision that meets the objective.

The draft decision

251. The Authority retained its broad approach to relevant material for the return on equity – which it had set out in the Guidelines – in its Draft Decision.[215] The Authority noted that DBP presented only limited new information in its proposal, in relation to

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212 Australian Energy Market Commission, *Rule Determination, National Gas Amendment (Price and Revenue Regulation of Gas Services) Rule 2012*, www.aemc.gov.au, 29 November 2013, p. 36.

213 The Authority notes that relevant means ‘closely connected or appropriate to the matter in hand’ (Oxford dictionary) or ‘bearing upon or connected with the matter in hand; to the purpose; pertinent’ (Macquarie dictionary).

214 APIA, *Economic Regulation of Network Service Providers: Response to AEMC*, www.aemc.gov.au, 4 October 2012, Appendix 1, p. 11. The Authority notes that that the Johnson Winter & Slattery advice stated:

> …as long as the Regulator has taken into account the specified factors, it remains in the Regulator’s discretion how those factors influence its decision. The practical application of this rule could result in the Regulator considering other estimation methods, financial models, etc. but then putting all but one to the side and continuing to estimate the cost of debt and cost of equity using its already stated preferred approach (i.e. the SL-CAPM)…
>
> If evidence is “irrelevant”, the Regulator will not fall into error by failing to “take it into account”.
>
> In practice, of course, this will require some form of value judgment by the Regulator about whether evidence put before it is relevant or not. This appears to be consistent with the very broad discretion envisaged by the AEMC in the Draft Rule Determinations.

215 Economic Regulation Authority, Draft Decision on Proposed Revisions to the Access Arrangement for the Dampier to Bunbury Natural Gas Pipeline, 22 December 2016, Appendix 4, p. 47.

relevant estimation methods, financial models, market data and other evidence, that was not considered as part of the development of the Rate of Return Guidelines.[216]

252. Specifically, based on CEG's advice, DBP contended in its initial proposal that both the Black CAPM and the Fama-French three-factor model (**FFM**) are relevant, in addition to the SL-CAPM, and as such, should be considered relevant for the purpose of estimating the return on equity for DBNGP.[217] An evaluation of CEG's views was undertaken for the Draft Decision.[218] As a result, the Authority agreed with DBP's inference that the Sharpe Lintner CAPM and Black CAPM are relevant models for estimating the return on equity.[219]

253. However, with regard to the Black CAPM, the Authority did not accept DBP's proposal to use it directly for estimating the return on equity. The Authority concluded that DBP's proposed betastar method has significant empirical flaws:

- the zero beta portfolio is sensitive to the data set used, highly variable through time with a wide standard error, and is therefore not robust;[220]
  - DBP's estimates – which use a single average estimate of zero beta premium – disguise the significant instability of the Black CAPM model;
  - DBP's model adequacy test is selective in its interpretation of the Black CAPM model;
- the betastar approach does not produce sensible results;[221]
  - the indicative overall market return on equity for a long period, estimated at the time of the Draft Decision, was approximately 10.83 per cent,[222] which is lower than DBP's estimated return for low asset beta entities such as the DBP;
  - DBP is therefore suggesting that its return on equity is more risky than the market as a whole;

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216 Economic Regulation Authority, Draft Decision on Proposed Revisions to the Access Arrangement for the Dampier to Bunbury Natural Gas Pipeline, 22 December 2016, Appendix 4, p. 40.

217 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 12, 31 December 2015, p. iv.

218 Economic Regulation Authority, Draft Decision on Proposed Revisions to the Access Arrangement for the Dampier to Bunbury Natural Gas Pipeline, 22 December 2016, Appendix 4A.

219 The Authority did not agree that the FFM is relevant in the Australian context, and hence considered that it should play no role in estimating a return on equity for DBP. This decision was based on the following considerations (Economic Regulation Authority, *Draft Decision on Proposed Revisions to the Access Arrangement for the Dampier to Bunbury Natural Gas Pipeline*, 22 December 2016, Appendix 4A, p. 170):

- the FFM was not developed on a theoretical basis;
- new factors that are now included in the new Fama French five factor model raise questions about the validity of the FFM three factor model;
- the estimates from the FFM factor model vary significantly and produce mixed results; and
- the FFM is not used by economic regulators either in Australia or overseas to estimate the expected return on equity.

Given that DBP does not rely on the results of the FFM for its proposal, it is not considered further.

220 Economic Regulation Authority, Draft Decision on Proposed Revisions to the Access Arrangement for the Dampier to Bunbury Natural Gas Pipeline, 22 December 2016, Appendix 4, p. 45.

221 Economic Regulation Authority, Draft Decision on Proposed Revisions to the Access Arrangement for the Dampier to Bunbury Natural Gas Pipeline, 22 December 2016, Appendix 4, p. 45.

222 Economic Regulatory Authority, Final Decision on Proposed Revisions to the Access Arrangement for the Mid-West and South-West Gas Distribution Systems, as amended 10 September 2015, p. 255.

- but this is not sensible on conceptual grounds.

254. Furthermore, the Authority did not accept DBP's model adequacy test, because:[223]

- relying on the historical data alone – as DBP does – for testing the relative adequacy of the Authority's approach, is erroneous;
- other forward looking information needs to be taken into account, as the Authority does in its approach to estimating the return on equity;
- it follows that DBP's model adequacy approach does not actually test the Authority's approach in using the SL-CAPM for estimating the return on equity;
- DBP in essence compares two models that are not robust in the Australian context (the Black CAPM and FFM) with another method that is not relied on either – an ex post SL-CAPM with an MRP that is based on historic data only.

255. The Authority therefore rejected DBP's proposal on conceptual and empirical grounds.

DBP's response to the draft decision

256. In response to the Draft Decision, DBP maintains the same approach to determining the return on equity as in its initial proposal – that is, DBP applies its 'model adequacy test' to determine the relevance of models for the return on equity.

257. Specifically, DBP tests the outputs of three models – the SL-CAPM, FFM and Black CAPM – in terms of their ability to predict actual (ex post) market outcomes.[224] DBP considers that a model utilising the prior historic data as input which, statistically, is shown not to be reliable (that is, 'biased') in predicting actual realised outcomes to the model, is unlikely to be appropriate as a relevant model for estimating the benchmark return on equity.[225] As a result, DBP concludes that only the outcomes of the Black CAPM – over a specific confidence interval for the zero beta premium (the 25th to 99th percentile confidence interval) – provide for unbiased estimates of the return on equity (whereas the results from the other two models are considered to be biased and hence poor forecast predictors).[226] DBP contends that only these Black CAPM estimates neither systematically overstate nor understate actual returns to equity.[227]

258. DBP then transforms the two percentile Black CAPM outcomes into 'betastar' estimates, for use in the SL-CAPM, as a means to estimate an unbiased range for the return on equity. DBP maintains that each betastar estimate delivers the same return on equity, in the SL-CAPM, as the equivalent Black CAPM result. DBP contends that this transformation allows the Black CAPM results to be

223 Economic Regulation Authority, Draft Decision on Proposed Revisions to the Access Arrangement for the Dampier to Bunbury Natural Gas Pipeline, 22 December 2016, Appendix 4, p. 42.

224 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 8.

225 DBP, Proposed Revisions DBNGP Access Arrangement, 2016 – 2020 Regulatory Period, Rate of Return, Supporting Submission: 12, 31 December 2014, p. 49.

226 The zero beta premium is given by the difference between the zero beta return and the risk free rate.

227 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. ii.

operationalised within the SL-CAPM framework, thereby 'following the Authority's Rate of Return Guidelines wherever possible'.[228]

259. DBP subsequently narrows the return on equity range using the so-called 'Merton framework' cross check method, before choosing the mid-point as the resulting return on equity.

260. Consequently, the core of DBP's proposal relates to the model adequacy test, the associated inference that only the Black CAPM leads to unbiased results for the return on equity, and the use of the betastar transformation so as to implement the results of the Black CAPM within the framework of the SL-CAPM. DBP's claims with regard to the Merton framework cross check method are also key to its estimate.

261. The Authority considers these four elements of DBP's response in turn regarding the return on equity in what follows.

Further evaluation of DBP's model adequacy test and application of betastar

262. The Authority has significant concerns – both conceptual and empirical – with DBP's model adequacy test and betastar transformation. The following two sections set out the Authority's reasoning regarding DBP's proposed approach from these conceptual and empirical perspectives.

Conceptual elements

263. The Authority considers that DBP's model adequacy test is not well founded in conceptual terms.

Ex ante expected returns versus ex post outcomes

264. First, and perhaps most fundamentally, the purpose of using asset pricing models for this regulatory decision is to ensure that the allowed rate of return objective and the other requirements of NGR 87 are met. The return on equity needs to be commensurate with the efficient financing costs of the benchmark efficient entity, allowing for the degree of risk involved.[229] Importantly, regard must be had to prevailing conditions in the market for equity funds,[230] which implies that the return on equity must reflect the return investors require – at the current time – to invest in the asset over the regulatory period.

265. When equity prices are in equilibrium in the market, this required return is equal to the expected return. However, crucially, there is no guarantee that expectations will be realised, or that prices are always in equilibrium.[231] If there were a guarantee

[228] DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 4.

[229] NGR 87(3).

[230] NGR 87(7).

[231] Partington, G. and Satchell, S., Report to the ERA: The Cost of Equity and Asset Pricing Models, May 2016, p. 6.

that expectations would be realised then the asset would have no risk.[232] This view is well expressed by Davis:[233]

> The required returns are also referred to as expected returns by financial economists by relying on an assumption that asset prices equilibrate in efficient markets through supply and demand influences. If, given the current price of an asset, investors' expectations about future cash flows or future market value of that asset imply an expected return different to their required return, they will buy or sell that asset causing its price to adjust until it equates expected and required returns. Thus, the theories are simultaneously theories of equilibrium asset prices and *required* and *expected* returns. The theories do not purport to fully explain actual returns, since these can differ from expected returns due to a variety of factors including news about future cash flows which cause investors to reassess the appropriate price of an asset. If actual returns are a poor proxy for expected returns, the ability of a theory of *expected* returns to explain *actual* returns may be limited.

266. Partington and Satchell are of the view that:[234]

> Asset pricing models are about equilibrium pricing. They are not forecasting models and to try and convert equilibrium pricing to a forecasting problem simply muddies the waters.

267. It follows that this conceptual difference between expectations and outcomes is a major problem for ex post tests of asset pricing models, such as that proposed by DBP.[235] Rational investors do not take on the additional risk of equity expecting it to deliver less than less risky debt, yet this has been an actual outcome in the market over recent times. DBP is not actually testing the return on equity models against investors' *expectations* for the return, ex ante, as it needs to do in order to determine whether the outputs of the asset pricing models are biased. Rather, it is testing those models against *actual outcomes, realised ex post*. DBP has not recognised this distinction, which constitutes an error.

Model testing issues

268. Irrespective of the correctness of the actual model adequacy test conducted by DBP – and the Authority considers that DBP is conducting an erroneous test - the test outcomes will be strongly influenced by the actual construct of the test itself. Partington and Satchell note:[236]

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232 Partington, G. and Satchell, S., Report to the ERA: The Cost of Equity and Asset Pricing Models, May 2016, p. 7.

233 K. Davis, Davis, Cost of Equity Issues: A Report for the AER, January 2011, p. 3.

234 Partington, G. and Satchell, S., Report to the ERA: Comments on statistical reports by Pink Lake, May 2016, p. 4.

235 The Authority notes that DBP, in their defence that the Black CAPM produces sensible results for 'portfolio 9' (see paragraphs 375 to 382 below) recognises exactly this (DBP, *Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56*, 24 February 2016, p. 46):

> Finally, the ERA suggests that it is somehow impossible for the return on equity to be less than the return on debt. However, this is not true. Firstly, as the Economist, points out, equity returns can be negative for long periods of time
>
> The same article points to the work shown in the left hand side of Figure 4, suggesting that bonds have actually out-performed equities over recent periods of time, and Dimson, Marsh & Staunton (2015) show similar evidence in the figure on the right hand side of Figure 4. Finally, Bloomberg, tracking returns on debt and equities over successive 30-year windows note that, in the 30 years to 2011, debt in fact did better than equities in the US.

236 Partington, G. and Satchell, S., Report to the ERA: The Cost of Equity and Asset Pricing Models, May 2016, p. 7.

> When the equity market has negative returns, low beta stocks are expected to perform better than high beta stocks. Thus, ex-post a negative relation between beta and returns would be expected and vice versa when the equity market has positive returns. Indeed Isakov (1999) argues that tests of the CAPM should be conditioned on the sign of the excess return on the market and shows that when this is done beta is a highly significant predictor of returns with the signs of the coefficient as expected, positive when the excess return is positive and negative when the excess return is negative. Whereas, when there is no conditioning on the sign of the excess return on the market there is no relation between beta and expected returns. We are not arguing that conditioning on the sign of the excess return provides a good test of the CAPM,[237] but merely that differences between expected and realised returns are a problem when testing asset pricing models.

269. Findings from academic papers such as Lewellen, Nagel and Shanken (2010), and Kan Robotti and Shanken (2013) illustrate that the results of asset pricing tests using realised returns vary substantially according to how the portfolios used in the tests are constructed and also on the restrictions placed on the estimate of the intercept.[238] They also illustrate that there is ongoing debate about the appropriate statistical tests that should be used in assessing the performance of asset pricing models.

270. In this context, the Authority notes that DBP's focus is on beta bias, so its main findings are based on portfolios which are sorted based on beta. DBP's results in this case tend to support the Black CAPM. However, the same approach, when sorted by industry does not produce the same outcomes.[239] This raises further doubts about the robustness of the DBP model adequacy method. The Authority considers this issue of the industry sort method further below, as it bears on the issue of whether any adjustment to the 'vanilla CAPM' is required at all.

Alternative methods A, B and C of model testing

271. Two zero beta estimation methods, A and B, were used by DBP in its initial proposal in the model adequacy test, as a means to compute the bias of forecasts based on time varying betas. Each of these model adequacy test methods compares the model forecast for time t, based on information available at time t-1. This is the so-called conditional CAPM.

272. Empirical estimates of forecast returns utilising the SL CAPM and the Black CAPM are then compared with actual returns. This comparison is used as a test of bias. As noted above, asset pricing models are not forecasting models, raising immediate questions about the exercise DBP undertakes.

273. Method A utilises an ex-ante estimate of the MRP, based on a mechanistic application of the Ibbotson method for determining the forward looking MRP. Method B sets the time varying excess return on the market (that is, the MRP) equal to its actual (ex post) value.

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237 The results are conditioned on ex-post information and had investors known this information they would have had different expectations and they would have set different prices. As a result the returns would differ from those observed.

238 Partington, G. and Satchell, S., Report to the ERA: The Cost of Equity and Asset Pricing Models, May 2016, p. 8.

239 DBP, Proposed Revisions DBNGP Access Arrangement, 2016 – 2020 Regulatory Period, Rate of Return, Supporting Submission: 12, 31 December 2014, Appendix D, p. 14.

274. In the case of DBP's 'method A' test, the use of a fixed Ibbotson-style historic estimate of the MRP of 6.5 per cent bears little resemblance to the Authority's method.[240] The Authority notes that DBP acknowledges that the Authority's method for determining the MRP, and hence the return on equity, cannot be implemented in the DBP model adequacy test method 'for lack of data'.[241] As set out below (see step 2 – 'Estimate of the MRP'), the Authority exercises its judgment to determine the MRP within a wide range, depending on economic conditions at the time of the decision. That range at the current time is 5.4 to 8.8 per cent.

275. DBP, in response to the foregoing criticism in the Draft Decision that it is not testing the Authority's approach,[242] added a Method C to its model adequacy test. Method C compares an estimate of the SL-CAPM, but this time based on a further mechanistic rule for the MRP, determined using the Wright method. DBP contends:[243]

> Method C assumes in the first instance that the upper bound for the MRP is that determined by the Wright method.[56] However, since the DGM result is currently around ten percent higher than that for the Wright method and since the Wright method result might not always be particularly high (we have no way of knowing what the ERA would do under these, or indeed any circumstances other than those at the ATCO Final Decision), we also allow variants of Method C whereby the MRP is five, ten, 15 and 20 percent higher than the estimate formed by the Wright CAPM. This gives rise to five variants of Method C…
>
> In all cases, the version of the SL-CAPM using an MRP formed via Method C fails to pass the model adequacy test. That is, even adopting the ERA's new approach to MRP and testing that approach using the most reasonable assumptions available, the conclusions from our Original AA Proposal remain. To the extent that the ERA chooses an MRP lower than the upper bound(s) specified in Method C, and to the extent that it would have done so for each past observation, since the result in Table 10 above is that Method C is biased downwards, the only reasonable conclusion is that the ERA's actual approach would have delivered a result which is more biased downwards. This ought not be particularly surprising; if the ERA could not get an unbiased answer with its version of the SL-CAPM using a perfect forecast of the MRP (Method B) it seems unlikely that it could do so when the forecast is imperfect (Method C).

276. However, as previously discussed, the point estimate of the forward looking MRP in the Authority's decision involves a large degree of regulatory judgment as to the five year *forward looking* expectation for the MRP at the point in time of the regulatory decision, whereas the adopted MRP in DBP's method C is a mechanistic fixed

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240 DBP, Proposed Revisions DBNGP Access Arrangement, 2016 – 2020 Regulatory Period, Rate of Return, Supporting Submission: 12, 31 December 2014, p. 80.

241 That mechanistic method adopted by DBP is in contrasts to the Authority's actual method for determining the MRP. Specifically, DBP state with regard to method A that it uses a (DBNGP Transmission Pty Ltd, *Proposed Revisions DBNGP Access Arrangement 2016 – 2020, Rate of Return - Supporting Submission: 12*, 31 December 2015, p. 61):

> …market risk premium that is a long-run historical average. This is almost exactly how regulators make predictions for rates of return through the next access period; by using an estimate of beta formed on past data, the current risk-free rate, and a forecast of the market risk premium. In the ATCO Draft Decision, the ERA changed the way it forms its estimate of the MRP, but as discussed below, this new approach does not appear to be very robust, and in any case **cannot be implemented back into history for lack of data**. Thus, we use the long-run historical average for the MRP that has been widely used by regulators in Australia in the past. [Authority's emphasis]

242 Economic Regulation Authority, Draft Decision on Proposed Revisions to the Access Arrangement for the Dampier to Bunbury Natural Gas Pipeline, 22 December 2016, Appendix 4, p. 211.

243 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 39.

ex-post outcome for the month ahead. DBP's Method C of its model adequacy test therefore does not test the Authority's implementation of the SL-CAPM.

277. Finally, Partington and Satchell query why Method B is adopted by DBP. As a test of expected returns in equilibrium, Method B suffers from the use of ex-post information in the setting of the MRP for the SL-CAPM input. This is contrary to standard tests of asset pricing models, which are generally careful to only use information available ex-ante.[244] Furthermore, Method B assumes perfect foresight with respect to the realised excess return on the market. But if investors could correctly forecast time varying excess returns on the market, then their behaviour would have been different. They would, for example, have avoided equity when the excess returns were forecast to be negative. In short, equilibrium prices and hence actual returns would have been quite different from those actually observed. Method B is therefore spurious.

278. The Authority concludes therefore that there are significant issues with the construct of DBP's model adequacy test. No method tests the Authority's actual implementation of the SL-CAPM. All methods seek, erroneously, to compare expected returns with ex-post actual returns.

Bias or anomaly?

279. DBP's model adequacy test is intended to uncover 'bias' in the performance of the SL-CAPM. DBP then makes an adjustment to the beta in the SL-CAPM, as a means to counter the perceived bias. That 'betastar' adjustment is based on the Black CAPM, and is of the form: [245]

$$\beta_{jt}^{*} = \left(1 - \frac{\hat{z}_{0t}}{\hat{z}_{mt}}\right)\hat{\beta}_{jt} + \frac{\hat{z}_{0t}}{\hat{z}_{mt}} \qquad (2)$$

where:

- z_{0t} is an estimate of the zero-beta premium computed using data from before month t;
- z_{mt} is an estimate of the market risk premium computed using data from before month t; and
- β_{jt} is an estimate of the beta of portfolio j computed using data from before month t

280. However, it is not the beta in the SL-CAPM that is biased. As noted by Pink Lake in its evaluation of the statistical properties of the SL-CAPM and the Black CAPM:[246]

> Upon review it is clear that the positions of the ERA and DBP are divergent. The Authority derives an RoE calculation from the Henry[247] statistical version of the Sharpe-Lintner Capital Asset Pricing Model (SL CAPM). The statistical model itself is

244 Partington, G. and Satchell, S., Report to the ERA: The Cost of Equity and Asset Pricing Models, May 2016, p. 20.

245 DBP, Proposed Revisions DBNGP Access Arrangement, 2016 – 2020 Regulatory Period, Rate of Return, Supporting Submission: 12, 31 December 2014, p. 68.

246 Pink Lake Analytics, Statistical Advice to ERA on DBP Submission 56, May 2016, p. 4.

247 Henry, O.T., Estimating β: An update, April 2014.

> valid – in predicting the data it minimises the squared error difference between observations and model predictions. Furthermore, the model includes a free intercept term in excess of the risk-free rate (α), so for its class of models (i.e., linear models with a single predictor) it provides an unbiased estimate of β, the measure of an asset's exposure to systematic risk in the market. The ERA then omits the α estimate of abnormal returns from the Henry model in its implementation of the Sharpe-Lintner CAPM, deeming these abnormal returns as not reflective of the systematic risk in market prices that is faced by benchmark efficient firms…
>
> In contrast, DBP implements the Black CAPM model by first estimating a zero-beta premium (ZBP). Effectively, this ZBP estimate is a measure of the abnormal returns in excess of the risk-free rate. As such, although the Black CAPM is marginally biased in terms of its predictions (as it does not include a free intercept term) this bias is statistically insignificant. Where DBP and the Authority differ in their positions is that DBP include the full weight of the ZBP, as a de facto measure of abnormal returns in their RoE calculation…

281. Pink Lake has set out very clearly the mathematical underpinnings of the two modelling approaches, so these are not reproduced here.[248] Pink Lake's evaluation confirms that the Authority's estimate of the SL-CAPM beta is not biased. However, by loading the betastar adjustment into the SL-CAPM beta, DBP biases the estimate of beta in its estimate. At the same time, in so doing, DBP imports all of the deficiencies of its Black CAPM into the resulting SL-CAPM estimate.

282. It is clear that DBP is mistakenly comparing one form of model (a model of ex-post actual returns – the Black CAPM with a full intercept term, where the zero beta return captures all ex-post anomalies) with another form of model (a model of ex-ante expected returns – the SL-CAPM with no α intercept included). As Partington and Satchell observe:[249]

> We need to be clear what unbiased means. If it means that the DBP Black CAPM estimates, when subject to a model adequacy test as proposed by DBP, are such that the model adequacy test is not rejected, then they are generally unbiased, at least with respect to the beta sorted portfolios.
>
> However, this view of unbiasedness then gets translated into a view that the regulator who uses the SL CAPM is providing investors with approximately 4% per annum less compensation. This treats low beta ex-post returns as equilibrium returns. Here and elsewhere in the document we take the view that the [SL-CAPM] low beta anomaly is indeed an anomaly. The correct regulatory return would be more sensibly based on subtracting the intercept term from [ex post SL-CAPM] returns, not adjusting the slope and certainly not treating the Black CAPM (unbiased) returns as fair compensation. The more so since the SL CAPM industry portfolios also pass the unbiasedness test.

283. It follows that if there is any 'bias' arising in the Authority's estimate, that bias occurs with the Authority's omission of the α intercept term from its statistical estimation process. DBP in essence agrees with this point.[250]

> …the only theoretical difference between the SL-CAPM and the Black CAPM lies not in beta, but on the intercept... The practical effect of this theoretical change is to shift the intercept of the security market line upwards, and thus lessen its slope. This, in turn, makes the expected returns of low beta stocks higher and of high beta stocks lower than predicted by the SL-CAPM.

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248 Pink Lake Analytics, Statistical Advice to ERA on DBP Submission 56, May 2016, p. 4.

249 Partington, G. and Satchell, S., Report to the ERA: The Cost of Equity and Asset Pricing Models, May 2016, p. 34.

250 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 51.

> This is important when considering the bias adjustments made by the ERA and DBP (through its betastar model). The ERA, motivating the "theory" of the Black CAPM, changes beta, using a higher level of beta than the mean value it obtains from its own regressions. However, the theoretical change from the SL-CAPM to the Black CAPM has nothing whatsoever with beta, it is a shift of the intercept.

284. Pink Lake also recognises that the 'low beta bias' issue relates to the interpretation of the intercept in the SL-CAPM estimation process. Pink Lake points out that this makes the whole model adequacy exercise redundant, in so far as it is testing for beta bias:[251]

> For the Authority, the statistical model employed is already an optimally fitting model under reasonable model assumptions. Hence, there is no reason to undertake further the model validation proposed by DBP when adopting the Authority's position. In contrast, DBP propose to apply the model validation to the RoE calculation itself. As the DBP RoE calculation is essentially the same as their statistical model, then it is self-evident that their RoE calculation does not exhibit significant model bias. Similarly, it is self-evident that the Authority's RoE calculation does exhibit model bias, as it deliberately excludes the abnormal return component estimated in the Henry model in excess of the risk-free rate. Both the Henry model and the Black CAPM are valid, depending on the position being adopted. The question of which position to accept - either the Authority's or DBP's - is therefore not a statistical question, but a question of economics, and one that falls outside the scope and expertise of this consultancy.

285. Consequently, the Authority now recognises that there is no justification for changing the value of beta in the SL-CAPM. The further implication is clear: DBP, by adjusting beta, is introducing a highly significant bias into the beta estimate in its implementation of the SL-CAPM. The Authority considers DBP's approach to be in error on this ground.

The case for an alpha adjustment

286. Having examined the implications of DBP's arguments with regard to the bias in the SL-CAPM, and rejected the case for any adjustment to beta in the SL-CAPM, the Authority now turns to consider whether there is any case to adjust for α in the estimates derived from the model tests.

287. The Authority considers that there is little compelling evidence about the degree to which the α intercept term, or even part of it, should be included.

288. A positive intercept in tests of the SL-CAPM does not automatically imply that the Black CAPM applies. Positive intercepts (α) in ex-post outcomes are not automatically estimates of a zero beta premium.[252]

289. The theory of the SL-CAPM does not include the α term. Rather, the presence of positive (or indeed, a negative value of) α relates to differences (so-called 'anomalies') between the *required* (or expected or equilibrium) returns and *realised* returns.[253] The Authority seeks to ensure that investors in the benchmark efficient

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251 Pink Lake Analytics, Statistical Advice to ERA on DBP Submission 56, May 2016, p. 4.

252 Partington, G. and Satchell, S., Report to the ERA: The Cost of Equity and Asset Pricing Models, May 2016, p. 17.

253 Refer paragraph 265 for the links between required, expected and equilibrium returns.

entity obtain the required return, consistent with NGR 87 (see paragraph 264). As Partington and Satchell observe:[254]

> When prices are in equilibrium this required return is equal to the expected return, but there is no guarantee that expectations will be realised, or that prices are always in equilibrium. If there were a guarantee that expectations would be realised then the asset would have no risk.

290. Consistent with that view, the α intercept in *observed* returns should be subtracted in its entirety, in order to establish the required forward looking equilibrium returns:[255]

> This usual argument for the Black CAPM is based on the premise that actual returns are equal to equilibrium returns on average and thus a positive intercept in tests of the SL CAPM are assumed to be driven by the SL CAPM underestimating (overestimating) realised returns for low (high) beta stocks. An alternative premise is that the results are a consequence of actual returns outperforming (underperforming) equilibrium returns for low (high) beta stocks. In the parlance of funds management such outperformance is expressed as alpha. Thus low beta stocks have positive alphas. In this case an estimate of the equilibrium return is obtained by subtracting alpha from the actual return. Whether the resulting return is then higher or lower than the regulated return is an open question and will depend upon the magnitude of alpha.

291. For similar reasons, this subtraction of the intercept term was employed by Henry, in estimating beta, and indeed the same subtraction is adopted by the Authority in its updated estimates of beta for input to the SL-CAPM.[256] That is, the intercept in excess of the risk free rate is ignored, forcing the SL-CAPM security market line through the origin, consistent with the theory of the SL-CAPM.

292. The Authority considers that there is no justification to 'add back in' any alpha from the observed returns to the SL-CAPM, where those are simply differences, ex-post, as compared to the ex-ante required returns.

293. At the same time, the Authority is not convinced there is any empirical evidence at the current time to justify an adjustment to the SL-CAPM for *expected* alpha for the benchmark efficient entity. As noted above at paragraph 265, theory suggests that if such an expectation was widespread among investors, it would be bid away as part of a movement toward equilibrium asset pricing.

294. To examine this, the Authority turns to DBP's own model adequacy test results (even though, for the reasons stated above, the Authority does not consider the model adequacy approach a valid rationale for rejecting the SL-CAPM). DBP's own estimates indicate that, based on industry sorts, the model adequacy tests conducted by DBP tends to support the SL-CAPM. DBP tests two versions of the SL-CAPM – a vanilla version and an 'ERA' version, where it takes the 95th percentile

254 Partington, G. and Satchell, S., Report to the ERA: The Cost of Equity and Asset Pricing Models, May 2016, p. 7

255 Partington, G. and Satchell, S., Report to the ERA: The Cost of Equity and Asset Pricing Models, May 2016, p. 15.

256 It is noted that the alphas in tests of the SL-CAPM, based on beta portfolio sorts, are not identical to the intercept term identified in the Henry-style beta estimation process. Nevertheless, they originate from the same source – that is, from anomalous returns observed in the ex post outcomes.

beta of beta for each industry – in two tables in Appendix D of its initial proposal.[257] As noted by Partington and Satchell:[258]

> Tables 7 and 8 from DBP [2015]… provide statistics for the mean forecast error for the SL CAPM by industry. The description in DBP's text says that the results of the ERA's version of the SL CAPM are in Table 8, whereas according to the title on Table 7 it gives the ERA's version of the SL CAPM. We think the latter is correct, but fortunately, the labelling is of no real consequence as there is relatively little difference in the nature of the results between the two tables.
>
> The results in Tables 7 and 8 generally are supportive of the SL CAPM. Across the 104 tests in the two tables significant bias is only observed with respect to 3 industries. These are retailing, pharmaceuticals and utilities, which provide six results significant at the 5% level. With the exception of retailing, these results are only significant for Method B. In short there is very little evidence of significant bias and the number of significant results is approximately the number expected by chance. With a type 1 error of 5% we would expect 5.2 of the 104 hypotheses to be rejected even if the null is true. Thus finding only 6 rejections suggests to us that the SL CAPM is supported by these testing procedures.

295. The Authority agrees with Partington and Satchell that the evidence in these tables is supportive of the SL-CAPM. This is particularly the case for method A, which is the more relevant test (method B does not test any form of expected return, as noted above). DBP dismisses this, on the basis that the industry tests are of low power. However, it is notable that DBP's argument relates to the – in the Authority's view – discredited method B:[259]

> The low power of the tests is illustrated by the fact that a Method B test of the null hypothesis that the ERA's version of the SL-CAPM provides an unbiased estimator of the return required on a portfolio of utilities is unable to reject at the five percent level the null despite the mean forecast error associated with the estimator being 0.557 percent per month.

296. The Authority therefore is not convinced that there is strong evidence from DBP's analysis to reject the standard theoretical form of the SL-CAPM.

297. The Authority now considers, given these insights, that there is inadequate evidence, at this time, to justify departure from an ex-ante alpha estimate of zero in its implementation of the SL-CAPM:

- a positive intercept in tests of the SL-CAPM does not automatically imply that the Black CAPM applies;
- the theory of the SL-CAPM does not include the α term; rather, the presence of positive (or indeed, a negative value of) α relates to anomalies; and
- DBP's own estimates indicate that, based on industry sorts, the model adequacy tests conducted by DBP tend to support the SL-CAPM.

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257 DBP explain this as follows (DBP, Proposed Revisions DBNGP Access Arrangement, 2016 – 2020 Regulatory Period, Rate of Return, Supporting Submission: 12, 31 December 2014, Appendix D, p. 14):

> The results of tests of the SL-CAPM that use industry returns appear in Table 7 below while the results of tests of the ERA's version of the SL-CAPM, which uses the 95th percentile of an estimate of the distribution of an OLS estimator for beta rather than an estimate of the mean of the distribution (the OLS point estimate), appear in Table 8.

258 Partington, G. and Satchell, S., Report to the ERA: The Cost of Equity and Asset Pricing Models, May 2016, p. 21.

259 DBP, Proposed Revisions DBNGP Access Arrangement, 2016 – 2020 Regulatory Period, Rate of Return, Supporting Submission: 12, 31 December 2014, Appendix D, p. 14.

298. On this basis, the resulting implementation of the SL-CAPM becomes consistent with the theoretical form of the SL-CAPM: ex-ante, the SL-CAPM security market line is expected to pass through the zero intercept on the y axis. If positive alpha was expected ex-ante, prices would be expected to adjust to restore equilibrium and an expectation of zero alpha (refer to paragraph 265 above for this rationale).

299. The corollary is that while the theoretical insights of the Black CAPM are relevant – for example, for informing the theoretical position of the efficient market portfolio on the frontier in mean variance space in the absence of a riskless asset – the thorough exploration of this issue by the Authority identifies that the empirical estimate of the zero beta return, adopted by DBP, contains a large measure of anomalous alpha, and hence overestimates the required return. It is therefore not fit for purpose for estimating the return on equity for the benchmark efficient entity.

Relative acceptability of the SL-CAPM and the Black CAPM

300. Related to these conceptual issues, the Authority notes that the SL-CAPM remains widely used and accepted, whereas the Black CAPM is not.

301. With regard to the SL-CAPM, the Authority notes that the 2013 KPMG Valuation Practices Survey found that 82 per cent of respondents used the CAPM, observing that it 'is the most popular model being used to derive a cost of equity estimate, with all participants always or sometimes using this model'.[260]

302. Consistent with this, the Authority notes that Grant Samuel, a highly respected market valuation house, has stated that:[261]

> The CAPM is probably the most widely accepted and used methodology for determining the cost of equity capital. There are more sophisticated multivariate models which utilise additional risk factors but these models have not achieved any significant degree of usage or acceptance in practice.

303. Partington and Satchell provide a strong rationale for this:[262]

> …the CAPM has passed an important test. That test is the test of time. While academics are still debating the merits of the different asset pricing models, how they should be tested and what the appropriate test statistics are, the users of models have made up their mind about which model to use when estimating the cost of capital. The SLCAPM has had several decades of widespread practical use in estimating the cost of capital. None of the other models have passed the same test.

and:[263]

> … an advantage of the SLCAPM is that it is a parsimonious model. The required input is confined to one variable and two parameters, one of which is taken to be the return on government debt and so is directly observable. Parsimony and observability reduces opportunities for cherry picking and also provides the opportunity for a relatively transparent implementation of the model.

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260 KPMG, Valuation Practices Survey 2013, p. 7.

261 Grant Samuel, Envestra: Financial Services Guide and Independent Expert's Report, 3 March 2014, Appendix 3, p. 1.

262 G. Partington. and S. Satchell, Report to the AER: Analysis of criticisms of 2015 determinations, October 2015.

263 Partington, G. and Satchell, S., Report to the ERA: The Cost of Equity and Asset Pricing Models, May 2016, p. 10.

304. Professor Handley has noted: [264]

> …the Sharpe-CAPM is the standard (equilibrium) asset pricing model. It has a long established and well understood theoretical foundation and is a transparent representation of one of the most fundamental paradigms of finance – the risk-return trade off.

305. The Authority agrees with these views on the SL-CAPM.

306. On the other hand, reflecting the shortcomings articulated above, the Black CAPM is not widely adopted by academics or practitioners in Australia or overseas for estimating a return on equity. Professor Stephen Satchell, based on personal experience, notes that the Black CAPM has no track record of use in practice in the financial industry and that it is a model that is never likely to have significant use in practice:[265,266]

> Considering the use of the Black CAPM in practice, one of the authors of this report has been a quantitative consultant for over 25 years and has advised many scores of top level 'quant' teams in the finance industry. Whilst he has seen applications of the SL CAPM and variants of the Fama French model on many occasions, he has never seen a single application of the Black CAPM. The other author has been researching and consulting on topics relating to corporate finance, including valuation, the cost of capital and capital budgeting for more than 25 years. In particular he has surveyed companies on their capital budgeting practices and how they determine their cost of capital and he has read many capital budgeting surveys and surveys of valuation practice. In all this material there has never been any evidence that corporates estimating their cost of capital, or financial experts doing valuations, have used the Black CAPM. Neither, in the many submissions from regulated businesses and their consultants that we have read over the years, have we seen any convincing evidence of use of the Black CAPM in business…
>
> We would make the same comment about the CEG (2016a) claims for use of the Black CAPM in practice. However, we do agree that some regulators in the USA have used the Black CAPM. One interpretation of this phenomenon is that the regulated businesses have realised that applications of the Black CAPM can lead to higher regulatory returns and have bombarded regulators with the model to the point that the regulators have (mistakenly) come to attach some importance to it.

307. The Authority is not convinced that the Black CAPM is an acceptable model for the return on equity, given:

- the empirical implementation of the Black CAPM is not robust because, in contrast to the risk-free rate, the expected return on the zero beta asset is unobservable and there is no apparent consensus on methods for estimating this return – Pink Lake in its report for the Authority highlights the widely varying outcomes resulting for the zero beta premium (**ZBP** from here on) from the handful of implementation attempts in Australia – the lack of consensus on methodological choices increases the sensitivity of the model to specification, reducing the reliability of the model and increasing the potential for bias:[267]

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264 Handley, Advice on return on equity, 16 October 2014, p. 4.

265 Partington, G. and Satchell, S., Report to the ERA: The Cost of Equity and Asset Pricing Models, May 2016, p. 12.

266 Partington and Satchell agree that some regulators in the USA have used the Black CAPM. However, they argued that the regulated businesses have realised that applications of the Black CAPM can lead to higher regulatory returns and have 'bombarded' regulators with the model to the point that the regulators have (mistakenly) come to attach some importance to it.

267 Pink Lake Analytics, Statistical Advice to ERA on DBP Submission 56, May 2016, p. 5.

> Throughout the DBP Submission the ZBP estimate provided is treated as a fixed value within the Black CAPM model. However, the ZBP estimate is perhaps the term in the Black CAPM that is most subject to uncertainty. Yet DBP ignore that uncertainty. There is evidence that the ZBP estimate can differ significantly both between time periods when estimated by the same practitioner, the same practitioner can put forward multiple methods of estimating the ZBP, and different practitioners apply different methods, and consequently the ZBP estimate can vary widely. Moreover, an incorrectly specified ZBP estimate can have significant financial consequences given the high sensitivity of the RoE calculation to the inclusion of abnormal returns, and indeed the calculated compensation to be paid for borrowing and transaction costs.

- implementation of the Black CAPM – which relies on an average zero beta return estimated over more than 20 years of data – typically results in estimates of the zero beta return, and the imputed ZBP, being less reflective of prevailing market conditions than the risk free rate estimates utilized in the SL-CAPM;
- there is little evidence that other regulators, academics or market practitioners use the Black CAPM to estimate the return on equity;[268]
  - regulators rarely have recourse to the Black CAPM;[269]
  - this view was supported by Handley, who summarises a number of salient points about problems with the Black CAPM with regard to the NERA (and by extension HoustonKemp/DBP) implementation:[270]

> The Black CAPM is not widely adopted in practice - there is one very good reason for this. The theoretical prediction which distinguishes the Black-CAPM from the Sharpe-Lintner CAPM is that the (shadow) risk free interest rate - more commonly called the zero beta rate - is unspecified except to say that it must be less than the expected return on the market portfolio. In the partially-restricted version of the model, the zero beta rate must also be above the risk free rate. From a practical point of view, this is not very useful due to the wide range of possible values that the zero beta rate may take on. The Black CAPM therefore presents the non-trivial task of having to estimate the expected zero beta rate which the theory says could be anywhere in a very wide range as well as having to estimate an expected market risk premium relative to the expected zero beta rate.[271]
>
> Two brief comments on two related items from the NERA (2014) report. First, NERA acknowledge that their finding that the zero beta premium is equal to the MRP appears implausible but they argue that this simply suggests that there is no relationship between beta and return.[272] Nonetheless a potentially unsettling implication is that there is a minimum variance portfolio that has no exposure to the risk of the market but is still expected to yield the same return as the market portfolio.[273] The plausibility of such a portfolio would largely depend on the level of risk of

[268] The AER considered this issue in depth – see the 'use in practice' subsection in section A.3.3 of Attachment 3 to the AER's preliminary decision for AusNet Services.

[269] A recent study examined regulatory practices in 21 countries and did not point to any uses of the Black CAPM (see Schaeffler, S., and Weber, C., 'The cost of equity of network operators - empirical evidence and regulatory practice', *Competition and Regulation in network industries*, Vol. 14(2), 2013, p. 386).

[270] J. Handley, *Advice on return on equity*, 16 October 2014, p. 12.

[271] [Handley's footnote] Consistency would demand that historic estimates of the market risk premium relative to the risk free rate be adjusted to reflect the time series of historic zero beta rates.

[272] NERA, Return on Capital of a Regulated Electricity Network: A Report for Ashurst, May 2014, p. 92.

[273] [Handley's footnote] Note this is not to say that the zero beta portfolio is riskless but rather that it is an asset with purely unsystematic risk.

> that portfolio. Second, NERA's distinction between the true market portfolio (of all risky assets) and a portfolio of risky stocks[274] is moot. We know that we can't observe the true market portfolio - which is relevant for tests of the CAPM but which is not overly important for applications since the typical starting point is to choose an appropriate proxy for the market against which the assets under consideration are believed to be priced.[275]

308. These observations further convince the Authority that it is reasonable to use the SL-CAPM, but that the Black CAPM cannot be relied on.

Empirical elements of DBP's return on equity estimate

309. The second major consideration for the Authority, in evaluating DBP's proposal for the return on equity, relates to the empirical aspects of the proposed implementation of a 'betastar' SL-CAPM. This seeks to apply the return on equity from the Black CAPM, but within a SL-CAPM construct, through the betastar transformation of the beta term in the SL-CAPM.

310. To facilitate its review, the Authority engaged Pink Lake to consider the empirical elements of DBP's and its consultants' work.[276] Pink Lake also updated the Authority's SL-CAPM and Black CAPM empirical work set out in the Draft Decision, while addressing the data issues raised by HoustonKemp for DBP.[277] The Authority then had Professors Partington and Satchell review the Pink Lake work, as a means of quality assurance. Professors Partington and Satchell are of the view that:[278]

> We are generally in agreement with the thrust of these [Pink Lake] reports and we find no statistical or mathematical problems that would significantly threaten the validity of the reports.

The betastar transformation is 'ill posed'

311. As a threshold issue, the Authority considers that the properties of DBP's betastar transformation are quite perverse for the return on equity. The resulting estimate of the return on equity, when the betastar is applied in the SL-CAPM, is likely to be in error.

312. To see this, consider that DBP's betastar method relies on the following CEG and DBP contentions:[279]

> It is relatively simple to solve for the value of β* that corrects the bias in the Sharpe-Lintner CAPM identified in the theoretical insight of the Black CAPM. Simply set Equation 4 equal to Equation 2 and solve for β*. When this is done the value of β* is defined by:
>
> $$\beta^{*}=\beta+ZBP/MRP\text{x}(1-\beta) \qquad \text{Eqn. 5}$$

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274 NERA, Return on Capital of a Regulated Electricity Network: A Report for Ashurst, May 2014, p. 81.

275 [Handley's footnote] For example, if the task is to estimate returns for domestic equities then one could choose a local stock index or an international stock index as the proxy for the benchmark market.

276 Pink Lake Analytics, Statistical Advice to ERA on DBP Submission 56, May 2016; and Pink Lake Analytics, Variance of the ZBP estimator, June 2016.

277 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 41.

278 Partington, G. and Satchell, S., Report to the ERA: Comments on the Statistical Reports by Pink Lake, May 2016, p. 3.

279 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, Appendix F, p. 13.

> This is DBPs approach and, for the reasons set out above, it is correct.
>
> The value of ZBP/MRP is not something that can be divined or intuited via internal introspection or judgment without reliance on data.

and:[280]

> One might reasonably expect the ERA to conclude from this that the minimum value it should use for ZBP/MRP is 0.61 – being the lowest of its estimates of ZBP/MRP (which is also lower than all but one of the other estimates that it surveys). However, this is not the conclusion that the ERA comes to. Rather, the conclusion that the ERA reaches is:[281]
>
> > Until a robust method is developed for estimating the zero-beta return, and the consequences of choosing different values for each decision variable are well understood, then the Black CAPM cannot be considered consistent or robust.
>
> This is an illogical position for the ERA to take. Whether the evidence suggests a wide or a narrow band for the best estimate of ZBP/MRP it is still incumbent on the ERA to arrive at the best estimate based on the available evidence. The theoretical insight of the Black CAPM is that a ZBP/MRP may exist and is likely to be greater than zero; necessitating an adjustment to the Sharpe Lintner CAPM. The fact that the evidence may not lead to a narrow range for the best estimate of ZBP/MRP is not a rational reason to make that adjustment without regard to best available evidence.

and:[282]

> It is therefore inexplicable that the ERA concludes that difficulty of estimating ZBP/MRP and/or a lack of stability in estimates the ZBP/MRP provides a reason for not basing its adjustment to the Sharpe-Lintner CAPM for the theoretical insights of the Black CAPM, on an estimate of ZBP/MRP. The existence of a zero beta premium is the theoretical insight of the Black CAPM. Attempting to make any adjustment to reflect this insight requires an estimate of the zero beta premium.

and:[283]

> Nonetheless, it is useful to take the lowest estimate of ZBP/MRP estimated by the ERA (0.61) and use this as a minimum threshold to assess the reasonableness of any increment applied by the ERA in moving from β to β*. If the ERA's increment applied in moving from β to β* is less than that implied by a ZBP/MRP value of 0.61 then it can be ruled out as demonstrably inconsistent with the evidence. I note that passing this threshold test does not imply that the ERA's estimate is reasonable – only that it cannot be immediately dismissed as inconsistent with the lowest available estimate of ZBP/MRP.

and:[284]

> The answer… is obtained by manipulating Equation 5 to solve for β given β*=0.7 and ZBP/MRP =0.61. The answer is as follows:

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280 Ibid, p. 22.

281 [CEG's footnote] Draft Decision on Proposed Revisions to the Access Arrangement for the Dampier to Bunbury Natural Gas Pipeline 2016 – 2020: Appendix 4 Rate of Return, p. 186.

282 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, Appendix F, p. 23.

283 Ibid, p. 32.

284 Ibid, p. 33.

$$\beta = \frac{\beta^* - \frac{ZBP}{MRP}}{1 - \frac{ZBP}{MRP}} = \frac{0.70 - 0.61}{1 - 0.61} = 0.23$$

The implication of this result is that even if one accepts the lowest ERA estimate of ZBP/MRP as the best the ERA would have to believe that the best estimate of β was 0.23 in order to justify adopting a value for β* of 0.70.

313. However, the resulting betastar transformation utilised by DBP is 'ill posed' mathematically.[285] Specifically, the foregoing mathematical relationship is discontinuous when the ZBP/MRP ratio is 1.[286] Pink Lake notes that the resulting properties of betastar are inconsistent:[287]

> The ill-posed nature of the β^* calculation is further illustrated by the ratio ZBP/MRP = 1.238 that DBP apply to their β^* calculation. It should be safely assumed that a value should have a higher β^* value than a lower β value, i.e., β^* is monotonically increasing with respect to β. However, given β=0.61 then β^*=1.093 (Eqn. 5). In contrast a lower value of β, say 0.52, returns β^*=1.11. This second β^* value is greater than the first β^* value despite the associated β estimate being lower, i.e., the β^* is not monotonically increasing whenever the ZBP/MRP >1. In fact, all β<1 returns a β^*>1 whenever the ZBP/MRP > 1.

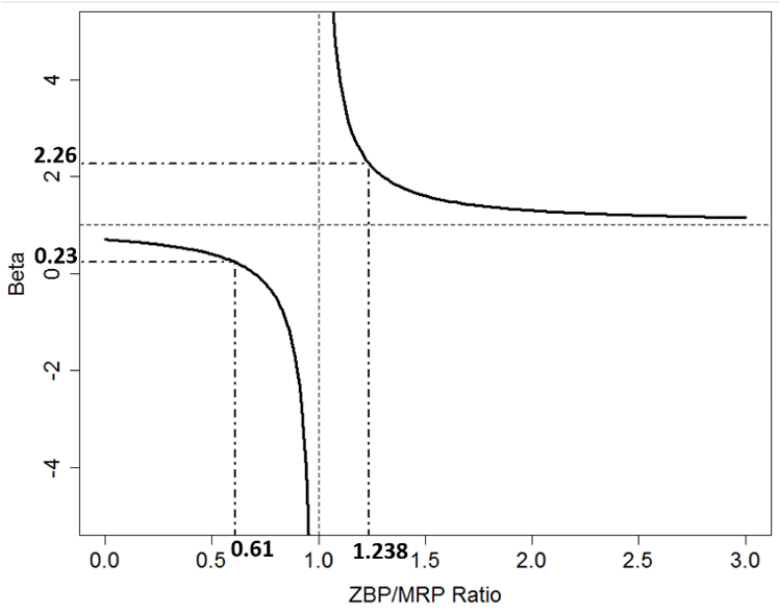
---

285 An ill-posed mathematical expression is *sensu stricto* one where at least one the following conditions do not hold: (1) a solution exists; (2) the solution is unique; (3) the solution's behaviour changes continuously with the initial conditions. Clearly, the inverse of the β^* is ill-posed as it violates the third condition. Likewise, the β^* calculation may be argued to be ill-posed as when the ZBP/MRP ratio varies continuously from below one to above one then behaviour of the function shifts from monotonically increasing to monotonically decreasing with respect to β. As both β and the ZBP/MRP ratio are uncertain then having a monotonically increasing β^* calculation would be a hard requirement for the performance of any calculation of compensation (Pink Lake Analytics, *Statistical Advice to ERA on DBP Submission 56*, May 2016, p. 21).

286 Pink Lake Analytics, Statistical Advice to ERA on DBP Submission 56, May 2016, p. 22.

287 Ibid.

Figure 3 The inverse function of the β^* calculation



Source Pink Lake Analytics, *Statistical Advice to ERA on DBP Submission 56,* May 2016, p. 22

In effect, the β^* calculation is a shrinkage estimator that shrinks all values of β to 1. The further away β is from one, the greater distance it is shrunk to the value 1. The inverse of this shrinkage estimator is discontinuous at ZBP/MRP =1, and indeed as ZBP/MRP moves away from 1 the closer β INV approaches 1 (Figure 3 above). The significant sensitivity of β^* to ZBP/MRP when β takes on low values, and when the estimate ZBP/MRP is highly uncertain and itself highly sensitive to input decision parameters, means that the β^* β calculation is unsuitable for RoE evaluations.

314. This ill-posed expression for the $\hat{\beta}^*$ calculation means that it is unsuitable for estimating any adjustment to the SL-CAPM. The foregoing calls into question the inflated DBP estimate of the ZBP/MRP ratio (the 1.238 in Figure 3), where the ZBR is greater than the market return:[288]

> Whatever the true market portfolio may be, for the ZBP/MRP ratio to be less than one it is only required that the expected return on the market be greater than the expected return on the zero-beta portfolio. That the zero beta portfolio must lie below the market portfolio is a point made in our prior report. We note that the economics of the situation and MV mathematics imply that this is true. Thus the finding by DBP that the ZBP/MRP ratio is greater than one should be a source of real concern to ERA as it suggests something is seriously wrong. We stress that this has nothing to do with the un-observability of the market portfolio.

315. The Authority notes that this is an extremely concerning insight which calls into question the whole mechanics of DBP's betastar transformation approach.

[288] G. Partington and S. Satchell, Report to the ERA: Comments on statistical reports by Pink Lake, May 2016, p. 5.

Estimates of zero beta return

316. The Authority notes that a range of empirical estimates, based on various interpretations of the Black CAPM, have been developed by consultants for network service providers in Australia. Key findings include the following:

- CEG (2008) used Australian data from 1964 to 2007 and reported estimates of the zero beta premium that range between 7.21 per cent per annum and 10.31 per cent per annum using various cross-sections of stocks traded on the ASX data formed into 10 portfolios on the basis of past estimates of beta.[289]
- NERA (2013) used Australian data from 1974 to 2012 and reports estimates of the zero beta premium that range between 8.74 per cent per annum and 13.95 per cent per annum using both individual stocks and stocks formed into portfolios on the basis of past estimates of beta.[290]
- SFG (2014) reported an estimate of the zero beta premium of 3.34 per cent per year. This study was based on 20 years of returns information from 1994 and 2013.[291]

317. In addition, the Authority developed its own zero beta return estimates for the Draft Decision. That evaluation showed clearly the sensitivity of the estimates to specification of the model and the dataset, for just a few of the decision variables.[292]

318. As noted above, DBP's consultant HoustonKemp criticised the Authority's Draft Decision empirical Black CAPM estimates, reported above, on a number of grounds.[293] In response, the Authority engaged Pink Lake Analytics to review its empirical estimates and respond to HoustonKemp.[294] Pink Lake updated and extended the estimates. Pink Lake concludes:[295]

> Before continuing with estimation of the variance of the various RoE parameters, criticisms raised by HoustonKemp (2016), on behalf of DBP, are addressed. Those criticisms are that data processing errors risk invalidating the Authority's estimates. However, in examining those claims, it is found that there was only a slight impact from the mis-specification of the denominator in the calculation of returns on the Authority's [SL-CAPM] RoE estimate (0.11%). There was a negligible effect on the Authority's RoE estimate arising from the treatment of missing data, or from the erroneous conversion to AUD of foreign dividends.
>
> In contrast, the Authority's implementation of DBP's estimator of ZBP was found to be highly influenced by these data manipulation issues, which can then severely impact on the Black CAPM evaluation of the RoE. This strongly suggests that the ZBP estimate is unduly sensitive to errors in data inputs and to data processing

289 CEG (September 2008) *Estimation of, and correction for, biases inherent in the Sharpe CAPM formula,* a report prepared for the Energy Networks Association Grid Australia and APIA.

290 NERA Economic Consulting (June 2013) *Estimates of the Zero-Beta Premium,* a report prepared for the Energy Networks Association, p. 16 and p. 23.

291 SFG Consulting (2014) *Cost of equity in the Black Capital Asset Pricing Model,* a report prepared for Jemena Gas Networks, ActewAGL, Ergon, Transend, TransGrid, and SA PowerNetworks, p. 27.

292 Economic Regulation Authority, Draft Decision on Proposed Revisions to the Access Arrangement for the Dampier to Bunbury Natural Gas Pipeline, 22 December 2016, Appendix 4, p. 43.

293 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 41.

294 Pink Lake Analytics, Statistical Advice to ERA on DBP Submission 56, May 2016; and Pink Lake Analytics, Variance of the ZBP estimator, June 2016.

295 Ibid, p. 4.

> assumptions. It is especially the case given DBP's time-dependent estimate of the ZBP having a much greater variance than the SFG (2014) approach to estimating the ZBP.

319. The Authority considers that the Pink Lake findings reinforce its concerns as to the robustness of the zero beta return in empirical estimation. At the same time, Pink Lake confirms the robustness of the SL-CAPM estimate of the return on equity.

320. The stability of the zero beta return is examined in more detail in what follows.

Stability of the zero beta return

321. The Authority in the Draft Decision questioned the validity of the estimates of the zero beta return.[296] The Authority noted, for example in relation to NERA's estimates of zero beta premium, that Professors McKenzie and Partington were of the view that:[297]

> There are many potential sources of error and bias in the estimation of zero beta returns and consequently such estimates should be viewed with great caution. Even if the foregoing problems were set aside, there are also question marks over the standard errors of the zero beta return estimates. This is an important unresolved issue given that the magnitude of the standard error is the basis for concluding whether estimated zero beta returns differ from zero.

322. Robustness means, among other things, that there is little or no variation of the estimated parameter in response to sensible alternative approaches to estimation. On this ground, McKenzie and Partington have argued that NERA's estimates of the zero beta returns are not robust. They also argued that:[298]

> We make a more general and more important point that "the empirical zero beta portfolio" is not unique. Consequently, there are many different zero beta returns that might be estimated and very large differences in the value of that return could be obtained.

323. In this context, in their report for the Authority, Partington and Satchell observe that the estimate of the zero beta return is susceptible to the specification of the proxy for the market portfolio:

> …both our theoretical analysis and the empirical data point to considerable variation in the estimates of the zero beta premium. This reflects inherent problems in the estimation of the zero beta premium and sensitivity of the estimates to choices made in the method of analysis, which renders the estimates open to gaming.
>
> We further point out that it is well understood that if the proxy for the market portfolio is not an efficient portfolio then there is an infinite set of possible zero beta portfolios and hence an infinite set of zero beta premiums that could be selected. The likely retort is that the use of regression constrains the choice, but then the result depends on the data included in the regression, for example the nature of portfolio sorts and the stocks chosen for analysis…
>
> There is also another problem in estimating the zero beta premium and that is that the proxy for the market portfolio inevitably changes through time. Consequently its location in mean variance/standard deviation space changes. It is well known that the

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296 Economic Regulation Authority, Draft Decision on Proposed Revisions to the Access Arrangement for the Dampier to Bunbury Natural Gas Pipeline, 22 December 2016, Appendix 4Ai, p. 186.

297 McKenzie, M and Partington, G. *Review of NERA report on the Black CAPM,* The Securities Industry Research Centre of Asia Pacific (SIRCA) Limited, 22 August 2012, p. 5.

298 McKenzie, M and Partington, G. *Review of NERA report on the Black CAPM,* The Securities Industry Research Centre of Asia Pacific (SIRCA) Limited, 22 August 2012, p. 4.

> location of the zero beta portfolio is sensitive, sometimes very sensitive, to the precise location of the proxy for the market portfolio. This is a problem for empirical estimation, which usually spans a decade or two.

324. The Authority raised the efficiency of the market portfolio in the Draft Decision.[299] DBP in response states that:[300]

> Simply put, if the market portfolio is inefficient, then the SL-CAPM fails to hold, and the conclusions the ERA has drawn in respect of beta are wrong. The same is true of all other asset pricing models as well, but at the very least, DBP is able to show that the predictions made by an SL-CAPM predicated on an inefficient market portfolio are downward-biased estimators of the actual returns made firms with (imperfectly measured) systematic risk similar to (likewise imperfectly measured) systematic risk exposure to the benchmark efficient firm, whilst the Black CAPM does not produce downward-biased estimators

325. However, the Authority agrees with Pink Lake that the influence of the market portfolio can be ameliorated using a free intercept term, α (which captures a number of abnormal return components in the estimates):[301]

> The ZBR is estimated using an indexed market portfolio (the ASX 300) and not a risk-efficient portfolio, and thus does not satisfy a key assumption of the theoretical model. This criticism can also be applied the SL CAPM model as well, and is one of a number of reasons why abnormal returns should be explicitly modelled… as is done with the Henry version of the SL CAPM.

326. Given that, the Authority notes that it explicitly models abnormal returns in its beta estimate for the SL-CAPM for this Final Decision by including a free intercept parameter that captures the influence of anomalous returns. That term will also mitigate the influence of any inefficiency in the market portfolio.

327. However, the same cannot be said for DBP's method – as noted above, all of the ex-post anomolous returns are fully incorporated in the zero beta premium estimate, which is then loaded into the SL-CAPM beta through the betastar.

328. The Authority noted McKenzie and Partington's view that the issue of zero beta measurement is not settled:[302]

> There is no generally accepted empirical measurement of the zero beta return in the Black CAPM. This is because the empirical measurement of the zero beta return is neither simple, nor transparent. There are many possible zero beta portfolios that might be used and the return on these portfolios is not directly observed, but has to be estimated. In the estimation process for the zero beta return, there are also inputs that cannot be observed and they too have to be estimated. The resulting estimate of the zero beta return is sensitive to the choices made in regard to the input variables and methods of estimation.

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299 Economic Regulation Authority, *Draft Decision on Proposed Revisions to the Access Arrangement for the Dampier to Bunbury Natural Gas Pipeline*, 22 December 2016, Appendix 4Ai, p. 44. In this context, the Authority notes that the sentence 'The Authority has also confirmed the inefficiency of the zero beta portfolio utilising the NERA method of estimation (to the extent that it lies inside the return mean-variance efficient frontier).' was an inadvertent error of inclusion. In response to a query from DBP, the Authority responded that it was referring to the market portfolio.

300 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 66.

301 Pink Lake Analytics, Statistical Advice to ERA on DBP Submission 56, May 2016, p. 9.

302 McKenzie, M and Partington, G. *Review of NERA report on the Black CAPM,* The Securities Industry Research Centre of Asia Pacific (SIRCA) Limited, 22 August 2012, p. 8.

329. Further, in a recent report prepared for the AER, Partington and Satchell also concluded that:[303]

> Beaulieu, Dufour and Khalaf have been working on this problem [of estimating zero beta return] for over a decade and have developed improved estimation procedures. Applying these procedures they conclude that the estimate of the zero beta return is unstable over time. Although these improved procedures are a valuable contribution to the research literature, they involve complex econometrics and are not yet widely accepted. Consequently, we would not currently recommend them for regulatory use.

and that:[304]

> Given that an inefficient portfolio is used as the proxy for the market portfolio there is an infinite possible set of zero beta returns and even when you constrain the estimate by using a regression model, what you get is very much determined by what you do. Hence the wide range of estimates previously submitted by regulated business.

and that:[305]

> First, the estimate of the return on the zero beta portfolio is sensitive to the choice of the portfolio used to represent the market and it can be very sensitive to this choice. Second the sensitivity depends on the curvature of the efficient frontier lying between alternative portfolios used to represent the market.
>
> At a theoretical level the choice of portfolio to represent the market leads to a multiplicity of possible values for the zero beta return and what you get in empirical work depends very much on what you do. The very substantial variation in the estimates provided by the regulated businesses, and the theoretical and empirical work showing the unreliable nature of zero beta return estimates, clearly suggests that estimates of zero beta returns are not appropriate for use in determining regulated returns.

330. In the Draft Decision, the Authority noted NERA's responses to McKenzie and Partington's view in relation to NERA's estimates of zero beta premium.[306] However, the Authority considered that none of these responses from NERA reassure as to the robustness of the zero beta premium in the Australian context.

331. To explore the issue of the robustness of the zero beta return, the Authority undertook, in the Draft Decision, its own analysis of the properties of the outputs of the Black CAPM. The Authority found that the Black CAPM was not robust, in the sense that the results exhibited high standard errors, and were sensitive to parameter specification and data selection.[307] The Authority considered that fundamental issues with the Black CAPM remain unsolved (refer to Appendix 4Ai of the Draft Decision for more detail).[308]

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303 Partington, G. and Satchell, S. "Report to the AER: Analysis of Criticism of 2015 Determinations", a report prepared for the Australian Energy Regulator, October 2015, p. 19.

304 Partington, G. and Satchell, S. "Report to the AER: Analysis of Criticism of 2015 Determinations", a report prepared for the Australian Energy Regulator, October 2015, p. 20.

305 Partington, G. and Satchell, S. "Report to the AER: Analysis of Criticism of 2015 Determinations", a report prepared for the Australian Energy Regulator, October 2015, p. 26.

306 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Regulatory Period Response to ERA Issues Paper Submission 26, 2 June 2015, Appendix C.

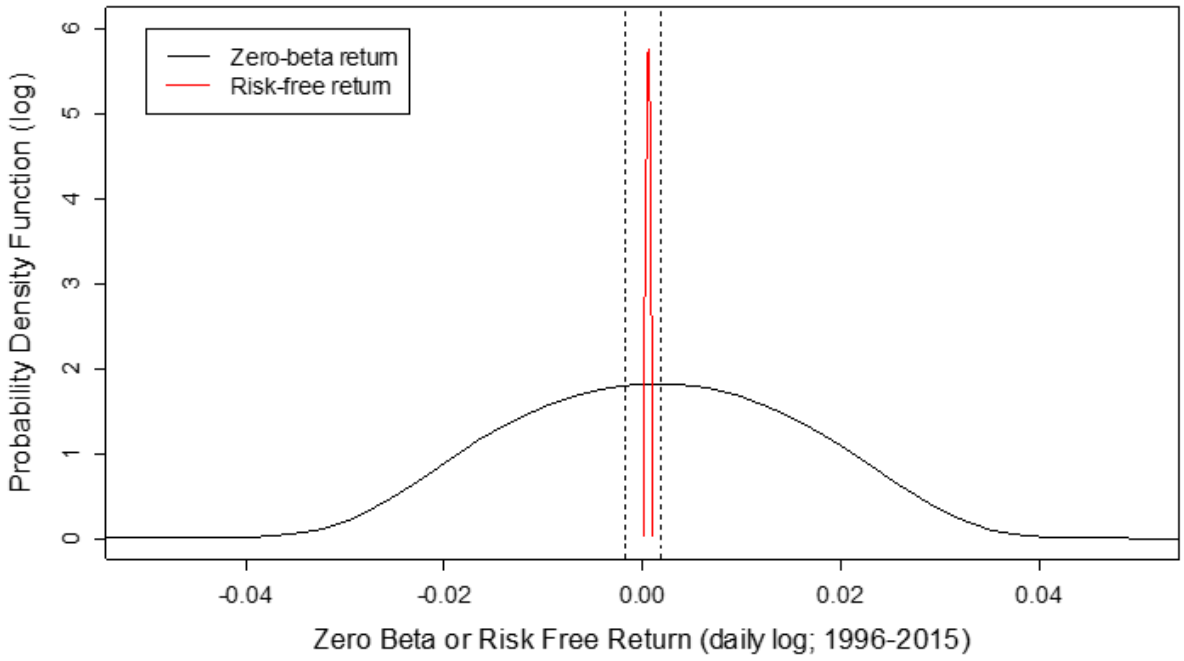
307 Economic Regulation Authority, Draft Decision on Proposed Revisions to the Access Arrangement for the Dampier to Bunbury Natural Gas Pipeline, 22 December 2016, Appendix 4, p. 40.

308 Economic Regulation Authority, Draft Decision on Proposed Revisions to the Access Arrangement for the Dampier to Bunbury Natural Gas Pipeline, 22 December 2016, Appendix 4Ai.

332. Importantly, the Authority in that work demonstrated that the zero beta estimates are extremely imprecise. As reported by the Authority in the Draft Decision:[309]

> One issue causing the fluctuation in zero-beta return estimates is that the spread of zero-beta returns is much greater than that of the risk-free return. The distribution of zero-beta returns are positively skewed, with extreme values of up to 0.15 for daily data and a one day evaluation frame. If a period of interest (last 20 years or 5 years) happens to include one of these extreme values then the mean zero-beta return estimate can increase dramatically. This is evidenced by the difference between annualised mean (11.5 per cent) and median (5.5 per cent) zero-beta returns over a 20 year period. In no sense can the dynamic zero-beta return estimate be considered stable.
>
> In contrast, the risk-free return has comparatively low variance. Indeed, this narrow variance is reason why the Henry SL CAPM is applied by the Authority to estimate β to circumnavigate the need to provide an estimate of the risk-free return.

Figure 4 Probability density estimates of the daily risk-free and zero-beta returns



Note The dashed vertical lines refer to annualised +/- 100% returns. The distribution of the zero-beta return displayed here excludes extreme estimates of zero-beta return of up to 0.15. The distribution of the risk-free return has been inflated horizontally by a factor of four for visual comparison purposes.

Source: ERA analysis

333. On that basis, the Authority considered that NERA's use of the recursive method to argue that the zero beta estimates are stable is misleading.

[309] Economic Regulation Authority, Draft Decision on Proposed Revisions to the Access Arrangement for the Dampier to Bunbury Natural Gas Pipeline, 22 December 2016, Appendix 4, p. 187.

334. In response to the Draft Decision, DBP appears to accept the problems with the zero beta estimates, but then sidesteps the Authority's concerns, by falling back on the conceptually flawed model adequacy test:[310]

> …variation in the estimation of a particular parameter, like the zero-beta premium is not a problem associated with the model adequacy test. Quite the opposite; it is a problem which the model adequacy test seeks to overcome…
>
> DBP has estimated the zero-beta premium a certain way, and found that this way of estimating the zero-beta premium leads to a version of the Black CAPM that passes its model adequacy test. However, we could have equally estimated the zero-beta premium in a plethora of different ways and subjected each of the resulting versions of the Black CAPM to a model adequacy test. This is in fact exactly what we did with the SL-CAPM, testing a version with the mean estimate of beta, with the 95th percentile estimate of beta and the 99th percentile estimate of beta (and similarly for betastar). Some versions of the Black CAPM with different estimation methods for the zero beta premium may have passed (as our implementation does) and some may have failed.

335. Further, DBP in its response contends:[311]

> A final point relates to the amount of variation found in estimates of the zero-beta premium and the degree to which these estimates are or are not robust enough to use. It would appear that the ERA has rather overstated its case in respect to the amount of variation found in estimates of the zero-beta premium. DBP does not dispute that there is some variation, but HoustonKemp argues that the problem is not nearly as large as the ERA suggests; it is not that much larger than the variation in estimates of the market risk premium.
>
> There are two pieces of evidence the ERA presents to support its point. The first is its own work in respect of the zero-beta premium. HoustonKemp (see Appendix H) has assessed this work in detail, and suggests that it may be subject to a number of important flaws…
>
> The second piece of evidence the ERA presents is the opinions of various experts. These have, in most cases, been engaged by the AER and not the ERA, but the ERA appears to be endorsing the views of experts as being supportive of its own view that estimates of the zero-beta premium are likely to be highly variable and potentially not very robust. HoustonKemp (Appendix H), has addressed the various pieces of expert evidence in some detail.

336. With regard to DBP's first point, in the first paragraph in the foregoing quote, the Authority notes that the variance of the ZBP is extremely large, ranging from negative to positive numbers, as evidenced in paragraph 332 above. While the *ex post* variance of the MRP is large, the forward looking expectations of the MRP, consistent with required returns, are positive, and fall within a reasonably tight range

310 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 41.

311 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 41.

(the Authority considers that its estimated range of 5.4 to 8.8 per cent informs this). The Authority therefore does not accept HoustonKemp's contention.

337. With regard to DBP's second point, in the second paragraph in the foregoing quote, the Authority engaged Pink Lake to evaluate HoustonKemp's claims with regard to the empirical properties of the Authority's own estimates.

338. Pink Lake corrected the Authority's estimates, confirming the broad thrust of the inferences made, finding:[312]

> Criticisms raised by HoustonKemp (2016), on behalf of DBP, that data processing errors risk invalidating the Authority's estimates needed to be addressed before continuing with estimation of the variance of the various RoE parameters. Analysis found only a slight impact from a mis-specified denominator in the calculation of returns on the Authority's RoE estimate (0.11%), and a negligible effect on the Authority's RoE estimate arising from the treatment of missing data (in the Authority's case, to be imputed) or the conversion to AUD of foreign dividends. In contrast, the Authority's implementation of DBP's estimator of ZBP was found to be highly influenced by these data issues, which can severely impact on the Black CAPM evaluation of the RoE. This suggests strongly that the ZBP estimate is unduly sensitive to errors in data inputs, and to data processing assumptions, especially given that DBP's time-dependent estimate of the ZBP has a much greater variance than the SFG Consulting (2014) approach to estimating the ZBP.

339. Pink Lake presents a statistically rigorous examination of the robustness of the zero beta estimates. Pink Lake finds that the variance of the ZBP estimator adds significantly to the uncertainty of the y intercept 'compensation',[313] finding:[314]

> Application of Monte Carlo simulation of the sampling distribution of the ZBP estimate, for a range of Black CAPM models used in the Australian context, demonstrates the ZBP estimate is associated with high variance (with a standard error of 2.3-4.4%, depending on the parameterisation of the Black CAPM during estimation). This high variance has almost negligible impact on the Black CAPM estimate of the asset β, and little relative impact on the RoE evaluation (increasing the standard error of the RoE calculation from 0.2% to 0.7% across the different parameterisations of the Black CAPM).
>
> However, the impact of the high variance of the ZBP estimate on the 'compensation' for borrowing and/or transaction costs is significant, with a standard error ranging from 1% to 1.6% for different parameterisations of the Black CAPM. This variance measure is high when compared to the mean compensation estimates themselves, which range from 0.7% to 2.4% for the variance weighted portfolio (i.e., a coefficient of variation of 70% to 130%, which compares to 45% for the risk-free rate which is projected to be 1.96% per annum). Moreover, this variance was significantly higher when serial autocorrelation was included in the model for estimating the ZBP (i.e., the variance of the ZBP estimator under an assumption of no serial autocorrelation that is reported here is a conservative estimate)

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312 Pink Lake Analytics, *Variance of the ZBP estimator*, June 2016, p. 4.

313 Pink Lake define 'compensation' in the following terms (Pink Lake Analytics, *Variance of the ZBP estimator*, June 2016, p. 14):

> The ZBP estimate represents a compensation to be paid for the premium of borrowing rates above lending rates under the Black CAPM. This compensation level may be defined simply as the difference between the Authority's RoE (prior to any discretionary adjustment of $\hat{\beta}_i^A$) and that of the Black CAPM derived RoE:
>
> $$Compensation = RoE^B - RoE^A = \left(1 - \hat{\beta}_i^B\right)\widehat{ZBP} + \left(\hat{\beta}_i^B - \hat{\beta}_i^A\right)MRP$$

314 Pink Lake Analytics, *Variance of the ZBP estimator*, June 2016, p. 4.

340. These results continue to raise questions about the robustness of the Black CAPM.

341. With regard to HoustonKemp's third point in the third paragraph of the foregoing quote, the Authority considers that the Australian Energy Regulator has addressed comprehensively the points raised by NERA/HoustonKemp with regard to criticisms of the expert views (put forth by consultants predominantly engaged by the Australian Energy Regulator), which the Authority has had regard to.[315]

342. Accordingly, the Authority remains of the view that the zero beta premium estimate is less reliable than the risk free rate.

343. The sensitivity of the zero beta returns to parameter specification and data selection mean that it is quite possible to obtain widely varying returns from the Black CAPM. In this context, the Authority agrees with Partington and Satchell that regulatory calculations should not be gameable.[316] However, adopting the Black CAPM allows for this potential.

344. DBP itself states:[317]

> DBP has estimated the zero-beta premium a certain way, and found that this way of estimating the zero-beta premium leads to a version of the Black CAPM that passes its model adequacy test. However, we could have equally estimated the zero-beta premium in a plethora of different ways and subjected each of the resulting versions of the Black CAPM to a model adequacy test. This is in fact exactly what we did with the SL-CAPM, testing a version with the mean estimate of beta, with the 95th percentile estimate of beta and the 99th percentile estimate of beta (and similarly for betastar). Some versions of the Black CAPM with different estimation methods for the zero beta premium may have passed (as our implementation does) and some may have failed.

345. It is clear then that DBP accepts that the zero beta return approach can be widely varying.

346. Pink Lake has observed in this context:[318]

> At the very least, the unremarked difference in estimation methods between SFG (2014) and DBP which - produce dramatically different results - is alone sufficient grounds to reject DBP's model, due to an unexplained inconsistency in what should be a standard method for computing the ZBP. This point was raised in Sections 853-860 in the Draft Decision, but is nowhere addressed by DBP in their Submission.

347. This is a further reason why DBP's Black CAPM estimate should be rejected, given that it is so sensitive to the approach, the data set and to the time period chosen for the estimation.

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315 Australian Energy Regulator, Final Decision AusNet Services distribution determination 2016 to 2020 Attachment 3 – Rate of return, May 2016 pp. 3-185 – 3-188.

316 Partington, G. and Satchell, S., Report to the ERA: The Cost of Equity and Asset Pricing Models, May 2016, p. 28.

317 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 41.

318 Pink Lake Analytics, Statistical Advice to ERA on DBP Submission 56, May 2016, p. 14.

Validity of a zero beta premium

348. Irrespective of the robustness properties of the zero beta return, the Authority considers there is a fundamental question relating to the validity of the so-called 'zero beta premium', which is applied by DBP in its estimates.[319]

349. DBP's zero beta premium was estimated by NERA, and is based on a long 20 year run of data. DBP argues that by adding the estimated zero beta premium to the current risk free rate, the result is a *current* zero beta rate, as if that somehow nullifies the fact that it was estimated based on 20 years of data:[320]

> Partington & Satchell (2015) are incorrect to conclude that an estimate of the zero-beta cannot be current because it requires almost 20-years of data to estimate robustly.[321] The argument ignores the fact that DBP, and HoustonKemp, estimate a zero-beta premium which is added to the current risk-free rate to produce a current zero-beta rate.

350. The Authority agrees with Partington and Satchell that this is simply wrong.[322]

> …the government bond rate does not have to be estimated as it is directly observable and has the advantage of being current. The zero beta premium in contrast has to be estimated, with all the attendant problems of that estimation and because decades of data are used in estimation of the zero beta premium it is not current. DBP respond by suggesting that by adding the estimated zero beta premium to the current risk free rate the result is a current zero beta rate. This is simply wrong. As an analogy consider computing an average premium of government bonds over Treasury notes for say the last 20 years. Then taking this premium and adding it to the current Treasury note yield and calling the result the current yield on government bonds, it would be ridiculous.
>
> HoustonKemp rely, rather curiously, on the argument that if we add a zero-beta premium to the current risk free rate, we get a current zero-beta rate and, somehow, mysteriously, this zero-beta rate is endowed with attractive stable properties from the attractive stable properties of the risk free rate. A little reflection, however, reveals that this is fallacious. If we add a variable with an infinite mean to a variable with a finite mean, the resulting variable will have an infinite mean.

351. Furthermore, Partington and Satchell demonstrate mathematically that zero-beta estimates typically do not have finite means. Intuitively this means that inaccurate estimates of the zero beta estimate are very possible.[323]

352. This provides further support for the Authority's view that the zero beta premium utilised in the betastar formula is not robust. It therefore cannot be relied on for the purposes of meeting the requirements of NGR 87, including the allowed rate of return objective.

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319 The zero beta premium is given by the difference between the zero beta return and the risk free rate.

320 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 42.

321 [DBP's footnote] Note that the ERA uses much less data than this to estimate its zero-beta premia. In fact 20 years is the longest time series used. It is not clear how the ERA's approach in this respect would align with Partington and Satchell's views.

322 Partington, G. and Satchell, S., Report to the ERA: The Cost of Equity and Asset Pricing Models, May 2016, pp. 26-27.

323 Partington, G. and Satchell, S., Report to the ERA: The Cost of Equity and Asset Pricing Models, May 2016, p. 25.

Other problems in estimating the zero beta premium

353. Additional evidence for the unreliability of the zero beta return and zero beta premium was noted in the Draft Decision. That included evidence from the work of Beaulieu, Dufour and Khalaf.[324]

354. Partington and Satchell note the following issue in that work:[325]

> Identification: as βi→1, γ becomes weakly identified. Weak identification (WI) strongly affects the distributions of estimators and test statistics, leading to unreliable inference even asymptotically. This should not be taken lightly: reported betas are often close to one (see e.g. Fama and MacBeth, 1973). Further, even if estimated betas are not close to one, irregularities associated with WI are not at all precluded [in view of (1) and (2) above]." Beaulieu, Dufour and Khalaf (2012. P.3, emphasis added).

355. On a separate issue, the Authority notes CEG's contentions which support DBP's method of model adequacy test and its estimated betastar, as summarised in paragraph 312 above. The Authority considers that even if some of the betas are a long way from one, only some of them need to be close to one for a problem to remain. The Authority notes that while the mathematics is complex, inaccurate estimates are possible.

356. DBP/HoustonKemp's response – that betas close to one are not an issue in their sample – is not a necessary condition for problems of estimation and inference. Partington and Satchell observe in this context:[326]

> Even if betas are not close to one problems in estimation and inference are not precluded. In any event, it would be very surprising if the top 500 stocks on the ASX all had betas distant from one. Also HoustonKemp (2016a, p14) report "…at each point in time the Black model looks back at past data, sees little relation between mean return and beta and so sets the betas of the 10 portfolios close to one."

357. Partington and Satchell agree with Pink Lake that there is evidence that the zero beta premium estimate can differ significantly both between time periods when estimated by the same practitioner, the same practitioner can put forward multiple methods of estimating the zero beta premium, and different practitioners apply different methods, and consequently the zero beta premium estimate can vary widely. On this basis, if the zero beta premium quantity were ever used to measure compensation for regulated businesses (something they are strongly opposed to), the value would change from year to year and be quite unfit for purpose of economic regulation.[327]

358. In addition, Partington and Satchell agree with Pink Lake's view in relation to the weak nature of zero-beta analysis. They argue that, faced with an array of models,

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[324] Economic Regulation Authority, Draft Decision on Proposed Revisions to the Access Arrangement for the Dampier to Bunbury Natural Gas Pipeline, 22 December 2016, Appendix 4, p. 219.

[325] Partington, G. and Satchell, S., Report to the ERA: The Cost of Equity and Asset Pricing Models, May 2016, p. 27.

[326] Partington, G. and Satchell, S., Report to the ERA: The Cost of Equity and Asset Pricing Models, May 2016, p. 27.

[327] Partington, G. and Satchell, S., Report to the ERA: Comments on the Statistical Reports by Pink Lake, May 2016, p. 4.

regulated businesses have an incentive to promote the one that provides maximum returns. They are of the view that:[328]

> Whatever the true market portfolio may be, for the ZBP/MRP ratio to be less than one it is only required that the expected return on the market be greater than the expected return on the zero-beta portfolio. That the zero beta portfolio must lie below the market portfolio is a point made in our prior report. We note that the economics of the situation and MV [minimum variance] mathematics imply that this is true. Thus the finding by DBP that the ZBP/MRP ratio is greater than one should be a source of real concern to ERA as it suggests something is seriously wrong. We stress that this has nothing to do with the un-observability of the market portfolio.

359. A further problem relates to the fact that estimated versions of the zero-beta premium can have infinite means in a number of different cases. Yet while DBP claims to put a great deal of emphasis on theoretical justification it seems that the theory is only adhered to on a selective basis. By way of example:[329]

> …in particular, if we follow the theory of Brennan (1971), it must be the case that ZBP must be less than or equal to the spread between the borrowing and lending rate, presumably at 10 years. The mean spread between 10 year bonds and A rated corporate debt over the period from the January 2005 to March 2006 was about 16 basis points per month. This is a generous estimate of the limits imposed by the Brennan model as these are not risk free or even the highest rate corporate bonds and the estimate was made over a period when credit spreads were much higher than normal. In contrast the DBP estimates of the zero beta premium are more than four times as big. Of interest is the large variation between the DBP estimates versus the much lower estimates from ERA and SFG. This fact alone illustrates the substantial difficulties in getting an unambiguous and reliable estimate of the zero beta return.

360. Partington and Satchell consider that a further issue with the zero beta portfolio is that it is necessarily mean variance inefficient, implying that no sensible investment decisions can be based upon it:[330]

> A second theoretical feature of the zero-beta portfolio is that it must lie below the global minimum variance portfolio if the market lies above the global minimum variance portfolio. This again provides a constraint on what the zero beta premium can be. Furthermore, since in this case the zero beta portfolio is necessarily mean variance inefficient, no sensible investment decisions should be based upon it. It is virtually a truism for professional investors that factors employed in risk/return models should be investable.

361. Further, the Authority notes that Partington and Satchell have conducted the technical analysis in their report to the Authority to assess the usefulness of the zero-beta CAPM for determining the cost of capital and hence the regulatory price. They conclude that:[331]

> …we present the mean variance (MV) mathematics behind the zero-beta CAPM and prove a result on the non-existence of the estimated mean of the zero-beta portfolio; a critical component in implementing this model.

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328 Partington, G. and Satchell, S., Report to the ERA: Comments on the Statistical Reports by Pink Lake, May 2016, p. 5.

329 Partington, G. and Satchell, S., Report to the ERA: The Cost of Equity and Asset Pricing Models, May 2016, p. 31.

330 Ibid.

331 Ibid, p. 35.

362. These additional problems for the Black CAPM further reinforce that it is not fit for purpose for estimating the return on equity.

Simulation and critical values

363. Partington and Satchell agree with DBP that it is correct to simulate in order to correct for issues with asymptotic distribution, given issues about the critical values of a test.[332]

364. However, they argue that a true model is needed and that the assumptions made need to be carefully explained as they may not be deemed appropriate in a particular context.[333] These assumptions are not readily apparent from the material presented by DBP and NERA.

Da, Guo and Jagannathan (2012)

365. DBP took issue with two references considered by the Authority in the Draft Decision.

366. First, the Authority cited the Da, Guo and Jagannathan (2012) paper as providing support for the SL-CAPM, particularly that empirical evidence against the CAPM based on stock returns does not invalidate its use for estimating the cost of capital for projects in making capital budgeting decisions.[334]

367. Partington and Satchell agree with DBP that the growth option approach of Da, Guo and Jagannathan (2012) differs from the application of the SL-CAPM as used by regulators and the complexities probably make it inappropriate for regulation.[335]

368. Accordingly, the Authority places no weight on this material in its evaluation.

Kan, Robotti and Shanken (2013)

369. Second, DBP notes:[336]

> The paper by Kan, Robotti and Shanken (2013) suggests that, when portfolios are formed a certain way, the superiority of the FFM over the SL-CAPM vanishes, but the authors do not say that the SL-CAPM is superior, and overall they find that the inter-temporal CAPM performs best, followed by the FFM. Like others, they find a negative, rather than a positive relation between the returns on portfolios of stocks and estimates of their betas.

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332 This makes reference to the work of Ray, Savin and Tiwari (2009) quoted by M. McKenzie and G. Partington, Report to the AER, Part A: Return on equity, October 2014, p. 9, which in turn was referenced by the Authority in the Draft Decision (Economic Regulation Authority, *Draft Decision on Proposed Revisions to the Access Arrangement for the Dampier to Bunbury Natural Gas Pipeline*, 22 December 2016, Appendix 4, p. 151).

333 Partington, G. and Satchell, S., Report to the ERA: The Cost of Equity and Asset Pricing Models, May 2016, p. 28.

334 Economic Regulation Authority, Draft Decision on Proposed Revisions to the Access Arrangement for the Dampier to Bunbury Natural Gas Pipeline, 22 December 2016, Appendix 4, p. 151.

335 Partington, G. and Satchell, S., Report to the ERA: The Cost of Equity and Asset Pricing Models, May 2016, p. 28.

336 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 42.

370. On that basis, DBP acknowledges that there is a reversal of ranking of the Fama French model and the CAPM when the method of portfolio formation changes.

371. Partington and Satchell note that the SL CAPM does not fare particularly well in the Kan, Robotti and Shanken tests, although the Inter temporal CAPM is a clear winner. Their view is that the results of Kan, Robotti and Shanken show the difficulty of all attempts to fit asset pricing models to realised returns, including the work of NERA/HoustonKemp.[337]

372. The Authority notes the sensitivity of model performance ex post to model specification and portfolio formation. This flags further caution with regard to the findings of DBP, as their work is based on a beta sort, rather than an industry sort.

373. On balance, the Authority considers that there are still many unsolved issues in relation to the estimates of the zero beta premium. As such, the Authority considers that DBP's estimates – which use a single estimate of zero beta premium – disguises the significant instability in the model. Therefore, the Authority does not consider that DBP's model adequacy test is empirically true to the Black CAPM model.

374. The Authority notes that the unresolved issues in relation to the estimates of the zero beta premium may explain why the Black CAPM has never seen widespread adoption by financial practitioners.

DBP's model adequacy test produces nonsensical outcomes

375. The Authority notes that based on the findings from its model adequacy test, DBP is of the view that the bias in its Sharpe Lintner CAPM analysis is not only statistically significant, but economically significant as well, with a mean forecast error of around four percentage points per annum. DBP considers that this means that a regulator using the Authority's approach to setting prices would provide investors with returns that are four percentage points lower than they could be earning by facing similar levels of systematic risk elsewhere in the economy.[338]

376. The implication of DBP's finding is that the expected return on equity for low beta assets, such as the ATCO GDS, the GGP and the DBNGP, needs to be increased by 4 percentage points, based on DBP's analysis and conclusion. For example, DBP argues that the expected return for DBP or ATCO (a low asset beta) using historical data on DBP's model adequacy test should be 11.28 per cent.

377. The Authority notes that the market return on equity for a long period is approximately 10.3 per cent,[339] which is lower than DBP's estimated return for low asset betas such as DBP and ATCO. DBP is therefore suggesting that its return on equity is more risky than the market as a whole. The Authority does not consider that this view is sound.

378. There is conceptual support for the equity beta of an infrastructure network benchmark efficient entity being less than 1:

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337 Partington, G. and Satchell, S., Report to the ERA: The Cost of Equity and Asset Pricing Models, May 2016, p. 28.

338 DBP, Proposed Revisions DBNGP Access Arrangement, 2016 – 2020 Regulatory Period, Rate of Return, Supporting Submission: 12, 31 December 2014, p. 60.

339 See the section 'Lower bound of the MRP range' below for the Authority's estimate of the long run historic return on the market.

- business risk – which may be disaggregated into intrinsic (economic) risk and operational risk – is the primary driver of systematic risk, and this risk is low for the benchmark efficient entity relative to the market average;
- despite relatively high financial leverage, the benchmark efficient entity does not have high financial risk – rather it is the intrinsic risk of the firm which is the key driver of systematic risk.

379. McKenzie and Partington endorse the view that the equity beta is likely to be below 1, concluding that there is:[340]

> …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.

380. The Authority noted these views in its Draft Decision and considered that the reasoning is relevant. This provided further support for the Authority's view that DBP's model adequacy test produces a nonsensical results.

381. DBP took issue with this point, submitting the Authority has ignored standard errors, has failed to take account of the expected return on debt for high risk firms in portfolio 9, and has overlooked that the return on equity can be below the return on debt for long periods.[341] However, the fact that the return on equity can be below the return on debt, ex post, simply amplifies the point that 'no rational investor invests in shares expecting decades of negative real returns ex ante, or expecting that bonds will outperform equities, yet these were actual outcomes. Thus differences between ex ante expectations and ex post outcomes are a major problem for tests of asset pricing models'.[342] The Authority remains of the view that the outcomes for portfolio 9 highlight the extreme empirical problems of DBP's approach.

382. On balance, the Authority remains of the view that the findings of DBP's analysis are not robust and the approach produces nonsensical outcomes.

Cross validation issues

383. The Authority in its Draft Decision raised issues with regard to the method used to determine bias in the model adequacy test:[343]

> The Authority is of the view that a more appropriate framework for assessing prediction accuracy, and hence model adequacy, is to utilise the cross-validation measure of prediction error. This framework can be extended to explicitly decompose prediction error into its irreducible bias and variance components by employing jack-knife methods (Efron 1979). Moreover, cross-validation is a widely applied framework within

340 McKenzie, Partington, Report to the AER: Estimation of the Equity Beta (Conceptual and Regulatory Issues) for a Gas Regulatory Process in 2012, April 2012, p. 15.

341 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 42.

342 Partington, G. and Satchell, S., Report to the ERA: The Cost of Equity and Asset Pricing Models, May 2016, p. 7.

343 Economic Regulation Authority, Draft Decision on Proposed Revisions to the Access Arrangement for the Dampier to Bunbury Natural Gas Pipeline, 22 December 2016, Appendix 4, p. 46.

> the statistical literature (Hastie et al. 2009), and its strengths and failings have been well researched. Further details of this framework can be found in Appendix 4A.

384. DBP addressed this issue by implementing the Authority's suggestions.[344]

385. In its statistical review for the Authority, Pink Lake considers that much of the discussion provided by DAA (2016)[345] with regard to model bias is largely irrelevant as it only states the obvious, and only examines the question of model appropriateness from the perspective where the Authority's position is *a priori* rejected (see paragraph 284 above). As such, Pink Lake is of the view that if the Authority's position – to not account for the α in estimation – was *a priori* accepted, then 'the problem of bias essentially vanishes'.[346]

386. In relation to ESQUANT's report prepared for DBP, Pink Lake is of the view that ESQUANT's findings on cross-validation are again largely self-evident.[347] Pink Lake considers that ESQUANT only examines the question of model appropriateness from the perspective where the Authority's position is *a priori* rejected, so the results do not add anything new to determining the return on equity.[348]

387. Pink Lake also considers that a one-step ahead time series cross-validation, consistent with ESQUANT's findings and recommendations, should be adopted by the Authority. Pink Lake notes that if forecasts over longer time horizons are required then time series cross-validation with overlapping data should be adopted.[349]

388. Pink Lake then concludes that a cross-validation approach is recommended over and above the model adequacy test. Pink Lake notes that:[350]

> Mathematically more complex situations arise when one considers the high sensitivity of the ZBP [zero beta premium] estimate to decision parameters, and when the ZBP has high variance. Hence, to enable a capacity to deal with these complex situations then the cross-validation approach should be preferred. In contrast, the model adequacy test will likely not be informative in these more complex situations, regardless of any other arguments for or against the model adequacy test.

389. The Authority notes these alternate views on the most appropriate statistical method. However, the Authority considers that it is a second order issue, given the more important conceptual and empirical issues that are at stake. For that reason, the Authority no longer considers that the *method* of the test provides much to distinguish the Authority's approach from DBP's proposed approach.

Data issues

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344 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 54.

345 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, Appendix K.

346 Pink Lake Analytics, Statistical Advice to the ERA on DBP's Submission 56, May 2016, p. 27.

347 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, Appendix I.

348 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, Appendix I.

349 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, Appendix I.

350 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, Appendix I.

390. Given that the Authority's conclusion that the SL-CAPM is the only robust model for estimating the return on equity in the Australian context is the SL-CAPM, the Authority does not see any current need for data sourced from the SIRCA SPPR database, as suggested by DBP.[351]

Consistency between debt and equity

391. The Authority notes DBP's consistency check – based upon theoretical insights as to the relationship between debt and equity – plays a key role in DBP's point estimate of the return on equity. DBP utilises it to narrow the range of the return on equity estimates, and thereby achieve its final estimate.[352] DBP notes that the approach is an application of options pricing, which is a well-established body of work within the finance field.

392. DBP's view in relation to the relationship between the required return on debt and equity was based on the advice from its consultant on the issue, SFG Consulting and subsequently, Frontier Economics (which subsumed SFG Consulting).[353,354]

393. In its report prepared for DBP in December 2014, SFG considered that one of the key insights of the so-called 'Merton framework' is that the equity risk premium and the debt risk premium must be linked. Specifically:[355]

> The linkage between the required returns on debt and equity in the same benchmark firm appears to be central to the NGR 87(5) requirements to have regard to all relevant evidence, consistency, and interrelationships between parameters for equity and debt. The Merton model provides the standard framework for modelling the linkage between the required returns on debt and equity in the same firm. The Merton framework shows that there are clear linkages between the required return on equity, the required return on debt, the elasticity between equity and debt and the relative volatilities of equity and debt.

394. SFG then argued that the Merton framework can be used in a regulatory setting as a check of the consistency between the allowed return on equity, a check of the interrelationships between parameters that are common to the return on equity and the return on debt, and as a check on the overall reasonableness of the allowed return on equity relative to the allowed return on debt.[356]

395. SFG noted that the Merton framework can be used in a number of ways.[357] *First*, an allowed return on debt and an empirical estimate of elasticity jointly provide information about what would be a reasonable range for the required return on equity. *Second*, an allowed return on debt and an allowed return on equity jointly

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351 DBNGP Transmission Pty Ltd, Proposed Revisions DBNGP Access Arrangement, 2016 – 2020, Rate of Return, Supporting Submission: 12, 31 December 2014, p. 55.

352 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 58.

353 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016.

354 DBP, Proposed Revisions DBNGP Access Arrangement, 2016 – 2020 Regulatory Period, Rate of Return, Supporting Submission: 12, 31 December 2014, Appendix L.

355 DBP, Proposed Revisions DBNGP Access Arrangement, 2016 – 2020 Regulatory Period, Rate of Return, Supporting Submission: 12, 31 December 2014, Appendix L.

356 DBP, Proposed Revisions DBNGP Access Arrangement, 2016 – 2020 Regulatory Period, Rate of Return, Supporting Submission: 12, 31 December 2014, Appendix L, p. 13.

357 DBP, Proposed Revisions DBNGP Access Arrangement, 2016 – 2020 Regulatory Period, Rate of Return, Supporting Submission: 12, 31 December 2014, Appendix L, p. 13.

imply a particular elasticity, which can then be tested against elasticity benchmarks for the regulated firm. [358]

396. In its report, SFG emphasised that it does not suggest that this framework can be used to obtain a single point estimate of the required return on equity from the analysis of primary data. SFG argued that the Merton framework is very useful when considering the relationship between the required return on equity and the required return on debt for the same firm and that this framework provides valuable insights into the relativity between these two quantities.[359]

397. In its Draft Decision for DBNGP, the Authority considered both the theoretical and practical aspects of the method.[360]

398. First, with respect to theoretical considerations, the Authority questioned the evidence for the direct link between the cost of debt and the return on equity. In addition, the Authority was of the view that the quantitative constraint between the cost of debt and the return on equity is not robustly established.

399. Second, with respect to the empirical aspect, the Authority noted that SFG's analysis was not robust. The Authority considered that simple evaluations indicate that a lower bound of the elasticity between the cost of debt and the return on equity in SFG's analysis is much higher than 6. The Authority noted that SFG's analysis produces non-sensible outcomes in relation to the MRP/return on equity, when various plausible estimates are used to evaluate the relationship between the cost of debt and the return on equity. The Authority evaluated the following: (i) the elasticity between the cost of debt and the return on equity; and (ii) the adjusted debt spread from SFG's analysis. Inter alia, the Authority observed that the outcomes of the estimates of elasticity are very sensitive to the input parameters and to any associated interpretation of the evidence.

400. In conclusion, the Authority was of the view that SFG's proposed approach to estimating the quantitative relationship between the cost of debt and the return on equity for DBP was flawed and as a result, this approach should not be adopted.

401. In response, DBP engaged Frontier (Professor Stephen Gray, formerly SFG Consulting) to review the Authority's position set out in the Draft Decision.[361] Frontier considers that:

> …it is unreasonable to conclude that the large literature that has followed the seminal work of Merton (1974) is not relevant to a regulatory task that requires consideration of all relevant evidence, consistent application of financial parameters that are common to the return on equity and the return on debt, and consideration of any interrelationships between estimates of financial parameters that are relevant to the estimates of the return on equity and the return on debt.
>
> … Applying the internal consistency test to the latest market data and to the contemporaneous return on debt estimates provided to us by DBP produces a lower bound for the equity risk premium of 7.76% to 8.17%. This test would be applied by

[358] DBP, Proposed Revisions DBNGP Access Arrangement, 2016 – 2020 Regulatory Period, Rate of Return, Supporting Submission: 12, 31 December 2014, Appendix L, p. 13.

[359] DBP, Proposed Revisions DBNGP Access Arrangement, 2016 – 2020 Regulatory Period, Rate of Return, Supporting Submission: 12, 31 December 2014, Appendix L, p. 13.

[360] Economic Regulation Authority, Draft Decision on Proposed Revisions to the Access Arrangement for the Dampier to Bunbury Natural Gas Pipeline, 22 December 2016, Appendix 4C, p. 240.

[361] DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, Appendix C.

> comparing a proposed equity risk premium with this lower bound, and rejecting any estimates that fell below the lower bound.

402. The Authority then re-engaged Professor Martin Lally to provide further expert advice on the issue and to respond to Frontier's contentions.[362]

403. In his report, Lally considers the key issues on which the Authority based its rejection of DBP's proposed approach, based on the advice by SFG, with respect to the relationship between the required return on debt and equity. Each of these issues is discussed in turn below.

404. First, Lally notes the formula representing the relationship between the expected returns on equity and debt, as presented in SFG (2014), where Ω is the elasticity of equity returns relative to debt returns, is as follows:[363]

$$E(R_e) - R_f = \Omega\left[E(R_d) - R_f\right] \quad \text{(S1)}$$

405. In addition, SFG (2014) also presented a formula for the elasticity from Schaefer and Strebulaev (2008) to estimate the elasticity of equity returns relative to debt returns:[364]

$$\Omega = \frac{1}{\left(\frac{1}{\Lambda} - 1\right)\left(\frac{1}{L} - 1\right)} \quad \text{(S2)}$$

where:

Λ is the derivative of equity value with respect to the value of the firm and L is the market leverage ratio.

406. Lally notes that SFG (2014) appeared to attribute the above formula to Merton (1974). However, Lally considers that the formula does not arise there or even derive directly from Merton's analysis. Lally is of the view that the most that can be said is that Merton (1974) is the seminal paper in this area.

407. However, Lally notes that the above equation does link the costs of debt and equity:[365]

> The ERAWA (2015, Appendix 4C) rejects SFG's analysis on five grounds. Firstly, the ERAWA claims that the Merton (1974), Campello et al (2008), and Schaefer and Strebulaev (2008) papers do not provide relevant results for assessing the link between the costs of debt and equity. In response, Frontier (2016a, section 3.2) argues that they are relevant. I am perplexed by the ERAWA's claim. Equation (S1) does link the costs of debt and equity, and equation (S2) permits estimation of one of the parameters in equation (S1).

362 M. Lally, Review of Arguments on the Equity Risk Premium and the Risk-free rate, 9 May 2016.

363 M. Lally, Review of Arguments on the Equity Risk Premium and the Risk-free rate, 9 May 2016, p. 4.

364 Ibid.

365 M. Lally, Review of Arguments on the Equity Risk Premium and the Risk-free rate, 9 May 2016, p. 6.

408. The Authority has reviewed its reasoning in this context and accepts – in principle – the cross-check method proposed by DBP.

409. Second, in its Draft Decision, the Authority was of the view that the above equation rests on specific assumptions and therefore is not generally valid. Lally considers that the Authority's claim is true and the most important assumption is one that is not even acknowledged by either SFG (2014a) or Campello et al (2008) – that corporate bond prices are not affected by the inferior liquidity of corporate bonds relative to the risk-free rate.[366]

410. Third, the Authority in the Draft Decision cited Schaefer and Strebulaev (2008, page 1) in stating that structural models providing poor explanations of bond prices, because they are poor predictors of default and do not incorporate factors other than credit risk, which implies that equation (S2) is not useful.[367] In response, Frontier in turn cites Schaefer and Strebulaev (2008, page 1) in stating that, despite such limitations, these models provide good estimates of the elasticity coefficient in equation (S1).[368] Lally considers that Frontier's claim may be true and, if so, would be sufficient to justify using equation (S2) to estimate the elasticity coefficient in equation (S1). However, Lally also considers that the Authority's point is also true and, more importantly, is relevant not to equation (S2), but to the credibility of SFG's method.[369] In particular, SFG/Frontier's application of the method errs in ignoring the impact of the illiquidity of corporate bonds (relative to the risk-free rate) on the DRP of corporate bonds.

411. Fourth, the Authority raised the issue of whether debt and equity prices are determined in the same (integrated) market, rather than being determined in segmented markets, citing the work of Handley.[370] Lally agrees with DBP's response that it is implausible that debt and equity in the same firm would be priced independently and inconsistently in segmented markets**.** However, Lally considers that:[371]

> I agree, but plausibility is secondary to the evidence. In particular, I am not aware of any evidence for inconsistent pricing and considerable evidence for consistent pricing. For example, Schaefer and Strebulaev (2008, section 5) find that bond returns are sensitive to returns on an equity index, a measure of volatility in equity returns, the return differential between large and small stocks, and the return differential between high and low book-to-market stocks, all of which have been found to be significant factors in equity returns.

412. Fifth, Lally agrees with the Authority's calculation that the lower bound on SFG's elasticity coefficient for a ten-year bond is 7 rather than 6.[372]

413. Sixth, Lally also agrees with the Authority's calculations that the estimate of the MRP using SFG's approach is implausible. In addition, Lally is of the view that these

366 M. Lally, Review of Arguments on the Equity Risk Premium and the Risk-free rate, 9 May 2016, p. 6.

367 Economic Regulation Authority, Draft Decision on Proposed Revisions to the Access Arrangement for the Dampier to Bunbury Natural Gas Pipeline, 22 December 2016, Appendix 4C, p. 240.

368 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, Appendix C, p. 11.

369 M. Lally, Review of Arguments on the Equity Risk Premium and the Risk-free rate, 9 May 2016, p. 6.

370 Economic Regulation Authority, Draft Decision on Proposed Revisions to the Access Arrangement for the Dampier to Bunbury Natural Gas Pipeline, 22 December 2016, Appendix 4B1, p. 243.

371 M. Lally, Review of Arguments on the Equity Risk Premium and the Risk-free rate, 9 May 2016, p. 7.

372 M. Lally, Review of Arguments on the Equity Risk Premium and the Risk-free rate, 9 May 2016, p. 7.

calculations inherit all of the deficiencies in SFG's analysis, particularly the failure to allow for illiquidity in corporate bonds.[373]

414. In addition, Lally also conducts his own analysis to support his view in relation to SFG's proposed approach with respect to the relationship between the required return on debt and equity. Each of the resulting inferences reported in Lally's analysis is discussed in turn below.

415. First, Lally considers that the premiums shown in equation (1) relate solely to risk, and therefore only data that relates to risk can be inserted. However, Lally notes that even after deducting expected default losses from the DRP, part of the remainder is compensation for the inferior liquidity of corporate bonds relative to government bonds. Lally is of the view that this has to be deducted, but SFG hasn't, and doing it would reduce the lower bound on the equity risk premium for the DBNGP.[374]

> The reasonable conclusion to draw is that Frontier does not dispute the point that the cost of debt contains an illiquidity allowance, and that it constitutes a significant proportion.

416. Second, Lally considers that neither SFG (2014) nor Frontier Economics (2016) is correct in relation to the selection of the credit rating for corporate bonds. Lally considers that the relevant bonds are in the wider BBB range and this is important because credit rating affects the default probability.[375]

417. Third, Lally is of the view that both reports prepared by SFG (2014) and Frontier Economics (2016) (including formerly SFG Consulting) have made the same error in relation to a combination between a default probability over a ten-year period (1.5 per cent) with other parameter values that relate to a one-year period. Lally argues that the correct calculation should have used the default probability for a one-year period.[376]

418. Fourth, Lally argues that since the bond in question is a ten-year one, the relevant default probability is that over the next ten years (converted to an annual equivalent) rather than the default probability over the next year.[377] Lally also notes that the former figure will be larger than the latter because it reflects the fact that a BBB bond with a residual life of ten years is highly likely to be re-rated over the next ten years ("ratings migration") and, whilst rating changes are approximately as likely to be up or down, the increase in the default probability from a downgrade is much higher than the reduction in the default probability from an upgrade.

419. Fifth, in relation to SFG's claim that an equity risk premium for DBNGP of 6.0 per cent is a lower bound, Lally argues that the calculation requires lower bounds for both the expected return on debt and the elasticity, and only the latter parameter estimate is a lower bound.[378]

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373 M. Lally, Review of Arguments on the Equity Risk Premium and the Risk-free rate, 9 May 2016, p. 7.

374 M. Lally, Review of Arguments on the Equity Risk Premium and the Risk-free rate, 9 May 2016, p. 8.

375 M. Lally, Review of Arguments on the Equity Risk Premium and the Risk-free rate, 9 May 2016, p. 8.

376 M. Lally, Review of Arguments on the Equity Risk Premium and the Risk-free rate, 9 May 2016, p. 8.

377 M. Lally, Review of Arguments on the Equity Risk Premium and the Risk-free rate, 9 May 2016, p. 8.

378 M. Lally, Review of Arguments on the Equity Risk Premium and the Risk-free rate, 9 May 2016, p. 9.

420. Sixth, Lally agrees with the Authority that the lower bound on the elasticity coefficient for a ten-year bond is 7 rather than 6 as presented by SFG (2014).[379] An increase in the estimate of the lower bound on the elasticity coefficient in the SFG's analysis effectively amplify the magnitude of the link between the required return on debt and equity which is increasingly implausible.

421. On the basis of the six errors above relating to SFG's analysis, Lally then considers the effect on the estimate of the elasticity coefficient when the above errors are corrected. Lally considers that the analysis requires upper and lower bounds on relevant parameter values, and midpoints.[380]

422. Lally corrects SFG's 2014 estimate for these errors, finding that it suggests that the equity risk premium of the DBNGP, should fall within the range of 0 per cent and 10.7 per cent, with a midpoint estimate of 5.3 per cent.[381] Lally notes that is not dissimilar to the Authority's Draft Decision estimate of 5.32 per cent.

423. In summary, in relation to SFG's proposed approach to directly derive the cost of equity from the observed cost of debt as a cross check, Lally concludes that:[382]

> …after correcting for the errors in the analysis by SFG (2014a) and Frontier (2016a), the resulting ranges for the ERP of the DBNGP do not conflict with any estimate by the ERAWA and are also very wide. Furthermore, these results arise from estimated ranges for the elasticity coefficient and the illiquidity allowance that are likely to be too narrow, and estimated ranges for the default probability and the expected recovery rate that are highly speculative. These bands of uncertainty are not an esoteric issue. If any of these four parameters are incorrectly estimated, the ERP for the DBNGP will also be incorrectly estimated using SFG's approach. In view of all this, I do not consider that this methodology contributes much to the existing approaches to estimating the ERP.

424. On balance, based on the above considerations, the Authority maintains its view that SFG's proposed approach to estimating the quantitative relationship between the cost of debt and the return on equity for DBP adds little and as a result, this approach should not be adopted as a method for determining the return on equity. However, the Authority utilises it as an additional cross check for the return on equity (see Step 4 below).

Conclusions with regard to relevant models and information

425. The Authority has significant concerns with DBP's estimate for the return on equity – both conceptual and empirical.

426. At the core of DBP's approach is the model adequacy test. However, this approach, which seeks to evaluate the forecast power of various models of the return on equity, is not appropriate for the purpose of estimating the return on equity for regulatory purposes.

427. Primarily, this is because asset pricing models seek to estimate the ex-ante return that investors require. Theory suggests that when prices are in equilibrium this required return is equal to the expected return. However, there is no guarantee that such expectations will be realised, or that prices are always in equilibrium. It follows

379 M. Lally, Review of Arguments on the Equity Risk Premium and the Risk-free rate, 9 May 2016, p. 9.

380 M. Lally, Review of Arguments on the Equity Risk Premium and the Risk-free rate, 9 May 2016, p. 9.

381 M. Lally, Review of Arguments on the Equity Risk Premium and the Risk-free rate, 9 May 2016, p. 12.

382 M. Lally, Review of Arguments on the Equity Risk Premium and the Risk-free rate, 9 May 2016, p. 13.

that differences between expectations and outcomes are a major problem for tests of asset pricing models, such as the model adequacy test undertaken by DBP.

428. In this context, DBP acknowledges that it is unable to test the Authority's method for setting the expected return in the SL-CAPM. The Authority's method takes into account a range of forward looking information. DBP instead substitutes a number of mechanistic approaches into the SL-CAPM which it tests, which do not reflect the Authority's method.

429. Subsequently, with its betastar transformation, DBP then seeks to quantify a beta adjustment for the SL-CAPM. DBP ultimately proposes an estimate for the return on equity that is derived within the SL-CAPM, but with the estimate of the beta term transformed to give an estimate underpinned by the Black CAPM. However, in doing so, DBP has led itself into error. This is because the betastar method adopted by DBP – to transform the results of the Black CAPM into the SL-CAPM – is fraught with conceptual and empirical problems. The method cannot be relied on to meet the requirements of the NGL and NGR. The betastar method:

- introduces a full quantum of ex post anomalous returns into the SL-CAPM beta term;
- thereby introduces an adjustment for the beta in the SL-CAPM which, perversely, introduces significant bias into what is an unbiased beta estimate;
- is 'ill-posed' in mathematical terms (that is, is increasingly distorted) as the ZBP/MRP ratio approaches 1, raising serious questions about the veracity of the resulting return on equity;

430. Beyond the fundamental flaw in the betastar transformation, DBP's resulting approach, based on the Black CAPM, suffers from the fact that estimates of the zero-beta return are unstable and cannot be relied on in the Australian context. As a consequence, the Authority is not convinced that the Black CAPM is an acceptable model for estimating the return on equity, given that the empirical implementation of the Black CAPM:

- is not robust – in contrast to the risk-free rate, the expected return on the zero beta asset is unobservable and there is no apparent consensus on methods for estimating this return;
- relies on an average zero beta return estimated over more than 20 years of data – which typically results in estimates of the zero beta return, and the imputed zero beta premium, being less reflective of prevailing market conditions than the risk free rate estimates utilized in the SL-CAPM; and
- is not widely used in practice – there is little evidence that other regulators, academics or market practitioners use the Black CAPM to estimate the return on equity.

431. This inappropriate use of the Black CAPM is exemplified by the nonsensical results that are produced by DBP's approach.

432. As a result, the Authority has determined that DBP's estimate of betastar should play no role in the determination of the return on equity for the DBNGP benchmark efficient entity. Accordingly, the Authority rejects DBP's proposed approach to estimating the return on equity for the DBNGP benchmark efficient entity.

433. These observations convince the Authority that the Black CAPM cannot be relied on. Accordingly, based on the foregoing evaluation, the Authority determines that

the SL-CAPM will be used as the primary means to estimate the return on equity for this Final Decision for the DBNGP benchmark efficient entity.

434. In making that decision, the Authority is reassured that, while a range of challenges to the Sharpe-Lintner CAPM have been raised over many years, the model has stood the test of time – it remains the dominant asset pricing model used to estimate firms' cost of capital in the finance industry.

435. In evaluating DBP's proposal, it has become clear that there is little evidence that the Authority's estimates of beta used in the SL-CAPM are biased. The Authority is satisfied that once the 'low beta' bias issue is properly framed, there is no evidence to justify any adjustment to the Authority's estimates of the beta term for use in the SL-CAPM.

436. The Authority has concluded that, if any adjustment could be justified, it should apply to the intercept term in the SL-CAPM, thereby taking account of the alpha term arising in ex post tests of the model. However, the Authority is not convinced there is adequate evidence, at the current time, to justify making such an adjustment. The theory supports the view that no adjustment should be contemplated. Further, there is empirical support for the 'vanilla SL-CAPM' in the 'industry portfolio sort' tests undertaken by DBP.

437. The Authority acknowledges that there is much debate about whether an adjustment needs to be made to the SL-CAPM. This was recognised by the Authority in the Guidelines and Draft Decision, with reference to the theoretical properties of Black CAPM. However, analysis since, by the Authority and its consultants, in response to DBP, has made the Authority concerned that it would likely be making a greater error by making an adjustment to the SL-CAPM – through alpha – than by making no adjustment. The Authority is not convinced such an adjustment would meet the allowed rate of return objective, or the requirements of the NGO or the RPP.

438. Accordingly, the Authority has determined to retain the use of the 'vanilla' SL-CAPM for this Final Decision, with the beta parameter based on the central, best estimate. Further, in light of the foregoing, no adjustment is made for alpha.

439. The Authority is satisfied that the resulting return on equity derived using the SL-CAPM is consistent with the allowed rate of return objective, and with the other requirements of the NGL and NGR. The Authority considers that the resulting SL-CAPM estimate for the return on equity:

- is reflective of economic and finance principles and market information;
- is fit for purpose, which is reflected in its broad acceptance in the finance industry as a means for estimating the cost of capital;
- can be implemented in accordance with good practice;
- is parsimonious, is not unduly sensitive to errors in inputs or arbitrary filtering, and is therefore difficult to game;
- uses input data that is credible and verifiable, comparable and timely and clearly sourced;
- is sufficiently flexible to allow for changing market conditions and new information to be reflected in regulatory outcomes, as appropriate.

440. In summary, the Authority determines the following for the purpose of estimating a return on equity in this Final Decision:

- The SL-CAPM will be utilised to estimate the return on equity.
- The Fama French (three factor) Model is not relevant and will not be used for the purpose of estimating a return on equity.
- The Black CAPM is relevant for informing the theory of the return on equity.
  - However, given it is not reliable and practical to estimate a robust return on equity using this model, the model will not be used directly.
  - Neither is it used indirectly. It is only used now to inform the theory of the return on equity.
  - A revised consideration of the theoretical implications of the model makes clear that no adjustment to equity beta is appropriate. In addition, the Authority considers that there is no compelling evidence to apply an alpha adjustment to the return on equity determined by the vanilla CAPM, as a means to account for 'low beta bias' observed in ex post returns, at the current time.
- The DGM is a relevant model for informing the market return on equity and also the forward looking MRP.
- Other information such as historical data on equity risk premium; surveys of market risk and other equity analysts' estimates are also relevant for the purpose of estimating the MRP and the market return on equity. In addition, DBP's primary cross-check method is also accepted. This other material will be used as a cross check for the return on equity.

441. The Authority remains of the view that its reasons for adopting the SL-CAPM are sound. The Authority considers that its application of the SL-CAPM meets the requirements of the NGL and NGR, including the allowed rate of return objective.

442. Accordingly, the Authority considers that the estimated return on equity adopted in this Final Decision is commensurate with the equity costs incurred by a benchmark efficient entity with a similar degree of risk as DBP with respect to the provision of reference services. The Authority therefore considers that the estimated rate of return meets the allowed rate of return objectives and the requirements of the NGR and NGL.

443. In line with the requirements of NGR 87(5), the Authority has evaluated the relevance of a broad range of material for estimating the return on equity, covering relevant estimation methods, financial models, market data and other evidence for this Final Decision.

Step 2 – Estimate parameters for the relevant models

Estimate of the risk free rate

444. The risk free rate is based on a 5 year term to maturity, determined as the average of the observed yields of the 5-year Commonwealth Government Securities over the nominated 20 Sydney business day averaging period that is just prior to start of the regulatory period.

445. The Authority notes DBP's nomination of the averaging period for the reference tariff proposed to apply from 1 July 2016, is the period of 20 Sydney trading days ending on 10 June 2016. As a result, the risk free rate for this Final Decision is 1.80 per cent.

Estimate of the equity beta

446. Following further evaluation of DBP's betastar claims, set out above, the Authority has determined that its estimate of the equity beta for use in the SL-CAPM is not biased. Accordingly, the Authority has determined that it will not adjust beta in determining the return on equity for this Final Decision. The task then is to determine the best, central estimate of beta.

447. Under the CAPM, the total risk of an asset is divided into systematic and non-systematic risk. Systematic risk is a function of broad macroeconomic factors (such as economic growth rates) that affect all assets and cannot be eliminated by diversification of the investor's asset portfolio.

448. The key insight of the CAPM is that the contribution of an asset to the systematic risk of a portfolio of assets is the correct measure of the asset's risk (known as beta risk), over and above the return on a risk free asset.

449. In contrast, non-systematic risk relates to the attributes of a particular asset. The CAPM recognises this risk can be managed by portfolio diversification. Therefore, the investor in an asset does not require compensation for this risk.

450. In the CAPM, the equity beta value is a scaling factor applied to the market risk premium, to reflect the relative systematic risk for the return to equity of the firm in question, as compared to the systematic risk for all assets. Two types of risks are generally considered to determine a value of equity beta for a particular firm: (i) the type of business, and associated capital assets, that the firm operates; and (ii) the amount of financial leverage (gearing) employed by the firm.

451. In the Rate of Return Guidelines, the Authority considered that empirical evidence provides the best means to inform its judgment for equity beta.[383]

452. However, as discussed above (paragraphs 378 to 380, there is conceptual support for the equity beta of an infrastructure network benchmark efficient entity being less than 1.[384] The Authority noted these views in the Draft Decision and considered that the reasoning is relevant.[385]

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383 Economic Regulation Authority, Explanatory Statement for the Rate of Return Guidelines: Meeting the Requirements of the National Gas Rules, December 2013, p. 161.

384 See for example Australian Energy Regulator, Draft Decision Jemena (NSW), Attachment 3: Rate of return, November 2014, p. 3-235.

385 In the Draft Decision, the Authority noted DBP's view that model adequacy tests suggest that application of the SL-CAPM is not estimating what low beta firms 'actually earn for their equity investors' (Dampier Bunbury Pipeline, DBP Submission to ATCO Draft Decision, 7 January 2015, p. 3). However, the Authority considers that the evidence provided by DBP does not accord with the well accepted theoretical underpinnings of the CAPM, in that it suggests that as beta (systematic risk) declines, the equity risk premium increases. This raises significant issues for the DBP empirical analysis, and the underlying quality of the data that is used for that analysis.

Similarly, the Authority considers that the points made by the ENA also refer to the same matters (Energy Networks Association, WA ERA Draft Decision for ATCO Gas ENA Response, 12 January 2015, p. 4). In particular, the evidence on the performance of SL-CAPM for low beta stocks evaluated by the ENA's consultant NERA utilises the same SIRCA database which is used by DBP (see NERA Economic Consulting, Estimates of the zero-beta premium, June 2013, p. 15). Furthermore, as a related point, the Authority does not consider that the four estimates cited by ENA are robust in the Australian context.

At the current time, the Authority remains of the view that the conceptual foundation of the CAPM supports the estimates of the return on equity set out in this Final Decision.

453. Nonetheless, the conceptual analysis does not provide sufficient grounds to establish the point value of the equity beta. To inform its decision on the point value, the Authority conducted a detailed empirical estimation of the required equity beta as part of the development of the Rate of Return Guidelines.[386]

454. In its Guidelines, the Authority evaluated the following issues in relation to the estimates of equity beta; including:

- the level of imprecision for any empirically estimated value of the equity beta;[387]
- a range of other issues, including those relating to sampling and instability; and
- that it was inappropriate to include overseas businesses in the comparator sample which was used to estimate the required equity beta of the benchmark efficient entity.[388]

455. The Authority noted in the Guidelines that it would update its estimate of beta at the time of each access arrangement decision.[389]

456. For this Final Decision, the Authority will continue to estimate beta in the way that was set out in the Guidelines, albeit updated. Given the decision not to adjust beta – as set out in 'Step 1 – Identifying relevant materials' above – the Authority adopts the best, central estimate of beta.

457. The Authority notes that DBP states that it has no issue with the Authority's revised estimates for beta that were set out in the Draft Decision:[390]

> In respect of beta, DBP has no issue with the estimation of beta as undertaken by the ERA; when we use five years of weekly, end-of-the-week returns, we obtain roughly the same results the ERA does.

458. The Authority therefore takes DBP's broad acceptance of the beta material set out in the Draft Decision, apart from a number of issues which it raised in its response to the Draft Decision. For example:[391]

> We do, however, have two issues in respect to beta:
>
> (a) The estimate of beta the ERA has used of 0.7 produces a result which is not consistent with the approach it has used in the past, because it has failed to take into consideration the changes in its beta estimation.
>
> (b) The second relates to a potential issue concerning the efficiency of the market portfolio.

Response to DBP's issues regarding the estimate of beta

386 Econometric analysis of beta was conducted in: Economic Regulation Authority, *Explanatory Statement for the Rate of Return Guidelines*, December 2013, Chapter 12. Justification and explanation for econometric techniques was provided in Economic Regulation Authority, *Appendices to the Explanatory Statement for the Rate of Return Guidelines*, December 2013, Appendix 17, 22 and 23.

387 Economic Regulation Authority, *Explanatory Statement for the Rate of Return Guidelines*, 16 December 2013, p. 162.

388 Economic Regulation Authority, *Explanatory Statement for the Rate of Return Guidelines*, December 2013, p. 188.

389 Economic Regulation Authority, *Explanatory Statement for the Rate of Return Guidelines*, 16 December 2013, p. 197.

390 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 63.

391 Ibid.

459. First, the issue raised by DBP that the Authority's Draft Decision estimate of beta, of 0.7, was not consistent with the approach used in the past, refers to the Authority's previous practice of adjusting beta for so-called low beta bias. However, the Authority indicated in the Rate of Return Guidelines that it would review the evidence for beta adjustment.[392] On the basis of the review set out in this Final Decision, the Authority now considers that there is no evidence to support it making an adjustment to beta. Accordingly, the Authority adopts the central, best estimate of beta for this Final Decision. DBP's point has no bearing on the central, best estimate, as no adjustment is being made. Accordingly, it is not considered further.

460. However, relevant to that central estimate, DBP raises the issue of a structural break in the estimate of beta, around late 2014, for rolling three year betas, and for five-yearly betas in April 2012 (value-weighted portfolios) and September 2013 (equal weighted portfolios).[393] DBP contends that:[394]

> The changing confidence interval in the ERA's own analysis points to a deeper issue in respect of beta. That is, beta appears to be changing, and changing substantially, over the past twelve months. Figure 5 provides a comparison of rolling three and five-year betas over the past several years.

461. However, it is not exactly clear what DBP's point is:[395]

> Both beta calculations give roughly similar results until around the end of October 2014. From the end of that date, both begin to trend upwards (as do the ERA's results), but the three-year betas trend upwards much more sharply. For a value-weighted portfolio, the mean beta estimate, before an adjustment for bias (like the ERA's choice of 0.7 is around 0.95 and, as CEG points out, the lower bound of the 95 percent confidence interval for a three-year beta is, at present, above the bias-adjusted figure that the ERA uses for beta.

462. The Authority takes the point that the beta is changing, and that there is then a question of the appropriate averaging period. The Authority notes conflicting views on this topic. For example, SFG submitted to the Authority that it considers it 'implausible' that equity beta estimates could change over a two year period.[396] However, the rolling beta estimates produced by the Authority in the Guidelines convinced it that, for individual firms, the relative sensitivity to systematic risk can vary quite dramatically.[397] The Authority has no reason to believe that this does not reflect a re-rating by the market of the respective firms, in terms of risk relative to the market.

463. Therefore, the Authority considers there is no issue with the fact that the measure of beta does change over time – that is exactly why it undertook, in the Rate of Return Guidelines, to update its estimate of the beta just prior to its Final Decision.[398] That said, the Authority considers that five years provides an appropriate estimation

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392 Economic Regulation Authority, *Explanatory Statement for the Rate of Return Guidelines*, 16 December 2013, p. 162.

393 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 65.

394 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 64.

395 Ibid.

396 ATCO Gas Australia, *ATCO Gas Australia's Response to the ERA's Draft Decision*, 22 December 2014, Appendix 9.1, p. 9.

397 Only HDF falls outside the estimated range.

398 Economic Regulation Authority, *Explanatory Statement for the Rate of Return Guidelines*, 16 December 2013, p. 197.

period which smooths out short term fluctuations in beta. The Authority does not consider it appropriate to depart from its current practice, of placing emphasis on the five year estimates, simply because the data suggests that a higher estimate of beta could be obtained by using a shorter averaging period. Nonetheless, the Authority notes that information.

464. Second, the Authority dealt with the issue of the efficiency of the market portfolio at paragraph 324 to 326 above.

465. DBP also argued that the Authority's approach to selecting beta based on confidence intervals is flawed. DBP argued that:[399]

> In essence, confidence intervals tell one something about the precision of a parameter estimate (such as of beta) within a given model. However, it tells one nothing about the performance of that model itself. A model can perform very poorly but still have very precisely estimated parameters. The issue of low-beta bias is not a problem in the estimation of beta per-se. As DAA point out, that can be improved simply by increasing sample size. The issue is rather that the outputs of the model produce results which are systematically wrong; too low where the beta of a stock is below one and too high when the beta of a stock is above one.

466. However, the Authority does not accept DBP's point here, for the reasons set out under 'Step 1' above. DBP is wrong to criticise the Authority's beta estimates on a basis that is, at its essence, a point about model adequacy. The Authority has rejected DBP's 'model adequacy test' approach to estimating the return on equity. However, the Authority notes that DBP considers that 'the issue of low-beta bias is not a problem in the estimation of beta per-se'.

The Authority's updated estimates of beta for this Final Decision

467. The following Table 1 reports a range of estimates of Australian infrastructure betas from various sources, with an emphasis on the most relevant and recent.

Table 1 Australian estimates of equity beta

Study	Period	Average of individual firms	Fixed portfolios	Varying portfolios
ERA 2015	2000 - 2015	0.41 – 0.81		
Henry 2014	1992-2013	0.37-0.56	0.38 – 0.71	0.39-0.53
Grant Samuel 2014	2009-2014	0.42-0.64		
ERA 2013	2002-2013	0.48-0.52	0.39-0.59	
SFG2 2013	2002-2013	0.60		0.55
ERA 2012	2002-2011	0.44-0.60		
Henry 2009	2002-2008	0.45-0.71	0.35-0.94	0.41-0.78
ACG 2009	1990-2008	0.50-0.58		0.69-0.91
Henry 2008	2002-2008	0.35-0.67	0.31-0.77	
ACG 2002	2000-2002	0.61-0.69		

Source: The AER's Draft Decision for ActweAGL Distribution Determination, Table 3-55, page 3-262 and the ERA's 2015 study (Economic Regulation Authority, *Draft Decision on Proposed Revisions to the*

[399] DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Regulatory Period Supporting Submission: 60 Response to Australian Competition Tribunal Decisions, 22 March 2016, pp. 8-9.

Access Arrangement for the Dampier to Bunbury Natural Gas Pipeline, 22 December 2016, Appendix 4Aii, p. 233 – 234.

468. The detail of the Authority's 2015 study set out in the table was reported at Appendix 4Aii of the Draft Decision.

469. The Authority noted in the Draft Decision it considered that the 95 per cent confidence interval for the beta estimate was 0.3 to 0.8.[400] The Authority then determined a point estimate for beta at 0.7, allowing for some adjustment towards the top end of the range to account for the theory underpinning the Black CAPM.

470. DBP contends that the Authority's approach to calculating averages has the effect of artificially lowering the range for beta and does not accord with the Henry approach considered by the Tribunal. DBP states:[401]

> Specifically, the ERA makes four estimates for the individual firms and then two different portfolio estimates. The upper and lower bounds of 0.81 and 0.41 (respectively) are formed by averaging across the six upper bounds of confidence intervals for the LAD regression estimates and the six lower bounds of the LAD regression estimates (the LAD estimates exhibit the widest range - see DDA4 Table 29, page 194). By contrast, Henry (2014) does not mix portfolio and individual estimates in this way, and reports his ranges as the minimum and maximum of the confidence intervals for each set of regressions, rather than the averages across lower and upper bounds.
>
> Three of the four firms examined by the ERA (APA, AST and SKI) give similar results to the portfolio results, generally, but one (DUET) gives results which are substantially below the other three firms, and the portfolios. By forming the averages in the way that it has, the ERA has effectively given disproportionate weight to DUET, and has dragged down its averages accordingly.

471. The Authority accepts these points in principle, rather than substance (there are issues with the numbers DBP quotes, and its subsequent inferences). The Authority takes account of those points in what follows.

The Authority's 2016 estimates

472. For this Final Decision, the Authority had Pink Lake Analytics further update the beta estimates for this Final Decision, in part to address the data issues that had been raised by HoustonKemp.[402] The detailed results are reported at Appendix 4A, with a key table reproduced here (Table 2).

400 Economic Regulation Authority, Draft Decision on Proposed Revisions to the Access Arrangement for the Dampier to Bunbury Natural Gas Pipeline, 22 December 2016, Appendix 4, p. 52.

401 Ibid.

402 Pink Lake Analytics, *Variance of the ZBP estimator*, June 2016, Appendix G, p. 59.

Table 2 Estimates of equity beta for individual firms and the two weighted portfolios in May 2016 for different estimation methods

	APA	AST	DUE	SKI	Mean Assets	EW	VW	Mean Portfolios	Mean All
Gearing	0.440	0.562	0.627	0.277	**0.476**	0.476	0.484	**0.480**	0.477
OLS	0.682	0.671	0.170	0.716	**0.560**	0.638	0.665	**0.652**	0.591
LAD	0.662	0.705	0.243	0.724	**0.584**	0.740	0.778	**0.759**	0.642
MM	0.665	0.675	0.268	0.776	**0.596**	0.703	0.715	**0.709**	0.634
T-S	0.647	0.661	0.263	0.713	**0.571**	0.669	0.681	**0.675**	0.606
Mean OLS, LAD, MM, T-S	**0.664**	**0.678**	**0.236**	**0.732**	**0.578**	**0.687**	**0.710**	**0.699**	**0.618**
ARIMAX	0.683	0.636	0.164	0.690	**0.543**	0.620	0.651	**0.636**	0.574
GARCH	0.618	0.673	0.254	0.731	**0.569**	0.677	0.681	**0.679**	0.606
Mean of all above methods	**0.660**	**0.670**	**0.227**	**0.725**	**0.570**	**0.675**	**0.695**	**0.685**	**0.609**

Source: Pink Lake Analytics, Variance of the ZBP estimator*, June 2016, Appendix xx???*

473. Drawing on the results reported in Appendix 4A, the Authority considers that a 95 per cent confidence interval range of equity beta using the most recent data is from 0.479 and 0.870 based on the portfolio results (see Appendix 4A, Table 21 and Table 22). The central estimate given by the average of the portfolios is 0.699. The Authority notes that portfolio estimates have a narrower range than the individual assets.

474. Based on its own analysis and the other evidence before it, together with the recognition that estimates of equity beta from empirical studies exhibit a high level of imprecision, the Authority is of the view that the point estimate of equity beta of 0.7 (rounded) provides a conservative and appropriate central best estimate for beta for use in the SL-CAPM.

Conclusions with regard to equity beta

475. Based on the above considerations, the Authority is of the view that available Australian estimates of equity beta are reliable and that the estimates from these studies should be used to determine an appropriate equity beta for a network service provider.

476. The Authority considers that available estimates of equity beta in Australia, including Henry's studies and the Authority's own analyses, as presented in Table 1 and Table 2 above, as well as submission material from DBP, indicate a best equity beta estimate of (a rounded) 0.7. Rounding the estimate to one significant figure accounts for the acknowledged imprecision of the estimate.

477. That estimate gives greatest weight to the Authority's 2016 estimates of equity beta – using data for the most recent 5 years.

478. On balance, the Authority remains of the view that it is appropriate to account for a range of evidence in its determination of the equity beta point estimate. Based on

its considerations outlined above, the Authority has determined to adopt the estimate of equity beta of 0.7 for this Final Decision for the DBNGP.

Estimate of the Market Risk Premium

479. The Authority set out in the Draft Decision that its views on the best means to estimate the forward looking MRP have evolved in recent decisions.[403]

480. The Authority gained access to the Brailsford, Handley and Maheswaran's (**BHM**) data during the development of the Rate of Return Guidelines, enabling it to undertake statistical testing on the long run average market return on equity and MRP, in order to ascertain whether each series was stationary (in the sense of being mean reverting). Stationarity is an important property of a data set if historic averages are to be used as a predictor for outcomes likely to prevail over future periods.

481. The results indicated the market *return on equity* was stationary.[404]

482. However, the results produced mixed evidence on the stationarity of the MRP, with the analysis supporting a conclusion that the MRP is non-stationary.[405,406] This finding led the Authority to the important conclusion that its previous long run historical estimate of 6 per cent could be a poor predictor of the MRP prevailing in future regulatory periods. The Authority therefore dropped the fixed estimate of 6 per cent, instead establishing a range of possible future outcomes for the MRP, informed by information that a rational market participant would use in making investment decisions.[407]

483. Furthermore, the Authority concluded that it is not reasonable to constrain the MRP to a fixed range over time. The random behaviour of the risk free rate in Australia to date, and more particularly, its pronounced decline in the current economic environment, leads to a situation where the combination of a fixed range for the MRP and prevailing risk free rate may not result in an outcome which is consistent with the achievement of the average market return on equity over the long run.

484. For this reason the Authority set out in the Draft Decision that it considers it appropriate to determine a range for the MRP at the time of each decision.[408]

485. As was set out in the Draft Decision, the range for the forward looking MRP is determined using both historical data and forward looking data/information. The range for the 5 year forward looking MRP in the Draft Decision was 5.5 to 9.7 per cent. The lower bound of the range is informed by the Ibbotson average excess

403 Economic Regulation Authority, Draft Decision on Proposed Revisions to the Access Arrangement for the Dampier to Bunbury Natural Gas Pipeline, 22 December 2016, Appendix 4, p. 58.

404 Economic Regulation Authority, *Appendices to the Explanatory Statement for the Rate of Return Guidelines*, 16 December 2013, Appendix 8, p. 63 and Appendix 16.

405 Economic Regulation Authority, *Appendices to the Explanatory Statement for the Rate of Return Guidelines*, 16 December 2013, Appendix 8, p. 63 and Appendix 16.

406 Further support for the non-stationarity of the MRP is given by the finding that the risk free rate is non-stationary (Economic Regulation Authority, *Appendices to the Explanatory Statement for the Rate of Return Guidelines*, 16 December 2013, Appendix 16). As the market return on equity is comprised of the risk free rate and the MRP, if follows that then that MRP must be non-stationary, by construction.

407 Economic Regulation Authority, *Explanatory Statement for the Rate of Return Guidelines*, 16 December 2013, p. 137.

408 Economic Regulation Authority, Draft Decision on Proposed Revisions to the Access Arrangement for the Dampier to Bunbury Natural Gas Pipeline, 22 December 2016, Appendix 4, p. 59.

premium over the 5 year risk free rate; the upper bound of the range is informed by an upper bound of recent DGM estimates.

486. The first issue is to determine the range for the forward looking MRP, taking into account various sources of information and data. The second issue then is to select the point estimate of the MRP, reflecting the prevailing market conditions.

487. The selection of the point estimate from within the range involves a high degree of a regulatory discretion, given the difficulties associated with mechanistic approaches to establishing the forward looking MRP.

DBP's response to the revised approach to estimating the MRP

488. DBP's concerns in its response to the Authority's Draft Decision regarding the Authority's estimate of the forward looking MRP appear to be:

(i) the Authority's estimate of the MRP changes at each regulatory decision, based upon how it interprets a number of 'forward looking' indicator variables; and

(ii) the Authority's use of conditioning variables including dividend yields; default and interest rate swaps spreads; and the stock market volatility index do not add any robustness to its estimates.

489. These principle points relate to how the specific point estimate of the forward looking MRP is derived. DBP does not raise issues with regard to the estimate of the MRP range.

490. These concerns, among others, are discussed in what follows.

491. First, the forward looking MRP is unobservable. Here, the Authority agrees with DBP that the SL-CAPM is not a model of the MRP.[409] Rather, the ex ante MRP is an input into the SL-CAPM. It is worth re-iterating here the point made by Partington and Satchell:[410]

> So let us be absolutely clear that the purpose of asset pricing models is to determine the ex-ante return that investors require. When prices are in equilibrium this required return is equal to the expected return, but there is no guarantee that expectations will be realised, or that prices are always in equilibrium.

492. As a result, the Authority's standard practice is to use various sources of information/data to determine a possible range of the expected MRP, and then to select a point estimate from within this range.

493. The Authority considers that it can only do this at the time of its decision, as it needs to take into account the prevailing information/data, and to exercise its judgment as to the relative importance of the various relevant information. The Authority's view is that it cannot be a mechanistic process. Hence, it is not amenable to pre-determination through some algorithm.

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409 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 39.

410 Partington, G. and Satchell, S., Report to the ERA: The Cost of Equity and Asset Pricing Models, May 2016, p. 7.

494. Second, with regard to this standard practice, DBP questions the relevance of the forward looking indicators.[411] Based on the advice of Esquant, DBP's consultant on the issue, DBP considers that:[412]

> The key finding of ESQUANT was that none of the individual forward-looking indicators is co-integrated with either market returns or the MRP, and hence any relationship between them would be entirely spurious (see Original AA Proposal para 5.185). This means, effectively that each individual indicator is actually revealing nothing meaningful at all about the MRP, and the ERA's assessment from paragraph 321 to 336 (pp70-4) which relies upon considering each indicator in turn (the ERA appears to have abandoned its approach of forming an index as per the ATCO Draft Decision; time-varying weights or no) of the Draft Decision is meaningless.

495. DBP's initial proposal inferred that the Authority proposed to use an 'index' composed of the forward looking indicators – as this was a position set out in the Guidelines, and also the approach set out in the ATCO Gas Distribution System Draft Decision. DBP engaged Esquant to determine whether the Guidelines index or indicators are empirically related to the MRP and market returns. Esquant's terms of reference set out by DBP were as follows:[413]

> Regress the four driver variables on the market risk premium (market returns minus the five and ten year CGS; two separate regressions), taking all due care in respect of statistical issues such as stationarity, serial correlation, multicolinearity and heteroscedasticity, and provide a report on the robustness of these statistical estimates.
>
> Examine the regression for any structural breaks, and also examine Granger Causality between the dependent and independent variables (we are interested in understanding what drives what; if the MRP drives these variables rather than the other way around, then clearly they cannot be leading indicators of it).
>
> Use the coefficients to re-weight the weighted average the ERA has constructed; with the understanding that some (or indeed all) of the weights may be zero.

496. Esquant's analysis proceeded on the basis the Authority's approach to using the four forward looking indicators involved an index, consisting of the four variables, mechanistically applied at each determination. This mechanistic approach was outlined in equation (3).

$$\begin{aligned} Index_t = {} & w_{VIX}\,(\text{Volatility Index}_t) + w_{DY}\,(\text{Dividend Yield}_t) \\ & + w_{IRS}\,(\text{5 Year IRS Spread}_t) + w_{DS}\,(\text{Default Spread}_t) \end{aligned} \tag{3}$$

where:

w_{VIX}, w_{DY}, w_{IRS}, and w_{DS} are the weights assigned to each variable.

497. A key point to note is that the weights have no t subscript attached, implying that the weights *do not vary through time.*

411 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 62.

412 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, pp. 62-63.

413 N.Diamond, *Estimating the Market Risk Premium: A Report for DBP*, Esquant Statistical Consulting, 24 December 2014, p. 4.

498. In the Draft Decision, the Authority noted that DBP and Esquant assumed various combinations of *time invariant* weighting for their analysis shown in Table 3.

Table 3 DBP/Esquant Time Invariant Weighting Assumed

Weight	w_{VIX}	w_{DY}	w_{IRS}	w_{DS}
Assumed ERA weights	0.1	0.3	0.3	0.3
Esquant's co-integrating weighting	1	-0.27	2.37	-1.34

499. The weightings in the first row of Table 3 were the initial weights proposed by the Authority in the Draft Decision for ATCO.[414] The weightings in the second row are those based on the results of Esquant's cointegration analysis, the output of which is a set of weights that create a stationary, or mean reverting index composed of the four variables.[415]

500. In its Draft Decision for DBNGP, the Authority noted that the methodology in the analysis undertaken by Esquant is both rigorous and conventional. However, the Authority considered that the assumption of time invariant weighting means the approach (represented by equation 3), analysed by Esquant, did not represent the approach that the Authority proposed in the Draft Decision for DBNGP. This is because the Authority applies its discretion at the date of *each determination* when considering the forward looking indicator variables.

501. The Authority does not fix the weights or even explicitly apply weights to the forward looking indicators. The circumstances driving changes in the forward looking indicators must be considered before determining whether the variable is useful in quantifying changes in the MRP. In addition, other factors outside the forward looking indicators may also be taken in to consideration when determining the MRP on a particular date.

502. The forward looking indicator variables are just one element of a broader set of information that the Authority takes into account when determining the MRP exercising a significant degree of regulatory discretion.

503. In response to the Authority's Draft Decision, DBP, based on the advice of Esquant, submits that ESQUANT's findings would not change at all if it had put t-subscript's on the weights or not.[416]

504. The Authority notes DBP's argument. However, it misses the point. It is empirically impractical to run regressions to determine co-integration of the indicators and the MRP, because the Authority's weighting of the indicators varies from decision to decision. The 'weighting' is not published as the Authority does not adopt a mechanistic approach. Rather, the information is accounted for in the Authority's overall exercise of regulatory discretion with regard to the forward looking MRP. Furthermore, the forward looking MRP adopted by the Authority for the purpose of estimating the return on equity may not be related to actual ex post outcomes for

415 N. Diamond, *Estimating the Market Risk Premium: A Report for DBP*, Esquant Statistical Consulting, 24 December 2014, p. 21.

416 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 62.

the MRP.[417] On a similar basis, the expected return on equity allowed through the Authority's decision may not necessarily reflect the ex post outcome either.

505. Accordingly, it is not possible for Esquant to test whether the forward looking indicators Granger-cause the market returns or the MRP, or vice versa.[418]

506. On this basis, the Authority is not convinced to depart from taking account of the forward looking indicator variables in its determination of the MRP. The Authority considers that selecting a point estimate of the forward looking MRP is a difficult process. As noted above, it cannot be a mechanistic exercise. At the same time, it should take account of relevant information.

507. On balance, the Authority considers that the four different conditioning variables – including (i) Dividend yields; (ii) Default spread; (iii) Interest rate swaps spreads; and (iv) Stock market volatility index are relevant information, as each of these indicators carries some degree of forward looking information into the next 5 years. The Authority agrees that the list of forward looking, relevant information is not exhaustive. However, the Authority considers that these four indicators can be considered to be informative of market forward looking expectations, and hence to be highly relevant guidance for the Authority's judgment. The Authority notes that these indicators are also used by other Australian regulators for the purpose of determining a return on equity and the cost of capital.

508. Third, the Authority notes DBP's contention that:[419]

> The risk-free rate in Australia, as measured by the CGS, is roughly 30 bps higher than the lowest point is has been at (roughly the same time as the ATCO Final Decision data were sourced) since 1969, and still the ERA has not used an MRP higher than that provided by the Wright method. Nor is it clear under what conditions the ERA would move towards what appears to be currently its highest bound, the DGM results.

509. As is apparent from the above, the Authority will determine its estimate of the MRP consistent with the information it has to hand at the time of each decision. The Authority does not consider that it is bound by the Wright method on the high side; rather, it is explicit in taking into account the higher range implied by the DGM. There may be times – for example during a high real interest rate regime as occurred in the 1980s and 1990s – where its estimate of the MRP may well have been above that implied by Wright.[420]

510. Fourth, DBP makes a number of other smaller points with regard to the MRP:[421]

> The change of approach to the MRP is the main "conceptual" issue the ERA raises in DDA4, but it also raises three smaller issues, as follows:

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417 This is a key point made regarding DBP's reliance on the 'model adequacy test', which is discussed under Step 1 above.

418 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 63.

419 Ibid, p. 39.

420 Real interest rates in Australia approached 8 per cent in 1991. Combining that with the (Ibbotson) lower bound of the forward looking MRP range of 5 per cent (give or take) would have given a real return on equity of 13 per cent at that time. That would be well above the historic average real return on equity over the past century or more of 8.71 per cent (reported in Table 5 below). The MRP implied by the Wright method at that time would have been close to zero.

421 Ibid, p. 40.

> (a) DBP cannot compare the Black CAPM and FFM with the SL-CAPM because the former two are not robust within the Australian context (para 167, p41 and para 173, p42).
>
> (b) DBP invokes the ERA's use of Diebold-Mariano tests as motivation for its model adequacy test, but this is not comparing apples with apples (para 945-6, p209).
>
> (c) The ERA is unconvinced that the ten portfolios DBP uses are relevant for testing the different models (para 959, p212)

511. With regard to point a) above, DBP avers that the model adequacy test circumvents the requirement for robustness, as 'the models that create the forecasts are irrelevant in respect of considering their errors'.[422] The Authority notes this point. The Authority remains of the view that the model adequacy test is flawed, for the reasons outlined in 'Step 1 – Identifying relevant material' above.

512. With regard to point b), as noted in 'Step 1 – Identifying relevant material', the model adequacy test is comparing the Authority's ex ante estimate of an *ex ante value* (not an ex post value), with the ex post actual outcome – that is apples and oranges. The Diebold-Mariano tests on the other hand are comparing an ex ante predictor of an ex post outcome with an ex post outcome – that is apples with apples.

513. With regard to point c), the Authority notes DBP's point in response, that it is reasonable to construct portfolios on the basis of the factor being evaluated.[423] In this context, the Authority notes Partington and Satchell's observation that the portfolio sort adopted by DBP is favourable to its case, but that alternative portfolio sorts tell a somewhat different story:[424]

> Results of asset pricing tests may differ according to the criteria used for sorting portfolios. In the current context it is appropriate to ask: What portfolios should we be considering? From a regulatory perspective, we want to estimate the return for the industry that is being regulated. It is therefore logical that it is industry portfolio returns that matter, rather than portfolios constructed by sorting on past estimates of beta. It is thus a shame that much of the focus of DBP (2016) is on the 10 beta-sorted portfolios rather than the 26 industry portfolios, as whatever evidence may have been gleaned from study of the former seems much less relevant than evidence from the latter. It would have been desirable to have seen some more detailed research on the industry portfolios, even allowing for deficiencies in the data, such as survivorship bias. As we discuss below the results reported for the industry portfolios do not lead to rejection of the SL CAPM.

514. In conclusion, for the foregoing reasons, the Authority remains of the view that the forward looking indicators are relevant information that it should take into account in exercising its judgment with regard to the prevailing value of the forward looking MRP.

Establishing the range for the MRP

515. The first step in establishing the MRP for this Final Decision is to determine an appropriate range for the MRP.

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422 Ibid.

423 Ibid.

424 Partington, G. and Satchell, S., Report to the ERA: The Cost of Equity and Asset Pricing Models, May 2016, p. 18.

Interpreting the historic evidence

516. The Ibbotson approach is consistent with the view that the MRP is stationary and therefore will return to some constant long run average that is a good predictor for the MRP in future. If the stationarity of the MRP is borne out in reality, then the Ibbotson approach, despite being based on historical data, could be used as a reasonable 'on-the-day' prediction of the MRP over a future period. It can be combined with the on-the-day estimate of the risk free rate, which is considered the best predictor of future rates in light of the efficient market hypothesis.

517. On the other hand, the Wright approach concludes that the MRP is not mean reverting, rather it is the long run real historical *market return on equity* that is mean reverting. With the Wright interpretation – at any point in time – the real average market return on equity may be combined with the estimate of the long run *expected* inflation rate, using the Fisher equation, to provide a best estimate of the expected nominal future average value of the return on the market. It follows then that deducting the on the day estimate of the risk free rate from that nominal estimate will provide the contemporaneous on the day forward looking estimate of the MRP. This approach implies that the MRP and risk free rate are perfectly correlated one for one.

518. The Authority maintains its view from the Draft Decision. The Authority accounts for the Ibbotson approach in its process for establishing the lower bound of a range for the forward looking MRP.

519. The use of the Ibbotson approach to inform the lower bound of the MRP does not mean the Authority ascribes to the view that the MRP in Australia is stationary.[425] The Authority remains of the view that evidence on mean reversion of the MRP in Australia is inconclusive as outlined in the Rate of Return Guidelines which conducted empirical tests on the Australian data.

520. The Authority also notes that any empirical testing may be subject to shortcomings such as those relating to the data itself, its span or in the methods applied. Empirical evidence may provide information that assists in understanding economic and financial relationships, but should be grounded in theory. For this reason, the Authority considers it reasonable that investors may give credence to historical averages of the MRP in forming their views for the future.[426] Therefore, the Authority considers that the two opposing theoretical interpretations for estimating the MRP (Ibbotson and Wright) cannot be dismissed.[427]

521. Turning now to the estimates themselves, the Authority first evaluated the long run average market return observed from the Brailsford, Handley and Maheswaran (**BHM**) series in the Rate of Return Guidelines. The BHM (2012) series spanned 128 years and so was considered the most appropriate data set for determining the long run average market return on equity and the related MRP.

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425 Equally, the Authority does not accept the Wright approach as being the sole guide for the estimate. The 'Wright' view on the stationarity of the market return on equity was considered in the Guidelines. However, the Guidelines rejected the view that the MRP and risk free rate are perfectly correlated one for one. The Authority remains of the view that while being an acceptable theoretical foundation, sole reliance on the one for one correlation over anything but the very long run is not likely to be helpful in practice.

426 For example, many private sector equity analysts, such as Grant Samuel, utilise a historic estimate of the MRP when undertaking valuations.

427 For the risk free rate, the efficient market hypothesis provides a theoretical foundation, which is therefore supported by empirics.

522. However, concerns have been raised relating to the quality of the BHM data. Additionally, the series covers a pre- and post-imputation credit regime and so requires adjustment from 1987 onward to ensure returns are estimated on a consistent basis over the whole series.

523. With regard to data quality, the BHM historic series are claimed to be downwardly biased on account of an inadequate adjustment made to the dividend yields employed in the data. To address this perceived issue, in 2013 NERA produced an Australian stock market total return series that readjusted the dividend yields prior to 1957.[428]

524. For the purpose of this Final Decision, the Authority has extended the BHM and NERA series through to 2015, based on the most recent data.[429]

525. The difference between the long run average (nominal) market return on equity based on the BHM and NERA series is 36 basis points (Table 4).

Table 4 BHM and NERA long-run historic nominal and real annual average market returns for 1883 to 2015 (excluding imputation credits)

	NERA approach	BHM approach	Difference
Nominal return	11.93%	11.58%	0.36%
Real return	8.89%	8.53%	0.36%

Source: NERA (2013), Brailsford, Handley and Maheswaran (2012) and ERA Analysis, December 2015.

526. Handley's advice to the AER prepared in October 2014 raised a number of concerns regarding the analysis underlying the NERA (2013) data. In particular, he highlighted a lack of consistency between NERA's source of dividend yields and those employed by Lamberton on which the BHM series was based.[430] Additionally, he highlighted that NERA had not reconciled their adjusted yields with those of Lamberton. The Authority therefore is of the view that the analysis underlying the NERA (2013) data is insufficient grounds to justify the full upward adjustment to the BHM series performed by NERA.

527. Given the uncertainty surrounding the most appropriate adjustment to the market return series, the Authority has used an average of the two series to minimise any potential error with use of either series alone. The real returns of both series are used (Table 4), removing inflation on a consistent basis (informed by the estimates of historic inflation set out in the BHM data).[431]

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428 NERA Economic Consulting, *The Market Risk Premium: Analysis in Response to the AER's Draft Rate of Return Guideline*, A Report for the Energy Networks Association, October 2013.

429 Daily ASX All Ordinaries (AS30) and Accumulation (ASA3) indices were sourced from Bloomberg. Annual outcomes were calculated consistent with the method set out by BHM in their 2012 study (see T.J. Brailsford, J.C. Handley and K. Maheswaran, The Historical Equity Risk Premium in Australia: Post-GFC and 128 Years of Data, *Accounting and Finance*, 52, 2012, section 2, p. 238). Bond and bill yields were extended based on the Reserve Bank of Australia statistics (90 day Bank Accepted Bills were used for 2013 through 2015 as there is no 3 month Treasury bills data for those years). Gamma was assumed at 0.4 consistent with the Authority's estimate for this Final Decision.

430 J. Handley, Advice on the Return on Equity, A Report prepared for the Australian Energy Regulator, 16 October 2014, p. 19.

431 T.J. Brailsford, J.C. Handley and K. Maheswaran, , The Historical Equity Risk Premium in Australia: Post-GFC and 128 Years of Data, *Accounting and Finance*, 52, 2012, p. 241; NERA Economic Consulting, *The Market Risk Premium: Analysis in Response to the AER's Draft Rate of Return Guideline*, A Report for the Energy Networks Association, October 2013, Table 2.7, p. 28.

Imputation Gross-Up Adjustment

528. The real long term average market return of the BHM and NERA series is estimated as the 'gross return' investors in equity would expect to receive on the market. That is, it is reported inclusive of yields from capital gains and dividends. The series do not account for the introduction of imputation after 1987, so need to be adjusted up from that point on to account for the imputation credit yields.[432]

529. The post-tax financial model which is a requirement under NGR 87 compensates for required returns lost to taxation by providing an explicit allowance in the model cash flows for the taxes payable, which are then recovered in regulated tariffs.[433] At the same time, the reduction for the value of imputation credits is also explicitly accounted for in the cash flows, following the requirements of NGR 87A.

530. Therefore, applying a return on equity in the post–tax model which was not 'grossed up' for imputation credits would result in under compensation for the investor. This would result because the value of imputation credits would be removed twice, first from the rate of return, and second from the revenue cash flows.

531. It follows that the Authority needs to 'gross up' the observed post 1987 market returns in the BHM data for the estimated value of imputation credits. Applying this in the post-tax revenue model will then ensure that the investor receives an 'after company tax, after some personal tax' return.[434] The final component of the required return on equity is then received through the investor's tax return.

532. To calculate the value of imputation credit yields in each year from 1988 (inclusive) onwards, equation (4) based on that set out by Handley (2008), accounting for theta directly, is used:[435,436]

$$c_t = F \; x \; d_t \left(\frac{T_t}{1 - T_t} \right) x \; \theta \qquad (4)$$

Where:

- θ is the value of distributed imputation credits consistent with the Authority's estimate of gamma;
- d_t is the dividend yield in year t ;
- F is the proportion of dividends which are franked; and
- T_t is the corporate tax prevailing in that year.

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432 T.J. Brailsford, J.C. Handley and K. Maheswaran, The Historical Equity Risk Premium in Australia: Post-GFC and 128 Years of Data, *Accounting and Finance*, 52, 2012, Table 2, pp. 237-247.

433 Gamma in the post-tax approach is factored in through a reduction in the compensation for company tax, reflecting the estimated cash flows received by investors from imputation credits through their personal tax.

434 J.C. Handley, Further comments on the historical equity risk premium, 14 April 2009, pp. 16-17.

435 T.Brailsford, J.Handley and K.Maheswaran, *Re-examination of the Historical Equity Risk Premium in Australia*, Accounting and Finance, vol. 48, 2008, p. 85. The F in equation 4 is taken to be 0.75, hence a value for theta of 0.53 corresponds to an estimate of gamma of 0.4.

436 The imputation credit regime commenced from 1 July 1987.

533. The yield is then added on to the total return in each year 1988 through to 2015.[437] The results for both series for the period following the introduction of imputation are the same, as the NERA and BHM total return series do not differ over this period. The average yield value of imputation credits to investors from 1988 to 2015 based on these assumptions and the real return data is an estimated 0.88 per cent.

534. The imputation credit yields for each year are then added to the real total returns for both the BHM and NERA series from 1988 on and the two series are then averaged (Table 5).

Table 5 Average annual imputation credit yields and grossed up arithmetic average returns (nominal, consistent with the estimate of gamma of 0.4)

	NERA	BHM	Average
Nominal returns excluding imputation yield (1883-2015)	11.93%	11.58%	11.76%
Grossed up nominal returns (1883-2015)	12.12%	11.77%	11.95%
Grossed up real returns (1883-2015)	8.89%	8.53%	8.71%
Expected inflation for AA4	1.43%	1.43%	1.43%
Grossed up nominal return commensurate with current inflation expectations	10.45%	10.08%	10.26%

Source: ERA Analysis December 2015, NERA (2013), Brailsford, Handley and Maheswaran (2012).

535. As a final step, the grossed up expected return on equity for the market may be developed consistent with the inflation outlook for the next 5 years. The estimate of inflation for the next 5 years used in for this Final Decision is 1.43 per cent. This estimate is used to inflate the resulting average real return geometrically (based on the Fisher equation). This produces a nominal estimate for the average return on the market of 10.26 per cent for the NERA based data and 10.12 per cent for the BHM based data.

536. The average of the two series is 10.14 per cent. The Authority considers that this estimate provides the estimate for the nominal average market return on equity that is consistent with Wright's interpretation of the historic data and the current inflation outlook.

537. This is an important marker for the market return on equity. As the available evidence supports the hypothesis that the market return on equity is mean reverting, this historic outcome from a long span of data may be used as a cross check for the long run average of the forward looking market return on equity from each regulatory period.

538. The Authority also notes that with the current risk free rate at 1.80 per cent, the MRP that is consistent with the Wright interpretation of the data is 8.46 per cent.

Upper bound of the MRP range

539. The upper bound of the MRP range in the Rate of Return Guidelines in 2013 was set at 7.5 per cent, based on the range for the return on the market from a range of Dividend Growth Models (**DGM**) evaluated for the Rate of Return Guidelines.

[437] The Authority has extended the series to 2015 for this Final Decision.

540. As noted above, the Authority considers that this bound is not high enough given prevailing market conditions. There are two potential issues with the range for the market return on equity estimates derived from the DGM:

- *first*, there is a need to ensure that returns from all estimates grossed up, as to be on a consistent basis for input to the Authority's estimate; and
- *second*, the Authority should account for the range of outcomes based on the credible DGM estimates.

541. The Authority has revisited the DGM estimates, gathering a range of grossed up market return on equity estimates from the more recent DGM models (Table 6). Dividend growth expectations are extremely variable due to the continuous arrival of new information in the market. The latest information is therefore the most relevant to the expected return and accordingly the Authority has included estimates that are one year old at most.

542. Many of the studies in Table 6 use a franking proportion of 0.75 to gross up returns. The commensurate estimate of theta for that franking proportion, which delivers a gamma of 0.4, is just under 0.55. Based on these results, the Authority judges that a range for the MRP commensurate with a gamma of 0.4 is 7.6 to 8.8 per cent. The lower bound is established by the AER's May 2016 lower bound estimate, while the upper bound of 8.8 per cent also is supported by the AER's most recent studies. The lower bound has increased compared to that adopted in the Draft Decision. This is due to removal of the Authority's 2013 estimate. On the other hand, the upper bound has declined with the removal of the earlier 2012 Capital Research estimate, which is considered no longer current.

Table 6 Recent estimates of the MRP using the DGM

Study/Author	Date	Dividend yield source	Theta	Risk free rate (%)	Implied MRP (%)
SFG	May 2015	Thomson Reuters I/B/E/S	0.35	2.55	8.82
Frontier Economics	July 2015	Thomson Reuters I/B/E/S	0.35	2.85	8.35
AER	May 2016	Bloomberg	0.6	2.93	7.57 – 8.84
ERA	May 2016	Bloomberg	0.6	1.82	8.12
Estimated range of the MRP consistent with gamma of 0.4			0.55		**7.6 – 8.8**

Sources:

Frontier Economics, *An updated estimate of the required return on equity*, Report prepared for Ergon Energy, July 2015, p. 6.

SFG Consulting, *Updated estimate of the required return on equity*, Report for SA Power Networks, May 2015, p. 4.

Australian Energy Regulator, *Final decision: AusNet Services distribution determination 2016 to 2020*, Attachment 3: Rate of return, May 2016.

Economic Regulation Authority estimate for this Final Decision, 31 May 2016.

543. In addition, the Authority updated its two stage DGM estimate (Box 1), to be current as at May 2016. The model was used to develop the range for the MRP in the Rate of Return Guidelines.[438]

544. The assumption for the long run dividend growth rate in the updated DGM model, *g*, at 4.6 per cent, is consistent with the analysis in Lally's 2013 study.[439] This equates *g* to the estimated long run nominal GDP growth, of 5.6 per cent, less 1.0 per cent to account for new share issues and new companies. The resulting grossed up DGM estimate of the required return on the market is 9.94 per cent as at 31 May 2016.

[438] Economic Regulation Authority, Appendices to the Explanatory Statement for the Rate of Return Guidelines, 16 December 2013, p. 122.

[439] M. Lally, *The Dividend Growth Model*, 4 March, 2013, p. 17.

Box 1 The two stage DGM

The return implied by the Gordon DGM is based on a forecast dividend based on a forecast dividend growth rate to calculate a forecast dividend yield and then augments this yield with the growth forecast itself. This is shown in equation (5).

$$r_e = \left(\frac{E(D_1)}{P_0} \right) + g \qquad (5)$$

where $E(D_1) = D_0(1+g)$ and is the last dividend per share paid.

The Authority's current estimate of the DGM is based on a simple two stage approach as outlined in equation (6).

$$P_0 = \frac{m \text{ x } E(D_0)}{(1+k)^{m/2}} + \sum_{t=1}^{N} \frac{E(D_t)}{(1+k)^{m+t-0.5}} + \frac{\frac{E(D_N)(1+g)}{k-g}}{(1+k)^{m+N-0.5}} \qquad (6)$$

Where:

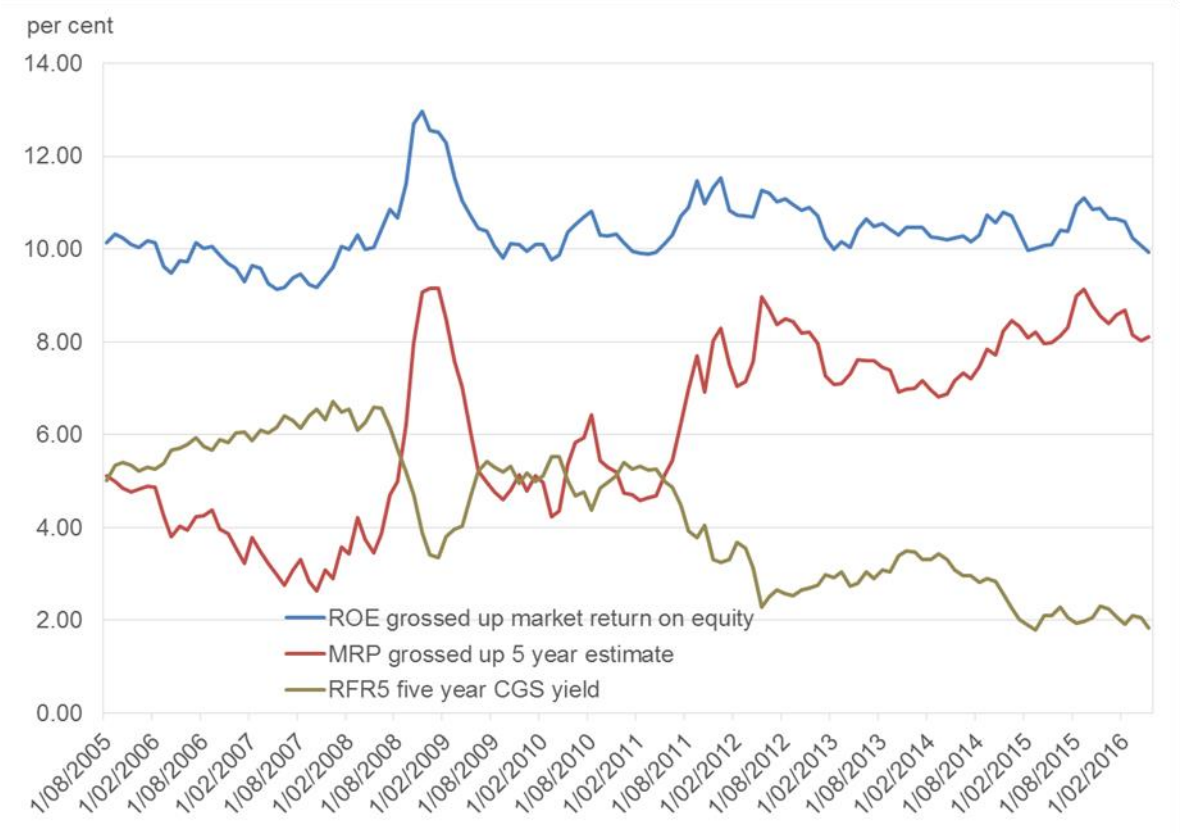
- D_t is current price the of the equity index;
- m is the fraction of the current year remaining;
- t is the dividend per share expected in the current year;
- $E(D_t)$ is the dividend per share expected years into the future;
- k is the return on equity implied by the model;
- N is the year of the furthest out dividend forecast; and
- g is the long run dividend growth rate.

Monthly net dividend per share forecasts for the All Ordinaries Index were sourced from Bloomberg for the current year, the next year and the year after. The monthly closing price for the All Ordinaries index was also sourced from Bloomberg.

Source: Australian Energy Regulator and ERA Analysis

545. The corresponding results for g of 4.6 per cent – when combined with the historic consensus dividend forecasts and share prices from Bloomberg going back to 2005 – are shown in Figure 5.

Figure 5 Dividend Growth Model implied return on equity: All Ordinaries Index (monthly, grossed up)



Source: Bloomberg and ERA analysis

546. The implied expected market return on equity (grossed up for imputation credit yields) typically fluctuates, in this case between 9 and 11 per cent, only breaking higher in periods of perceived heightened risk, such as 2008 to 2009 and 2011 to 2012. The model indicates that, from the third quarter of 2015 through to May 2016, expected returns declined somewhat.

547. From a Gordon growth model perspective expected returns are driven by current dividend yields and growth expectations. Figure 6 shows that dividend yields were at a relatively high level for a period before falling since the third quarter of 2015. Given that long run growth expectations are fixed at 4.60 per cent and that the stock market has been fairly volatile whilst exhibiting no clear growth trend over this period, it appears that a combination of a fall in earnings growth expectations over the medium term, and falling dividends payments are the main driver of the decline. In turn, this suggests that uncertainty surrounding growth prospects is elevated.

548. The monthly observation for 31 May 2016 at 9.94 per cent is below the middle of the 'more typical' range for the return on equity (that is, excluding the Global Financial Crisis (**GFC**) type periods). It is at the 20th percentile of the observations reported in Figure 5. It is also 0.1 per cent down on the Authority's 31 March 2015 estimate undertaken for its ATCO Final Decision.

549. Deducting the Authority's on-the-day estimate of the 5 year risk free rate, of 1.82 per cent, from the return on the market for the end of May 2016, gives a forward looking 5 year MRP of 8.12 per cent, which also may be observed in Figure 5.[440]

550. It can also be seen, that more recently, the decline in the risk free rate has no longer been able to offset the fall in expected returns and has begun to retreat from its peak in October 2015. Despite this, the MRP series suggests that the current forward looking estimate is towards the top end of its typical range, significantly exceeded only by estimates at the height of the GFC. The major difference between the current MRP and that in the GFC period is that more recently low risk free rates are driving the premium.

551. The estimates from the DGM are sensitive to input assumptions, particularly the long run growth rate. Varying the long run growth rate, *g*, from 4.0 to 5.1 per cent leads to a range for the MRP estimate at May 2016 of an indicative 7.55 to 8.59 per cent.

552. The Authority notes that DGM estimates are recognised to have shortcomings, including that:[441]

- analyst forecasts (which underpin some of the studies reported in Table 6 and which will be incorporated in the 'consensus' estimates) have a tendency to be upwardly biased, as they are based on over-optimistic expectations for target prices and earnings;
- DGMs may not fully reflect market conditions if firms follow a stable dividend policy;
- DGMs do not capture non-dividend cash flows, such as share repurchases or dividend re-investment plans.

553. Furthermore, the DGM estimates reported here provide a single discount rate, which equates the present value of the future infinite dividend stream with the observed share price. The estimate therefore looks out beyond the 5 year period for which the Authority is seeking to estimate the MRP. If a lower nominal GDP estimate is expected than assumed – say for the two years beyond the three actual dividend growth rate forecasts incorporated in the model – then the estimates of the DGM should be lower than that reported here. The implication would be that the 5 year forward looking MRP would also be lower.

554. The Authority notes that there is no clear agreement among experts as to the best form for the DGM, or its input assumptions. For that reason, the Authority adopts a wide range, informed by a spectrum of recent studies.

555. Ideally, DGM return on equity estimates should be based on the most current on-the-day dividend forecasts. However, the Authority notes that the number of studies estimating return on equity using the DGM in Australia is limited and that it is not

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440 Lally considers that deducting the risk free rate with a term of 5 years from a DGM estimate will tend to over-estimate the MRP (see M. Lally, *Review of arguments on the term of the risk free rate*, 20 November 2015, p. 21). This is based on the view that consistency between the perpetuity nature of the DGM and the associated estimate of the MRP requires a deduction of the 10 year risk free rate, rather than a 5 year risk free rate. The Authority notes that the majority of estimates in Table 6 deduct a 10 year risk free rate in that way. However, the Authority considers that expectations for the 5 year and 10 year MRP can diverge at any point in time. For that reason, the Authority retains the estimate of the MRP reported here as being one of the estimates made using the DGM.

441 See for example M. McKenzie and G. Partington, *Report to the AER, Part A: Return on equity*, October 2014, pp. 26-31.

possible to update all of the various estimates available. Therefore, to allow for a broad range of information, DGM return on equity estimates since 2012 have been accounted for. The Authority is of the view that it is appropriate that the most recent estimates (since mid-2015) provide the more relevant and up-to-date information as presented in Table 6.

556. Overall, the Authority infers from the DGM MRP information before it that the market expectation is that the MRP has moved upwards in recent times due to declines in the risk free rate.

557. Figure 5 suggests that the assumed range for the estimate of the grossed up MRP from the DGM, consistent with the estimate of gamma of 0.4 adopted for this Final Decision, of 7.6 to 8.8 per cent, is not unreasonable.

558. The Authority adopts this range for the DGM estimate for this Final Decision. The upper bound of the DGM range – 8.8 per cent – provides the upper bound of the Authority's overall range for the MRP. However, as indicated, the Authority considers that this estimate of 8.8 per cent is a less relevant estimate in comparison with all other estimates as presented in Table 6.

Lower bound of the MRP range

559. As noted above, for this Final Decision, the Authority will utilise the 'Ibbotson' approach to inform its estimate for the lower bound for the range of the forward looking MRP. The Ibbotson approach uses the concept of a long run average MRP as today's best estimate of the MRP in future and combines this with an on the day risk free rate to arrive at an on the day estimate of the market return on equity.

560. For consistency, the estimate of the long run average MRP must reflect the term of the risk free rate used in the SL-CAPM, which is 5 years for this Final Decision. For this purpose the Authority has made an estimate of the historic average MRP with reference to 5 year bonds, by taking an average of the historic MRP annual estimates referenced to bonds and bills.[442]

561. The nominal 5 year MRP estimates (grossed up for imputation credit yields) were calculated on both the NERA and BHM data by subtracting relevant bond and bill yields from the nominal NERA and BHM annual grossed up returns. The average arithmetic and geometric means of the resulting four series were then calculated (Table 7). Averaging the bill and bond MRPs for both NERA and BHM produces 5 year MRP estimates that range between 5.6 and 6.5 per cent for the arithmetic means and 3.7 and 5.2 per cent for the geometric means.

562. The Authority notes that there are mixed views as to the best estimator of historic returns. Arithmetic average returns will tend to overstate returns, whereas

[442] In the BHM data, bills are around 3 months and bonds are around 10 years, thus the average term of the two estimates is approximately 5 years (see T.Brailsford, J.Handley and K.Maheswaran, *Re-examination of the Historical Equity Risk Premium in Australia*, Accounting and Finance,vol.48, 2008, pp. 81 to 83). Taking the average of the historic annual MRPs with respect to bonds and bills will give an estimate of the annual MRP that is close to a 5 year term. The Authority notes Lally's observation that this is likely to underestimate the 5 year risk free rate due to the concavity of the typical yield curve (see M. Lally, *Review of Arguments for the Term of the Risk Free Rate*, 18 November 2015, p. 8). However, the effect is to slightly overstate the historic estimate of the MRP. Lally notes that there will only be a few basis points in it. Accordingly, the Authority considers that the resulting estimate remains reasonable, making use of the available information.

geometric average returns will tend to understate returns.[443] An unbiased estimator is likely to lie somewhere between the two estimates.

Table 7 Estimates of bill and bond-based 5 year grossed up nominal average Market Risk Premiums

Period	BHM	NERA	Average	BHM	NERA	Average
	Arithmetic mean			Geometric mean		
1883-2015	6.72%	6.36%	**6.54%**	5.34%	4.99%	**5.17%**
1937-2015	6.06%	6.11%	**6.08%**	4.17%	4.22%	**4.19%**
1958 - 2015	6.52%	6.52%	**6.52%**	4.10%	4.10%	**4.10%**
1980 - 2015	6.14%	6.14%	**6.14%**	3.74%	3.74%	**3.74%**
1988 - 2015	5.58%	5.58%	**5.58%**	3.85%	3.85%	**3.85%**

Source: Brailsford, Handley, Maheswaran (2012) and ERA Analysis

563. The Authority in this instance is looking for a reasonable lower bound for its range. On this basis, the Authority is inclined to the arithmetic mean as a preferred estimator. A lower bound informed by the lowest arithmetic mean estimate from Table 7 would be 5.6 per cent. However, the Authority considers that this lower bound may be too high, given potential upward bias in the arithmetic estimate.

564. The Authority therefore exercises its judgment to adjust this bound down, informed by the lower estimates of the average MRP that are provided by the geometric means (Table 7). The Authority considers that 5.4 per cent provides a reasonable lower bound, being the average of the lowest arithmetic mean of 5.58 per cent and the highest geometric mean of 5.17 per cent.

Range for the MRP

565. The Authority will adopt a range for the 5 year forward looking MRP for this Final Decision of 5.4 to 8.8 per cent. The:

- lower bound of the range is informed by the Ibbotson average excess premium; and
- upper bound of the range is informed by the upper bound of recent DGM estimates.

566. This range is wider than that informed by the historic estimates (5.4 to 8.5 per cent based on Ibbotson and Wright respectively), given that the upper bound of 8.8 per cent reflects the range for the DGM estimates shown in Table 6.

567. The Authority uses forward looking indicators and its judgment to assist in determining a point estimate for the MRP from within this historic range for input to the SL-CAPM.

[443] M. McKenzie and G. Partington, *Supplementary report on the equity MRP*, 22 February 2012, p. 5.

Forward looking indicators (conditioning variables)

568. The Guidelines set out that forward looking indicators approach would be used to condition the point estimate of the MRP within the estimated range, for the five years of the access arrangement:[444]

> The Authority considers that a range of other information is relevant for determining the point estimate of the MRP… this additional information will be considered as to whether it implies a revision, upwards or downwards, to the midpoint of the MRP range.

569. In light of this the Authority now considers it preferable to take a non-parametric approach, estimating an upper and lower bound at each determination and considering the position of the MRP relative to the mid-point. Mechanistic calculation and application of distributions may not be robust due to issues associated with non-stationary and unrepresentative data series. There are also qualitative issues as to how forward looking data is viewed and interpreted by market participants.

570. For this Final Decision, four forward looking indicators of market conditions for the next 5 years – that are readily available and consistent with the date of the 10 June 2016 estimate for the rate of return – are adopted to inform the point estimate. These are:

- dividend yields on the All Ordinaries, a financial metric;
- interest rate swap spreads on 5 year bonds, which can be viewed as a type of term structure variable;
- default spreads, another term structure variable that makes forward looking expected returns explicit; and [445]
- the Australian Stock Exchange (ASX) 200 volatility index (**VIX**) which measures investors' perceptions of equity market risk.

571. In addition, the Authority considers the May 2016 outlook for economic conditions in the Reserve Bank of Australia's Statement of Monetary Policy to be useful.

Dividend yields

572. Bloomberg's dividend yield series provide a forward looking indicator of returns from dividends (excluding growth).[446]

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444 Economic Regulation Authority, *Appendices to the Explanatory Statement for the Rate of Return Guidelines*, 16 December 2013, p. 216. The Authority undertook that step in the indicative example in the Guidelines in Step 4, but now considers that it is better placed in Step 2. However, the use of forward looking indicators is not a 'new development' (ATCO Gas Australia, *ATCO Gas Australia's Response to the ERA's Draft Decision*, 22 December 2014, Appendix 9.1, p. 22).

445 The default spread was calculated as the difference between the 5 year AA Australian corporate Bloomberg fair value curve and 5 year Commonwealth Government Bond index. These series are the most liquid, complete and up to date default spread measures available to the Authority and so are considered the most efficient reflection of market price movements.

446 The Authority notes that dividend yields contribute to the DGM estimates for the expected return on the market. Their use here is intended to provide an indication of forward earnings relative to the past, and hence provide an indication of the forward looking MRP relative to the range derived from the historic estimates.

573. The dividend yields referred to above are expressed as equation (7) below.

$$Dividend\ Yields_0 = \left(\frac{D_0}{P_0}\right) \quad (7)$$

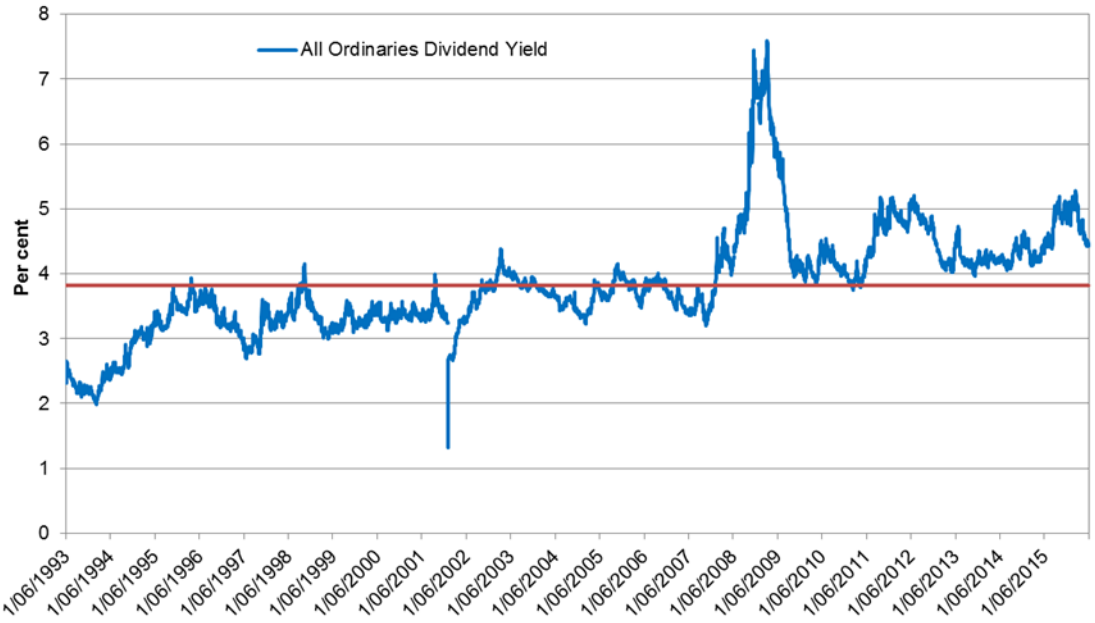
where:

- D_0 is the latest net dividend paid; and
- P_0 is the latest price of the equity in question.

574. Recent dividend yields at the end of May 2016 were 4.46 per cent, above the longer term average of 4.1 per cent (since 1 January 2000 – see Figure 6 below).

575. The Authority considers that dividend yields support an estimate for the forward looking 5 year MRP that is somewhat above the mid-point of its historic range.[447]

Figure 6 ASX All Ordinaries analyst consensus dividend yields



Source Bloomberg EQY_DVD_YLD_12M

576. As noted in paragraph 547, Figure 6 shows that dividend yields were at a relatively high level for a period before falling since the third quarter of 2015. Given that the All Ordinaries index has been fairly volatile whilst exhibiting no clear growth trend over this short period (see Figure 7), it appears that the main driver of the decline is falling dividends per share. This supports the view that earnings growth is declining and that the growth outlook is low and uncertain. Again, from a Gordon growth model perspective, declining earnings growth has a negative effect on expected market returns and MRP, while increased uncertainty has a positive effect.

[447] The current dividend yields are at the 60th percentile of the historic observations in Figure 6 ASX All Ordinaries analyst consensus dividend yields

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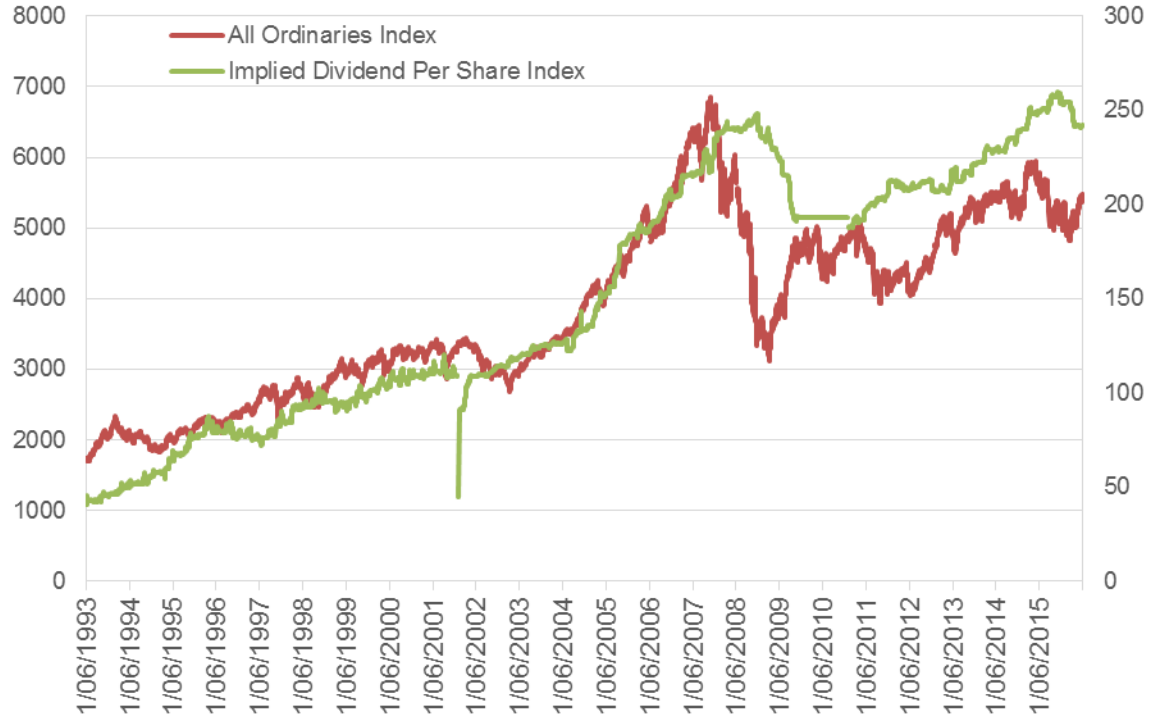
Figure 7 All Ordinaries Index and Implied Dividend



Source: ERA Analysis, Bloomberg 2016.

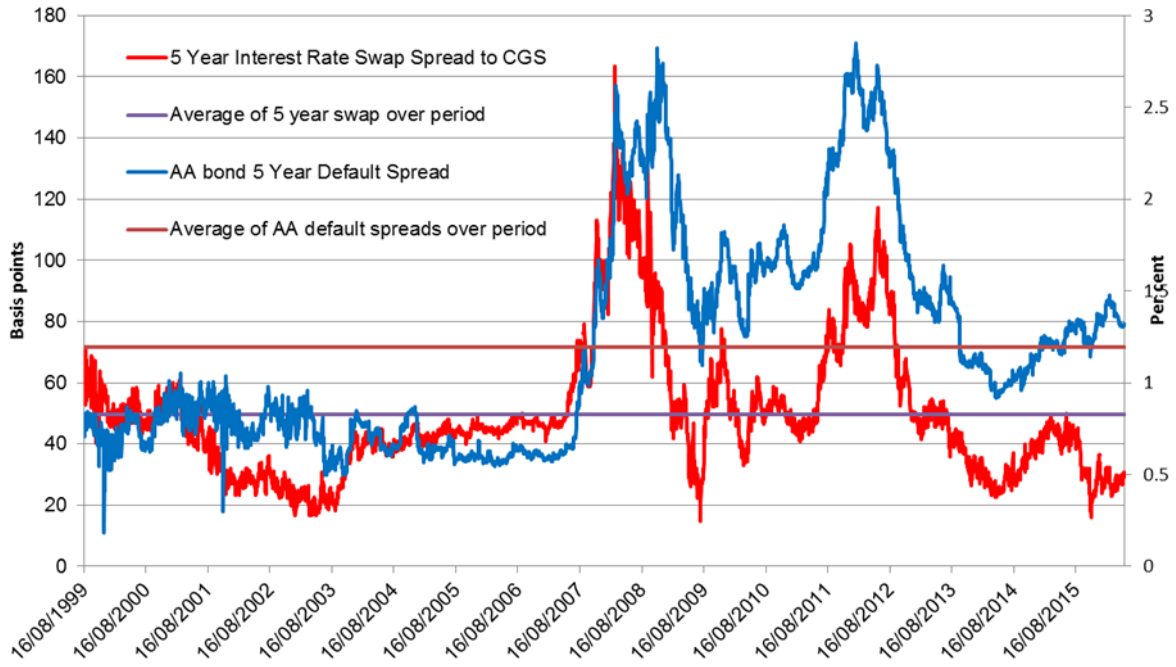
Default and Interest Rate Swap Spreads

577. The 5 year interest rate swap spreads capture, among other things, the credit risk of financial institutions. The interest rate swap (**IRS**) rate is the index rate at which financial institutions borrow and lend from each other. This rate is higher than the Commonwealth Government bond (**CGS**) yield of an equivalent term with the 'spread' over the CGS capturing the credit risk of financial institutions.

578. Figure 8 below shows that the 5 year AA default and IRS spread move in a very similar fashion which tends to confirm that they are subject to similar market risk.[448]

[448] The Authority notes that the majority of bonds that constitute the Bloomberg AA fair value curve are those issued by financial institutions. As at 18 March 2015, 89 per cent of the constituent bonds are issued by issuers classified as financials.

Figure 8 5 Year interest rate swap spread versus 5 year default spread



Source: Bloomberg and ERA Analysis

579. The 5 year interest rate swap spread (Figure 8, LHS, basis points) appears to have returned below pre-2007 levels. The current spread suggests that levels of risk in the financial sector are fairly benign and thus there is no justification for a relatively high MRP on the basis of financial system risk.

580. The default spread (Figure 8, RHS, per cent) has not returned to pre-crisis levels and also has been trending upward, diverging from the recent trend in the swap spread. This suggests that in the broader corporate sector (other than financials) levels of credit risk are still perceived to be relatively high, although still below the levels associated with 2008 to 2009 and 2011 to 2012. The current estimate – at 1.31 per cent – is above the mid-point of the range of more typical' observations, which is 0.5 to 1.7 per cent.[449] This supports the view that uncertainty and risk stemming from the corporate sector is above average levels warranting slightly elevated risk premiums.

581. The Authority considers that default spreads therefore support an MRP estimate somewhat above the mid-point of the historic range.

Stock Market Volatility Index

582. The benefit of using stock market volatility indices is that it represents a different class of index to those discussed already. As outlined above, the IRS spreads and default spreads convey similar information while the DGM is an extension of dividend yields. Using different versions of similar indicators introduces the risk of double counting, or over-weighting measures that contain the same information. A volatility index of some variety provides a differentiated measure of risk as it is concerned with variance (uncertainty around return outcomes) as opposed to levels

[449] The most recent estimate is at the 62nd percentile of all the observations in Figure 7.

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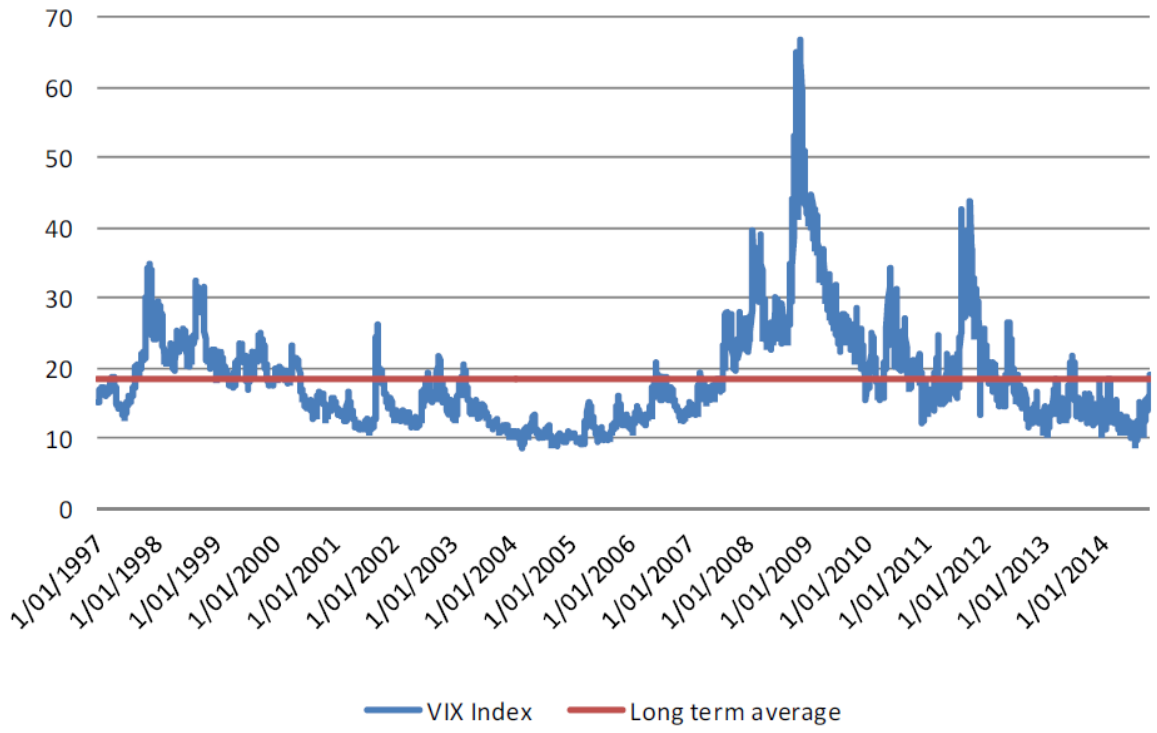
of return or yields. The VIX was therefore used as measure of forward looking risk for this Final Decision.

583. Although useful for gauging future perceptions of risk stemming from forecast variability in returns, the Authority has access to only a limited history, dating back only to 2008. However, the AER has sourced a longer term series of the ASX 200 VIX index which allows for more meaningful historical comparison between the most recent level of the VIX and previous levels back to 1997. This series is reproduced in Figure 9. [450]

Figure 9 Implied Volatility (ASX200 VIX) Over Time



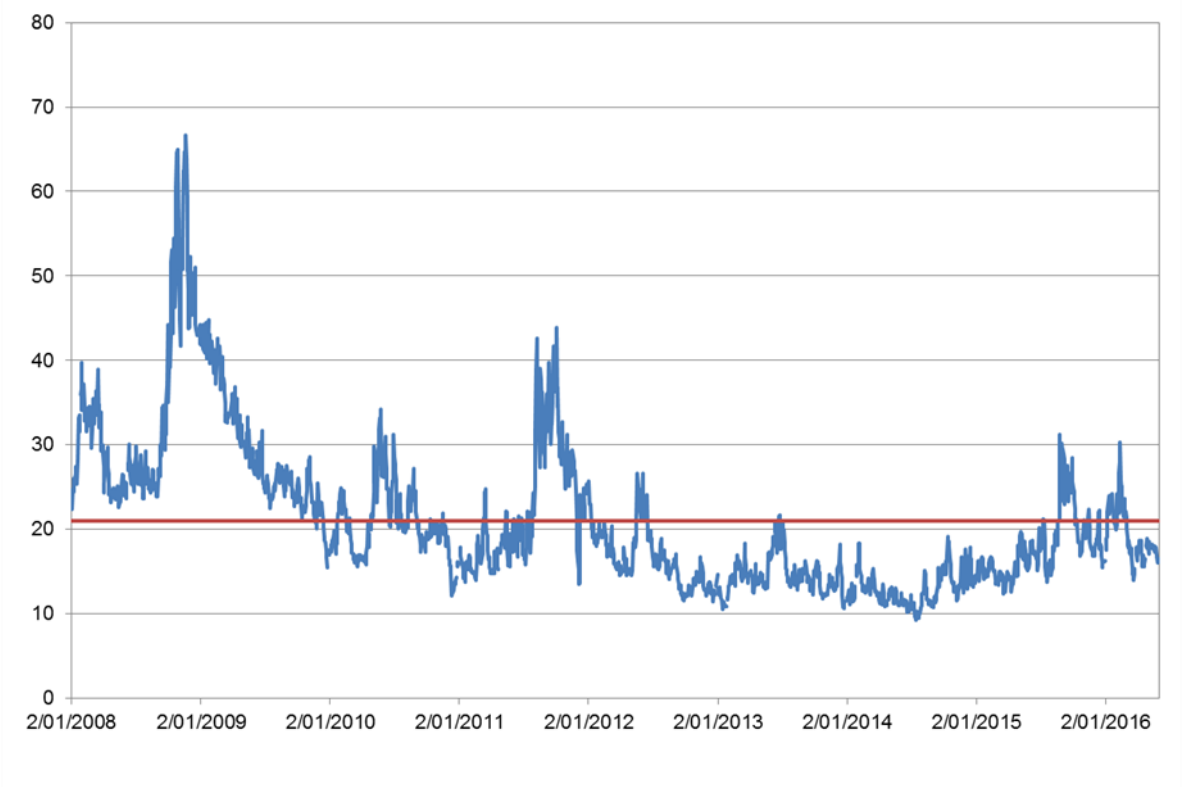
Source: Australian Energy Regulator[451]

584. The series around 2014 reaches a level which is approximately on par with the low points observed over 2004 to 2005. More recently the series has begun to revert toward the long term average level observed. The series has been updated to 31 May 2016 in Figure 9 with data that is accessible to the Authority.

450 Australian Energy Regulator, *Jemena Gas Networks (NSW) Ltd Access Arrangement 2015-2020: Draft Decision*, Attachment 3: Rate of Return, November 2014, p. 205. The Authority is not able to access this proprietary data as it is no longer available. The Authority has been advised by the Australian Energy Regulator that the series prior to 2008 was sourced from Bloomberg as the CITJAVIX Index, which is no longer provided by Bloomberg. The AER's chart of this data is therefore reproduced here.

451 The Authority has been advised by the Australian Energy Regulator that the series prior to 2008 was sourced from Bloomberg as the CITJAVIX Index, which is no longer provided by Bloomberg.

Figure 10 Implied Volatility (ASX200 VIX): 2 January 2008 to 31 May 2016



Source: Bloomberg and ERA Analysis

585. This series suggest that the VIX is below the long term median value in the observed data in Figure 9 and Figure 10. This supports the choice of an MRP that is below the mid-point of the historic MRP range.

The RBA's outlook

586. The Authority notes that the Reserve Bank of Australia's May 2016 Statement on Monetary Policy (**SMP**) cites that economic conditions in Australia's major trading partners has eased of late with a particular emphasis on the moderation of growth in China. While the SMP notes China's stimulatory policy settings, it expressed concern relating to excess capacity in key sectors of the Chinese economy.

587. From a domestic point of view employment indicators are mixed, while mining investment is expected to fall. However, project completions are expected to support further growth in exports along with contributions from the service exports sector. Wage growth is very low and there is evidence of spare capacity. This supports the uncertain outlook around future growth.

588. The uncertain growth will be a factor in market expectations, driving a somewhat higher MRP as compared to more normal conditions.

The point estimate of the MRP

589. In considering that information for this Final Decision, the Authority has concluded that the MRP can exhibit marked variation, depending on circumstances. Given that marked variation, the Authority considers that it should not unduly constrain the range for the MRP.

590. The resulting estimated range for this Final Decision is 5.4 per cent to 8.8 per cent, which spans:

- the range of the MRP implied by the historic data, which is 5.4 per cent to 8.5 per cent;
- the range for the MRP implied by recent estimates from the DGM, which is 7.6 per cent to 8.8 per cent.

591. With the range established, the Authority then exercises its judgment, to determine a point estimate that is consistent with prevailing conditions in equity markets as at 10 June 2016 (which is the end of the averaging period for this Final Decision).

592. With regard to the historic estimates, the Authority draws on a range of forward looking indicators to assist its determination of the most reasonable point estimate of the MRP from within the estimated range:

- The VIX data indicate that the 5 year post-tax nominal MRP is below the mid-point of the historic range.
- The spread data for the corporate sector supports a forward looking estimate that is somewhat above the mid-point of the historic range (although it is clear that banking sector risk has declined significantly).
- Dividend growth data also suggest an estimate that is above the mid-point of the range.

593. The conditioning data, taken together, suggest that the forward looking MRP should be somewhat above the mid-point range for the MRP using historic data, which is 7.0 per cent. The Authority also notes the current outlook for market conditions more broadly also supports this view.

594. In addition, the Authority notes that a forward looking MRP estimated using the DGM falls within a range of 7.6 per cent and 8.8 per cent. However, the Authority considers that it is widely accepted that an estimate of the market return on equity (and by extension the MRP) developed using the DGM tends to be over-estimated. In addition, at the same time, the Authority recognises that the DGM estimates need to be tempered to account for a range of issues which imply upward bias, as indicated above, in the resulting estimates of the MRP.

595. On balance, taking all the above mentioned information into account, the Authority exercises its judgment to determine an estimate of the forward looking post-tax nominal MRP for this Final Decision of 7.4 per cent, as reflecting the expectations of the market as at 10 June 2016.

596. With this estimate, the Authority has accounted for:

- the information provided by the forward looking indicators relative to their history, which suggest an MRP that is around the mid-point of the historic range;
- the implied MRP from a range of recent DGM estimates, which suggest that expected returns are between the mid-point and the upper bound of the overall range, noting;
  - that the DGM outcomes do not exactly match the 5 year outlook adopted for this Final Decision;

- the recognised shortcomings of the DGM approaches which lead to upward bias in the estimates;
- differences in approach and vintage, which render some estimates more relevant than others;

- the current outlook for market conditions more broadly.

597. The Authority is satisfied that the resulting estimate meets the requirements of the NGL and NGR. In particular, the Authority is satisfied that the estimate for the MRP of 7.4 per cent reflects prevailing conditions in the market for equity funds and that it contributes to the achievement of the allowed rate of return objective, as required under NGR 87.

Step 3: Estimation of the return on equity using the SL-CAPM

598. Utilising the SL-CAPM, informed by the point estimates for the parameters identified above, the Authority calculates that the indicative estimate of return on equity for this Final Decision, consistent with the 10 June 2016 averaging period date is:

Estimated return on equity = 1.80 per cent + 0.7*(7.4 per cent) = 6.98 per cent

599. The implied return on the market for the average firm with a beta of 1 is 9.20 per cent. The resulting equity risk premium for the benchmark efficient entity is 5.18 per cent.

Step 4: Cross checking the estimate of return on equity

600. The Authority set out in the Rate of Return Guidelines that it would consider a range of other material as a test for reasonableness of the estimate derived in Step 3.[452]

601. The Authority notes DBP's view that the following three different cross checks are used to ensure that the estimate of the overall return on equity for DBNGP is reasonable: (i) submissions made by other service providers; (ii) reports prepared by independent experts; and (ii) DBP's consistency check based upon Merton (1974) and his insights as to the relationship between debt and equity, based upon options theory.[453] DBP was also of the view that of the three, the third is the most important cross-check, and is given most weight by DBP.[454]

602. The Authority considers that, with regard to the range of estimates proposed by other service providers, which DBP proposes as a cross check, have not been accepted by either the Australian Energy Regulator, the Authority or the Australian Competition Tribunal. [455] The remaining cross check methods proposed by DBP, and other relevant cross-check material, is considered in what follows.

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452 Economic Regulation Authority, *Appendices to the Explanatory Statement for the Rate of Return Guidelines*, 16 December 2013, Appendix 29 – Other relevant material.

453 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 58.

454 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 58.

455 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 59.

Other evidence on the risk free rate

603. The estimate of the risk free rate is the 20 day average of the 5 year yield on Commonwealth Government Securities (**CGS**). As this estimate is observed from the market, the Authority considers that it is robust.

604. The Authority notes that at 1.80 per cent at 10 June 2016, the CGS estimate is lower than the average of 5 year rates over recent decades, reflecting a concerted downward trend. However, the Authority has no evidence as to the prospect for significantly higher rates over the next five years. The Authority considers that the prevailing 5 year CGS estimate is the best predictor for the next five years. On this basis, the Authority considers that 1.80 per cent as at 10 June 2016 is the best estimate for use in the SL-CAPM.

Cross checks of parameters in the SL-CAPM

Other evidence on the market risk premium and the implied market return on equity

605. For this Final Decision, the Authority has taken account of forward looking information to inform its estimate of the point MRP, including:

- a range for the MRP that reflects historic excess returns over the risk free rate;
- forward looking conditioning variables – measures of risk based on interest rate spreads and market volatility, as well as current expectations for dividend yields; and
- a range for the forward looking MRP based on the DGM model.

606. The Guidelines noted that a range of other material is considered relevant which may provide a cross check for the estimate of the MRP and the resulting estimate of the return on equity:

- views of valuation experts and surveys;
- decisions of other regulators; and
- the relationship between the return on equity and the return on debt.

607. A threshold issue in any comparison involves ensuring that estimates are on a consistent ‘apples with apples’ basis. Key issues in this context involve:

- the term of the estimates; and
- the treatment of imputation.

Term of the estimates

608. As noted above, the Authority is of the view that the term over which the rate of return expectations should be assessed is 5 years, so as to match the regulatory period. This is consistent with the Authority’s intention to account for the ‘present value’ principle.

609. The 5 year forward looking horizon contrasts with that of independent analysts. Independent analysts tend to adopt a longer horizon for their discount rates because they are typically valuing assets on the basis of the cash flows to perpetuity. In Australian financial markets, 10 years is the most common outstanding ‘long’ tenor on government bonds, and thus traditionally, the 10 year tenor has been used as a proxy for the perpetual risk free rate. For this reason, analysts estimate the equity

premia as that in excess of the return on Australian government bonds at the 10 year tenor.[456]

610. A 10 year view tends to 'smooth' out the large, but infrequent spikes in expected risk premia that are more evident in shorter investment horizons. The implication is that risk premia under a 5 year approach are generally lower than the 10 year average, for much of the time. However, the 5 year estimates are more volatile than the 10 year estimates, as they are more sensitive to fluctuations in prevailing market conditions. Over time, the average of the many 5 year observations should converge toward the average risk premium observed under a longer perpetuity approach.

611. The Authority's 5 year estimates therefore are not directly comparable to the long run estimates commonly developed by independent analysts.

612. Lally endorses exactly this view when he responds to similar arguments for the QCA in the context of the risk free rate:[457]

> This line of argument presumes that the QCA is engaged in the same exercise as the valuers and therefore ought to be using the same parameter values. However the two exercises are fundamentally different, and this readily explains the difference in rates. The QCA resets the risk-free rate every few years (typically five years) and therefore need only be concerned with the prevailing risk-free rate for the next five years. By contrast these valuers are conducting DCFs for businesses with infinite-life cash flows and therefore would be interested in the prevailing term structure of risk-free rates for terms out to infinity. Since observed rates exist only out to ten years, these valuers would have to speculate upon the rest of the term structure, and then invoke an average rate if they used only one rate (as they do). Since the term structure is currently markedly upward sloping, the term structure beyond the five year term invoked by the QCA will be in excess of this regulatory rate and therefore the average rate invoked by the valuers over the entire term structure would be in excess of the five-year rate invoked by the QCA.

613. Seeking comparability, the Authority notes that the Wright estimate of the return on the market is a perpetual nominal estimate. To develop a Wright estimate of the market return on equity, the Authority applies the mid-point of the Reserve Bank of Australia's target inflation range, which is 2.5 per cent, to its Wright estimate of the long run historical real market return on equity, grossed up, which is 8.71 per cent.[458] The resulting perpetual nominal estimate of the return on equity for the market is 11.43 per cent (grossed up –Table 8).[459]

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456 The DGM, for example, estimates the discount rate that equates the future stream of cash flows to the current share price.

457 M. Lally, Response to submissions on the risk free rate and the MRP, 22 October 2013, p. 24.

458 Note that this Table 8 is the same data as Table 5 above, apart from the forward looking inflation rate (2.5 per cent here to perpetuity, as opposed to the 1.43 per cent expectation for the next five years in Table 5).

459 T.J. Brailsford, J.C. Handley and K. Maheswaran, , The Historical Equity Risk Premium in Australia: Post-GFC and 128 Years of Data, *Accounting and Finance*, 52, 2012, p. 241; NERA Economic Consulting, *The Market Risk Premium: Analysis in Response to the AER's Draft Rate of Return Guideline*, A Report for the Energy Networks Association, October 2013, Table 2.7, p. 28.

Table 8 Average annual imputation credit yields and grossed up arithmetic average returns (nominal, consistent with the estimate of gamma of 0.4)

	NERA	BHM	Average
Nominal returns excluding imputation yield (1883-2015)	11.93%	11.58%	11.76%
Grossed up nominal returns (1883-2015)	12.12%	11.77%	11.95%
Grossed up real returns (1883-2015)	8.89%	8.53%	8.71%
Expected inflation to perpetuity	2.50%	2.50%	2.50%
Grossed up forward looking return on the market to perpetuity	11.61%	11.25%	11.43%

Source: ERA Analysis, NERA (2013), Brailsford, Handley and Maheswaran (2012)[460]

614. Therefore, the Authority is of the view that its 5 year forward looking estimate is not directly comparable to the perpetuity estimates developed by independent analysts for valuing firms. It is more appropriate to compare an estimate based on the long term average of the return on equity – such as the Wright estimate – with those of independent analysts.

Adjustments for imputation credits

615. A further consideration when comparing estimates relates to the treatment of imputation credits.

616. Longer term average return on equity estimates which include data before 1987 – such as the long term 128 year average historic estimates of Brailsford et al will tend to overstate the average observed 'market' return on equity under the current imputation credit regime (that is, the return observed in the market arising from dividends and capital gains). [461]

617. This is because many investors in the post 1987 period receive a proportion of their required return on equity through imputation credits; yet this return is not observed in the market. The return through imputation credits therefore accounts for a proportion of the overall return on equity, all other things being equal. Hence the pre 1987 observed return on equity is not comparable to the post 1987 observed return; the latter will be lower due to part of the required return coming from imputation credits which cannot be observed in the market.

618. It is therefore important to 'gross up' any post 1987 observed market return to account for the impact of imputation credits, if the full return on equity is to be accounted for.

619. The amount of the gross up will depend on the assumptions relating to the impact of imputation credits in the Australian capital market. The assumptions adopted in grossing up the historic estimates for this Final Decision are consistent with those used when estimating the gamma term.

460 T.J. Brailsford, J.C. Handley and K. Maheswaran, , The Historical Equity Risk Premium in Australia: Post-GFC and 128 Years of Data, *Accounting and Finance*, 52, 2012, p. 241; NERA Economic Consulting, *The Market Risk Premium: Analysis in Response to the AER's Draft Rate of Return Guideline*, A Report for the Energy Networks Association, October 2013, Table 2.7, p. 28.

461 Ibid.

620. As noted by Handley:[462]

> The Officer model typically used to inform returns on equity in Australia under the CAPM has one before company tax and four after company tax WACCs. The four after tax company tax WACCs each differ, based on whether the interest tax shield and the value of imputation credits are included or otherwise in the definition of the corresponding after tax cash flows.

621. Officer assumes the CAPM holds when returns are expressed on an 'after company but before personal tax basis'. As shown in (8):

$$X_E = X_E' + \gamma T\left(X_O - X_D\right) \qquad (8)$$

Where:

- X_0 is the firm's operating income (free cash flow) that is ultimately distributed to X_D (that is, to debt claimants), X_E (equity claimants) and X_G (government claimant through the tax rate T);
- $X_E' = (1-T)\left(X_O - X_D\right)$ is the cash dividend distributed to equity investors;
- $T\left(X_O - X_D\right)$ is the amount of franking credits distributed to investors;
- $\gamma T\left(X_O - X_D\right)$ is the proportion of the franking credits distributed to investors.

622. X_E is the 'grossed up' value of the returns to investors which includes the value of franking credits. It is consistent with the value on an 'after company before personal tax basis'. On the other hand, XE' is consistent with the value on an 'after company after some personal tax' basis.

623. The conventional approach to describing a return as 'after company tax' is somewhat misleading in an imputation setting, as company tax paid $T\left(X_O - X_D\right)$ consists of a mixture of personal tax $\gamma T\left(X_O - X_D\right)$ – being the part rebated against personal taxes – and the effective company tax $T\left(X_O - X_D\right)(1-\gamma)$ being the part that is not rebated against personal taxes.

624. The Officer CAPM for the Australian imputation tax system is as shown in (9):

$$E(R_E) = R_F + \beta\left[\mathrm{E}(\mathrm{R}_M) - R_F\right] \qquad (9)$$

Where:

- $E(R_E)$ is the expected grossed up return on equity;
- R_F is the risk free rate of return;
- β is the equity beta of the firm; and

[462] J.C. Handley, *Further comments on the historical equity risk premium*, Report for the Australian Energy Regulator, 14 April 2009, pp. 16-17.

- $E(R_M)$ is the expected grossed up return on the market portfolio.

625. Officer assumes the CAPM holds when expected returns are expressed on an 'after company before personal tax basis' that is consistent with X_E.

626. The Authority's starting estimate of the return on equity is the vanilla $E(R_E)$, which can be derived using Officer's after tax case (iii).[463] The $E(R_E)$ is consistent with X_E, being the return observed in the market inclusive of imputation credits. As noted above, the Authority's longer term average of the estimates of $E(R_E)$ may be higher or lower than its current 5 year forward looking estimate, inclusive of imputation credits.

627. In the post-tax revenue model building block approach adopted by the Authority, the return on equity included in the rate of return weighted average cost of capital will be k_E (that is, returns to investors which includes the value of franking credits). The PTRM then explicitly accounts for the return to investors $\gamma T\left(X_O - X_D\right)$ as an adjustment to the cash flow allowance for tax within the model.

Views of valuation experts

628. Evidence of market analysts' views suggest that their expectations for the forward average market returns on equity are consistent with the longer term average of the forward looking return on equity underpinning the Authority's estimates.

629. An example is the recent WACC estimate by Grant Samuel used in discounting Envestra's cash flows, which was cited by SFG Consulting.[464]

630. Grant Samuel's estimate of the return on equity is informed by the SL-CAPM, with the risk premium and risk free rate then adjusted to have regard to a range of other evidence, including that from the Gordon Dividend Growth Model (**DGM**).[465]

631. Grant Samuel's initial estimate for the *market* return on equity derived using the SL-CAPM is 10.2 per cent. Grant Samuel states that:[466]

> The CAPM is probably the most widely accepted and used methodology for determining the cost of equity capital. There are more sophisticated multivariate models which utilise additional risk factors but these models have not achieved any significant degree of usage or acceptance in practice. However, while the theory underlying the CAPM is rigorous the practical application is subject to shortcomings and limitations and the results of applying the CAPM model should only be regarded as providing a general guide.

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463 J.C. Handley, *Further comments on the historical equity risk premium*, Report for the Australian Energy Regulator, 14 April 2009, pp. 16-17.

464 ATCO Gas Australia, Access Arrangement Information: 1 July 2014 – 31 December 2019, 3 April 2014, Appendix 19, p. 84.

465 Grant Samuel, Envestra: Financial Services Guide and Independent Expert's Report, 3 March 2014, Appendix 3.

466 Grant Samuel, Envestra: Financial Services Guide and Independent Expert's Report, 3 March 2014, Appendix 3, p. 1.

632. The Grant Samuel estimate is based on a long run historic MRP of 6 per cent, which is added to the prevailing 10 year risk free rate (at the time) of 4.2 per cent. Grant Samuel notes that it:[467]

> …has consistently adopted a market risk premium of 6% and believes that this continues to be a reasonable estimate. It:
>
> - is not statistically significantly different to the premium suggested by long term historical data;
> - is similar to that used by a wide variety of analysts and practitioners (typically in the range 5-7%); and
> - makes no explicit allowance for the impact of Australia's dividend imputation system.

633. The Grant Samuel estimate is defined as a 'classical', after tax rate that is based on the estimated nominal ungeared after tax cash flows.[468] On this basis, it is defined consistent with Officer's after tax case (iv).[469] In this case, the k_E is identical to the k_E in case (iii), being the total return on equity from all sources.

634. The Grant Samuel WACC CAPM estimate of 10.2 per cent ignores the impact of imputation credits.[470]

635. The Authority notes that the resulting estimate should be grossed up. Appropriately configured – assuming that dividends provide around 4.5 per cent of the total 10.2 per cent yield – the grossed up return would be 10.97 per cent (utilising the Authority's estimate of gamma of 0.4).

636. The Grant Samuel estimate was made at a time when the 10 year risk free rate was 4.2 per cent. The prevailing rate is closer to 2.0 per cent. Adjusting the grossed up Grant Samuel estimate for this change would yield an estimate of the grossed up market return on equity using the SL-CAPM of 8.8 per cent.

637. Grant Samuel ultimately assess' an overall equity *market* return to be in the range of 10.7 to 15.2 per cent, an estimate that is higher than its CAPM-based estimate, which is 10.2 per cent, as noted above. The higher range accounts for:

- first, estimates from other return on equity models, such as the Gordon DGM;
- second, for Grant Samuel's view that equity investors have re-priced risk since the global financial crisis (lifting the MRP above 6 per cent); and

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467 Grant Samuel, Envestra: Financial Services Guide and Independent Expert's Report, 3 March 2014, Appendix 3, p. 6.

468 The Authority notes that Grant Samuel's 'classical WACC' differs from the 'nominal vanilla WACC' estimate.

The classical WACC reduces the cost of debt to account for the impact of the tax shield (that is, the cost of debt component is D/V*(1-T)*Rd), whereas the nominal vanilla WACC ignores the impact of the tax shield as this is accounted for in the cash flows. However, both approaches adopt the same estimate for the return on equity component (that is, E/V*k_E using Handley's terminology).

469 J.C. Handley, *Further comments on the historical equity risk premium*, Report for the Australian Energy Regulator, 14 April 2009, pp. 16-17.

470. Grant Samuel, Envestra: Financial Services Guide and Independent Expert's Report, 3 March 2014, Appendix 3, p. 9:

In Grant Samuel's view, however, the evidence gathered to date as to the value the market attributes to franking credits is insufficient to rely on for valuation purposes. More importantly, Grant Samuel does not believe that such adjustments are widely used by acquirers of assets at present… Accordingly, it is Grant Samuel's opinion, that it is not appropriate to make any adjustment.

- third, that bond rates are at unsustainably low levels (which Grant Samuel therefore 'normalise' by increasing the risk free rate from the observed current value around 4 per cent to 5 per cent).[471]

638. The resulting grossed up range is 11.47 to 15.97 per cent, using the Authority's assumptions on the dividend yield and on gamma, set out above.

639. The Authority considers that a comparison estimate for the return on the market to perpetuity, such as that undertaken by Grant Samuel, is that based on a long run average of the grossed up historic return on equity estimates, which is around 11.43 per cent (see paragraph 613 and Table 8 above).

640. The Authority in the Draft Decision did not consider it appropriate to adjust up the risk free rate to a higher rate, as is done by Grant Samuel. The Authority considered a more relevant lower bound for the Grant Samuel estimates is the SL-CAPM adjusted estimate of 8.8 per cent, with the range then 8.8 to 16.0 per cent (grossed up).

641. However, the Authority notes that DBP observes:[472]

> …the ERA proposed that it ought to compare its long run estimate of the return on equity to the market (11.48 percent [in the Draft Decision, now 11.43 per cent]) with a range of 9.4 to 16 percent derived from the Grant Samuel range of 11.47 to 15.97 percent (once the ERA's views on dividend yields and gamma are taken into account) by reversing Grant Samuel's replacement of the current 10-year government bond yield with a higher risk free rate considered more representative of long-term trends by Grant Samuel. This is an apples with oranges comparison, because the ERA's estimate of the long run return to the market incorporates a long run risk-free rate which is much higher than the current risk-free rate which it uses in place of the Grant Samuel estimate. The proper comparison is between the ERA's long run return on the market estimate of 11.48 percent and the original Grant Samuel range of 11.47 to 15.97 percent, which would mean that the ERA estimate is right at the very bottom of the Grant Samuel range. Alternatively, if the ERA's preferred version of the Grant Samuel range, using current risk-free rates is used, then one must use the ERA's estimate of the current return to the market of 9.56 percent (1.96+7.6*1), which is again right at the bottom of the relevant range of 9.4 to 16 percent, and now 33 percent below the mid-point, rather than 53 percent as outlined by SFG previously.

642. The Authority notes that the estimate is toward the bottom of the range, but is not inconsistent, given recent developments. Furthermore, the Authority agrees with DBP when it states that:[473]

> Perhaps more importantly than a single study which is, through the passage of time, becoming decreasingly relevant, the ERA ignores the wider point DBP makes concerning expert studies. That is (Original AA Proposal para 6.11), the ERA (and AER) made estimates of the return on equity in the past which sat within the range of estimates made by market analysts and professional investors, but it (and the AER) have deviated sharply downwards in the most recent round of decisions when analysts have not. The ERA has failed to engage with this evidence,73 and explain why in the past it produced estimates in line with market analysts but more recently it appears to

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471 Authority estimate based on Grant Samuel data, assuming a nominal risk free rate of 5.0 per cent. Also see ATCO Gas Australia, *Access Arrangement Information: 1 July 2014 – 31 December 2019*, 3 April 2014, Appendix 35, pp. 14-15.

472 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 60.

473 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 60.

have come to the view (at least implicitly) that market analysts are wrong and that substantially lower estimates of the return on equity for energy firms are required.

643. The Authority agrees that the Grant Samuel study is becoming stale. This may explain why its estimated range is now wholly above the long run return on equity estimated from the historic data (11.43 per cent). Otherwise, Grant Samuel is clearly in error if it considers that the historic market return on equity is a low growth expectation. In the current economic climate, that is clearly an untenable assumption.

644. The Grant Samuel estimates therefore give the Authority no cause to revise its estimate of the return on equity, or its current estimates for the MRP.

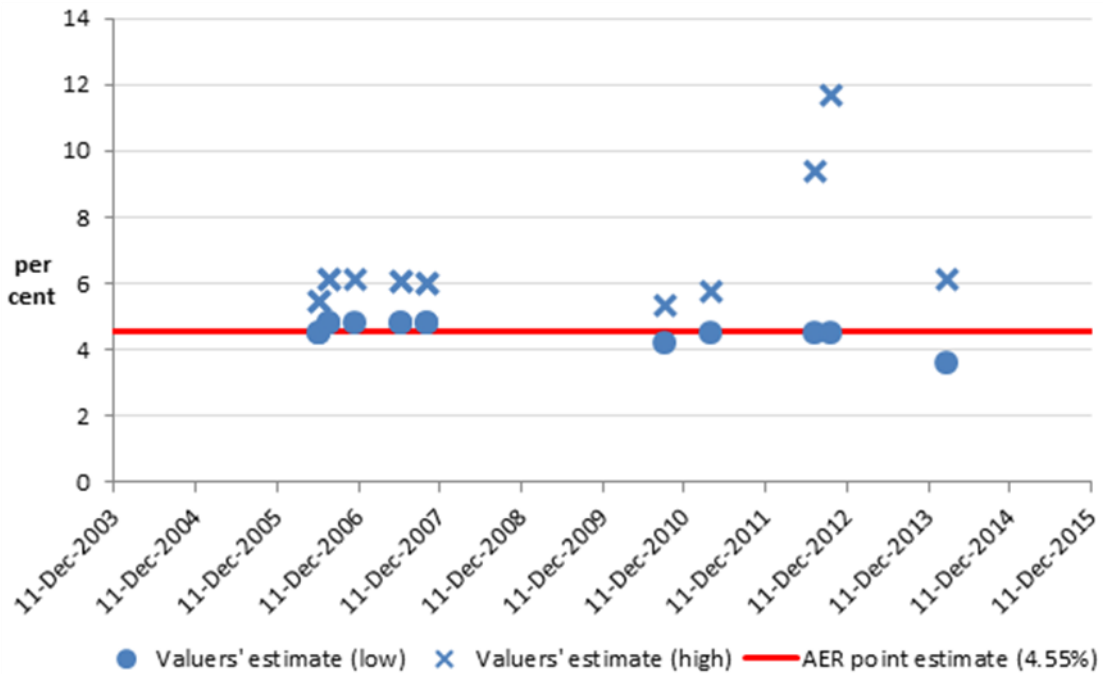
645. The survey by Ernst & Young of other analysts' estimates gives results that are broadly consistent with the Grant Samuel view. Ernst & Young note that in 2012, independent market experts' market cost of equity estimates averaged 10.7 per cent. Ernst & Young also notes that independent experts typically do not assign a value to imputation credits, and that adjustment for this outcome would raise the estimate of independent brokers.[474] Grossed up using the Authority's assumptions, the estimate would equate to 11.47 per cent, which is close to the Authority's perpetuity estimate. Again, this outcome would give the Authority no cause to revise its estimate of the return on equity, or its current estimates for the MRP.

646. The AER report a range of return on equity and equity risk premium estimates from relevant independent valuation reports (Figure 11). The Authority notes that its estimate of the equity risk premium is 5.18 per cent. The Authority notes that if it adopted a 10 year term its estimate would be lower – perhaps by around 50 b.p.[475] Nonetheless, these outcomes do not give the Authority cause to question its estimate.

474

475 The Authority's estimate of the MRP is higher, as it is based on a 5 year term. It therefore accounts for the lower return on debt associated with the shorter 5 year term for the risk free rate (given a typical upward sloping yield curve). If the Authority adopted a 10 year term, its MRP would be necessarily lower.

Figure 11 Equity risk premium from relevant valuation reports over time



Notes *AER analysis based on reports from the Thomson Reuters Connect4 database. The AER has shown the equity risk premium based on a nominal vanilla WACC, expert reports using a different WACC form have been adjusted accordingly. This equity risk premium ('Valuers estimate-high') also reflects the impact of any discretionary uplifts applied by the independent valuer.*

Source Australian Energy Regulator, *AusNet Services distribution determination final decision 2016–20*, Attachment 3 – Rate of return, May 2016, p. 3-255.

647. On this basis, the Authority is satisfied that its current estimate, albeit based on a different term, is reasonable.

Views of Australian regulators

648. As noted in the Rate of Return Guidelines, the Authority will consider other regulators' estimates to check outcomes of its own decisions.

Australian Energy Regulator

649. The AER's return on the market is derived using the SL-CAPM, with point estimates informed by a range of relevant information and models.

650. The AER has the view that a longer term 10 year perspective is appropriate, based on the view that equity investors have long term investment horizons.[476]

651. In line with this view, the AER adopts a different term for the risk free rate in the SL-CAPM. Specifically, in its recent Victorian Distribution Network Service Provider decisions, the AER adopted:[477]

[476] S. Pratt and R. Grabowski, *Cost of Capital: Applications and Examples*, 4th edition, 2010, pp. 118–120; A. Damodaran, 'What is the risk free rate? A search for the basic building block', December 2008, pp. 9-10. Lally, M., The risk free rate and the present value principle, 22 August 2012. cited in Australian Energy Regulator, *Rate of Return Guidelines, Explanatory Statement*, December 2013, p. 49.

[477] Australian Energy Regulator, *Final decision: Jemena Gas Networks (NSW) Ltd: Access arrangement 2015–20,* Attachment 3: Rate of return, May 2016, p.44.

- a term for the return on equity of 10 years, with:
  - the risk free rate based on the estimated CGS yield, of 2.93 per cent;
  - a point estimate for the MRP of 6.5 per cent, from within an estimated range of 4.8 to 8.84 per cent; and
  - an equity beta of 0.7;
- giving a 7.5 per cent return on equity for the benchmark efficient entity, incorporating a 4.55 per cent equity risk premium, and a resulting overall estimate of the return on the market of 9.43 per cent.

652. While the AER's established range for the MRP is comparable to that of the Authority's, the overall point estimate is somewhat lower than the Authority's estimate.

653. This can be reconciled through the Authority's use of a 5 year term for the risk free rate instead of a 10 year term. The comparable 10 year risk free rate on 31 May 2016 is calculated at 2.30 per cent; 52 basis points higher than that (1.80 per cent) used by the Authority to derive the MRP.[478] This would bring the Authority's MRP estimate down to 6.9 per cent.

654. The remaining 40 or so basis appear to result from differences in information used by the AER and Authority to arrive at a point estimate within the established range. Differences include the Authority's reliance on forward looking indicators of risk and the economic outlook and the AER's reliance on surveys and stakeholder submissions.[479]

655. The Authority considers that the AER's estimate is comparable to this Final Decision, once differences in parameter estimates and judgment on the current economic and risk outlook are accounted for. An example of this is given below in paragraphs 662 and 663.

IPART

656. The Independent Pricing and Regulatory Tribunal (**IPART**) uses an average of a current 40 day and 10 year term for the risk free rate.

657. IPART proposes to adopt an estimate of the MRP which is informed by the mid-point of historic estimates (estimated at 5.5 per cent to 6.5 per cent) and a range based on other current market data approaches – including using DGMs – which fall in the range 7.9 per cent to 8.7 per cent, giving an overall range for the MRP of 6.0 per cent to 8.5 per cent (as at February 2016). The mid-point of the assessed range – 7.3 per cent (as at February 2016) – may then be adjusted to account for strong contrary evidence.

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478 Reserve Bank of Australia, Capital Market Yields – Government Bonds – Daily, Table F2, accessed 24 June 2016.

479 Australian Energy Regulator, *Final decision: Jemena Gas Networks (NSW) Ltd: Access arrangement 2015–20,* Attachment 3: Rate of return, May 2016, pp. 57-62.

658. Given an estimated mid-point risk free rate as at February 2015 of 3.7 per cent, IPART's return on the market is estimated to be around 11.0 per cent.[480]

659. The Authority considers that the IPART estimate is comparable to its own estimate because it incorporates current market data allowing deviation from long-term historical estimates, albeit based on a somewhat different method and judgements.

Other regulators decisions

660. As discussed in paragraph 610, the Authority's estimates for the MRP are forward looking over the next 5 years and hence can deviate from the long run historical averages implied by mean reversion or the 'Ibbotson' approach. As shown in Table 7 these estimates tend to be around the 6 to 6.5 per cent range. The Authority notes that this range of estimates coincides with those typically employed by other regulators.[481] If the Authority were to adopt a longer term view it would be logical to adopt this range. However, the Authority adopts a 5 year risk free rate in the return on equity and correspondingly allows deviation in the MRP from the long run value typically employed by other regulators.

661. Reconciliation with other regulators' estimates can be undertaken as follows using the examples in Table 9. The average term spread between the 5 and 10 year risk free rate is typically in the order of 50 basis points. From this perspective the QCA estimate requires no adjustment because it uses a 5 year term for the risk free rate. The ESCV/NTUC estimates would be increase to around 6.5 per cent to account for the deduction of a lower risk free rate if undertaken by the Authority.

Table 9 Other regulators' recent MRP decisions

Regulator	Decision date	Sector	MRP (%)
QCA	December 2015	Rail	6.5
ESCV	June 2014	Water	6.0
NTUC	April 2014	Electricity	6.0

Source *Australian Energy Regulator, Draft decision: Jemena Gas Networks (NSW) Ltd: Access arrangement 2015–20, Attachment 3: Rate of return, p. 3-205, ERA Analysis.*

662. The Authority's estimates have been undertaken almost two years later than those of ESCV and NTUC. The period of April, May and June 2014 was a period of below average risk according to three of the four forward looking indicators used by the Authority (see Figure 8 and Figure 10). Dividend yields were the only indicator to show above average risk although this was very slight (see Figure 6). A somewhat lower MRP implied by the DGM in Figure 5 also corroborates this.

663. If the Authority made its estimate during this period it would likely select an estimate below the mid-point. This is likely to reconcile the remaining difference between the ESCV/NTUC's and the Authority's MRP estimates and so they appear to be consistent. In the case of the QCA estimate the Authority is likely to have applied a higher estimate than 6.5 per cent based on the four forward looking indicators because it allows itself to depart from the range produced by the long-run average if warranted by the indicators.

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480 Authority analysis, based on IPART, *Fact sheet – WACC update*, February 2016.

481 For example see Australian Energy Regulator, *Final decision: Jemena Gas Networks (NSW) Ltd: Access arrangement 2015–20,* Attachment 3: Rate of return, May 2016, pp. 399-400.

Beta

664. In the Draft Decision, the Authority noted that the Australian Energy Regulator had assembled a range of international empirical estimates for energy networks, which it had regard to.[482] The evidence pointed to a wide range of empirical estimates, with estimates both below and above the Authority's point estimate. The reported estimates span a range of 0.45 to 1.3. The Authority notes there are issues with regard to re-levering international estimates, which may render them unreliable, given the underlying differences in conditions in the countries of origin.[483]

665. Furthermore, in the Draft Decision, the Authority expressed the view that there is conceptual support for the equity beta of an infrastructure network benchmark efficient entity being less than 1:[484]

- business risk – which may be disaggregated into intrinsic (economic) risk and operational risk – is the primary driver of systematic risk, and this risk is low for the benchmark efficient entity relative to the market average;
- despite relatively high financial leverage, the benchmark efficient entity does not have high financial risk – rather it is the intrinsic risk of the firm which is the key driver of systematic risk.

666. The Authority cited McKenzie and Partington in support, who concluded that there is:[485]

> …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.

667. DBP take issue with these views, presenting Figure 12 relating to beta estimates for US energy firms as evidence.

668. However, the Authority agrees with Partington and Satchell that this Figure 12 supports the conceptual view for a beta less than 1, as only 3 of the data points are above 1, with the remaining 95 per cent of observations less than 1. Approximately 86 per cent of the betas are less than 0.8.

669. The Authority concludes that the US evidence provides support for the conceptual view that beta should be less than 1.

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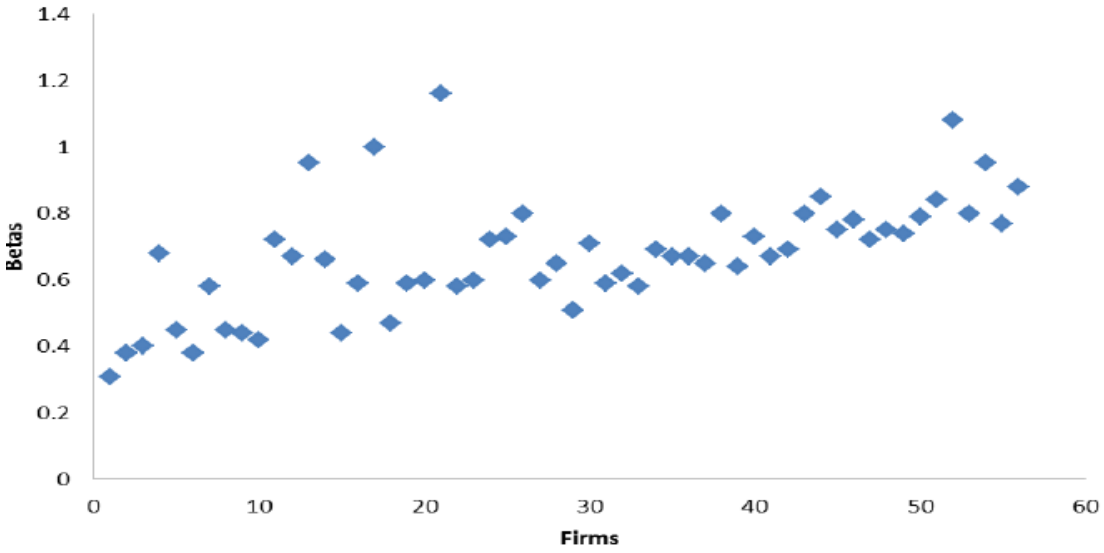
482 Australian Energy Regulator, *Draft Decision: Jemena Gas Networks (NSW) 2015-20,* November 2014, p. 3-263.

483 G. Partington, Report to the AER: Return on equity (updated), April 2015, p. 74.

484 Economic Regulation Authority, Draft Decision on Proposed Revisions to the Access Arrangement for the Dampier to Bunbury Natural Gas Pipeline, 22 December 2016, Appendix 4, p. 45.

485 McKenzie, Partington, Report to the AER: Estimation of the Equity Beta (Conceptual and Regulatory Issues) for a Gas Regulatory Process in 2012, April 2012, p. 15.

Figure 12 Beta estimates for US firms



Source DBP, *Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56*, 24 February 2016, p. 44.

670. In conclusion, the Authority has considered the information on equity betas for utilities operating in overseas jurisdictions. The Authority has determined that these estimates are likely to provide a less reliable estimate of beta than that derived from the domestic comparator sample. The Authority does not rely on them either for establishing the range, or for determining the point estimate of beta. Nevertheless, the Authority considers that its domestic range and point estimate of beta of 0.7 is not inconsistent with the reported range. The Authority therefore is satisfied that the beta estimate it has determined is robust and fit for purpose, and will therefore contribute to the achievement of the allowed rate of return objective.

Consistency of the return on equity with the return on debt

The Merton framework

671. As noted above (see the Step 1 section 'Consistency between debt and equity'), the Authority is of the view that DBP's proposed 'Merton framework' approach informs the quantitative relationship between the debt risk premium and the equity risk premium (**ERP**). As a result, it can provide a cross check for the return on equity, if configured correctly.

672. The Authority considers that the outcome from this cross check proposed by DBP supports the Authority's estimate of the return on equity determined for this Final Decision. The Authority's reasoning is as follows.

673. The return on equity for the DBNGP for this Final Decision is 6.98 per cent as at 10 June 2016, incorporating an equity risk premium of 5.18 per cent.

674. The Authority notes Lally's conclusions in relation to his analysis that:[486]

> In respect of the lower bound, I use an upper bound default probability of 0.8%, a lower bound recovery rate of 25%, an upper bound illiquidity allowance of 1.2% (66% of 1.8%), and a lower bound elasticity coefficient of 7. The result is a lower bound on the

[486] Lally, M., Review of Argument on the Equity Risk Premium and the Risk-free rate, 9 May 2016, p. 12.

ERP of 0. Finally, in respect of the upper bound, I use a default probability of 0.3%, a recovery rate of 75%, an illiquidity allowance of 0.52%% (29% of 1.8%), and an elasticity coefficient of 9. The result is an upper bound on the ERP of 10.7%. This range from 0 to 10.7% does not conflict with any estimate by the ERAWA referred to earlier.

Repeating the process for Frontier's (2016a) analysis, shown in section 2.1, and differing only in using a promised yield of 5.48% comprising a risk-free rate of 2.87% and a DRP of 2.61%, the bounds on the ERP are 1.7% to 15.8% with a midpoint estimate of 8.7%. Again, this range does not conflict with any estimate by the ERAWA referred to earlier. Furthermore, since the DRP in Frontier's (2016a) analysis (2.61%) differs significantly from that in SFG's (2014a) analysis (1.8%), at least one of the illiquidity allowance, default probability or expected recovery rate must have changed and therefore using the same estimates for all three parameters in both cases would be wrong. This further illustrates the need for wide bands of uncertainty on these three parameter estimates.

675. The Authority considers that DBP's proposed approach, after errors corrected as identified by Lally, gives it no cause to reject the estimated return on equity adopted by the Authority for this Final Decision. The Authority's estimate of the ERP is well within the bounds of the estimated ranges identified by Lally in the foregoing passages.

Cross-check that the return on equity exceeds the return on debt

676. The estimated debt risk premium as at 10 June 2016 ('on the day', not the estimated average over calendar year 2016) is 2.523 per cent above swap. The margin of the 5 year swap rate to the 5 year Commonwealth Government Security (**CGS**) rate used for the return on equity is 0.300 per cent, implying a total risk premium for the return on debt above the CGS rate of 2.82 per cent.

677. The Authority's estimate of the MRP is 7.4 per cent. With a beta of 0.7, the equity risk premium for the benchmark efficient entity in this Final Decision is therefore 5.18 per cent. The Authority considers that the resulting margin between the equity risk premium and the debt risk premium, of around 2.36 percentage points is reasonable. With hedging of the benchmark efficient entity's cost of debt, the corollary would be that the return on equity for the benchmark efficient entity would comfortable exceed its cost of debt.

Step 5 – Determine the return on equity

678. Following its review of DBP's proposal, the Authority is not convinced that the empirical estimate of the return on equity adopted by DBP is either theoretically supported, or empirically robust. The Authority considers that the DBP proposed return on equity does not meet the requirements of the NGR. The Authority is therefore not persuaded to move away from the method for estimating the return on equity that was set out in the Guidelines, and amended in the recent ATCO GDS Final Decision.

679. Taking into account all of the relevant information, the Authority is of the view that an expected return on equity of 6.98 per cent is appropriate as an estimate for the forward looking 5 year return on equity for the benchmark efficient entity, as at 10 June 2016:

Estimated return on equity = 1.80 per cent + 0.7*(7.4 per cent) = 6.98 per cent

680. This is based on the forward looking 5 year estimate from the SL-CAPM. The cross checks set out in Step 4 confirm that this estimate is reasonable.

681. The Authority considers that the estimate is commensurate with the efficient equity financing costs of the benchmark efficient entity with a similar degree of risk as that which applies to the Service Provider in respect of the provision of Reference Services prevailing at this time. On this basis, the Authority considers that the estimate meets the allowed rate of return objective and the requirements of the NGR and NGL more broadly.

Return on debt

682. In the Draft Decision, the Authority required that DBP set the return on debt for the DBNGP benchmark efficient entity through use of the 'hybrid trailing average' method. That involved:

- adopting a hybrid of an 'on the day' estimate of the risk free rate in combination with a simple 10 year trailing average of the DRP;
  - without any transition – thus utilising the RBA data back to 2005 for the construction of the first DRP estimate;
  - rejecting the use of capex weights for any sized tranche of new investment;
- the risk free rate set once, on the day, at the start of the access arrangement period, based on the 5 year term of the bank bill swap rate (**BBSW**);
- a term for the debt risk premium (**DRP**) of 10 years;
  - utilising the 'extended bond yield' approach for estimating the DRP, incorporating bonds issued internationally;
- debt raising costs of 12.5 bppa and hedging costs of 11.4 bppa, no new issue premium.

683. In its revised submission, DBP accepts the Draft Decision 'in general terms'.[487] Specifically, DBP accepts the hybrid trailing average method for determining the return on debt, with:

- the adoption of the five year BBSW for the risk free rate, set on the day;
- a 10 year trailing average for the DRP, updated annually;
  - the 'extended bond yield' method to estimate the annual DRP;
  - the use of past RBA data to supplement the initial trailing average estimate.

684. However, DBP continues to propose the capex weights method, rather than the 1/10 equal weighting, *where the new investment in a year exceeds 10 per cent of the existing RAB in that year*, otherwise it will be 1/10;[488]

- in contrast to the initial proposal, the proposed capex weighting method would apply only for the future, on the basis that

487 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 73.

488 Ibid, p. 75.

- DBP accepts the equal weighting for the *historic* trailing average terms, prior to 2016, which are based on the RBA data.

685. DBP also resubmits its debt raising costs, hedging costs and new issue premium proposal.

686. DBP also seeks to formalise the timings for the annual update, and that the 'ERA processes be protected via a fixed principle'.

687. The Authority does not accept any aspect of DBP's revised proposal.

688. Each aspect of the return on debt is discussed as follows.

The hybrid trailing average

689. The Authority determines that the estimate of the return on debt is based on the hybrid trailing average approach, and:

- is comprised of the sum of a debt risk premium and a base BBSW risk free rate, combined with a margin for administrative and hedging costs:

  Return on Debt = Risk Free Rate + Debt Risk Premium + Debt raising costs + Hedging costs

- estimates the risk free rate once, based on an averaging period at the start of the regulatory period (implying the 'on the day' approach for the risk free rate);
- adopts a 10 year term for the DRP, consistent with the estimated average term at issuance, which the Authority determines is 10 years;
- annually updates the estimate of the DRP, just prior to the start of each regulatory year, based on the updated hybrid trailing average estimate of the DRP;
  - with the annually updated hybrid trailing average feeding through into each annual tariff variation.

690. Having determined to adopt the hybrid trailing average approach for this Final Decision, the remaining key details of the approach to determining the return on debt for the DBNGP benchmark efficient entity are now set out:

- the 'on the day' 'base' risk free rate for the hybrid trailing average;
- the averaging periods for the annual updates DRP estimates;
- the term of the DRP;
- the number of years in the trailing average for the DRP;
- the method for weighting for the trailing average;
- the credit rating for the benchmark efficient entity;
- the method for estimating the DRP and the resulting point estimate for this Final Decision;
- the method for estimating the other debt raising and hedging costs and the resulting point estimates for this Final Decision;
- the method for annually updating the return on debt in tariffs, so as to account for the annual update of the DRP component.

The risk free rate

691. DBP accepts the use of the five year BBSW as the 'base' risk free rate for the hybrid trailing average – set 'on the day' – based on an averaging period comprising 20 Sydney trading days ending 10 June 2016.

692. The five year BBSW, determined consistent with the 20 day averaging period ending 10 June 2016, is 2.100 per cent. Accordingly, this provides the estimate of the risk free rate for the return on debt determined for this Final Decision.

The averaging period of the estimates for the DRP

693. The averaging period for the 2016 DRP estimate for the return on debt for this Final Decision is also the 20 Sydney trading days ending 10 June 2016.

694. Accordingly, for the calendar year 2016 DRP estimate used for this Final Decision, the Authority developed a forward looking estimate for the DRP – for the period in calendar year 2016 that falls after 10 June 2016 – based on an average DRP estimate over the 20 day averaging period ending 10 June 2016. Prior to that date, the Authority used RBA monthly data in the trailing average DRP estimates stretching back to 2007.[489]

695. For the annual *updating* of the DRP trailing average, it is necessary to adopt a different averaging period for the DRP.[490] The annual update process requires additional averaging periods for the forward looking estimates of the DRP for 2017, 2018, 2019 and 2020.

696. For the DRP update estimates for 2017, 2018, 2019 and 2020, the averaging period for the forward looking DRP would be based on a 20 Sydney trading days period that is as close as practicable to the start of each of the calendar years to which it will apply, while still allowing sufficient flexibility to conduct debt operations without moving the market. The period also needs to give sufficient time for the Authority to consider and approve the annually updated tariffs prior to their subsequent application date on 1 January in each of the specified years.

697. For those reasons, the Authority considers that choosing the averaging period in the window between two months and seven months prior to the regulatory period is preferred. The five month period is considered sufficient to ensure that the 20 day averaging period cannot be inferred by other market participants.

698. Accordingly, for the future 20 day averaging periods, the Authority will require that the nominated averaging period occur in the period 1 June to 31 October in each year, which is reasonably close to the following 1 January update. Hence the averaging period for 2017 will be in the window 1 June 2016 to 31 October 2016, providing the updated DRP for inclusion in the 1 January 2017 tariff variation.

699. The Authority considers that adopting a consistent length for the averaging period – therefore of the same length as that used for the risk free rate – has clear advantages for internal consistency. This will be important when the averaging

489 Ultimately, for the Final Decision – which is expected to occur in the middle of 2016 – a similar composite estimate for the DRP for 2016 will be developed. That estimate will be based on the RBA historic monthly data up to the nominated averaging period

490 The risk free rate will remain unchanged, as in the hybrid trailing average approach it is the 'on the day' estimate made once at the start of the regulatory period. It will therefore be based on the 2016 calendar year estimate for the whole of the access arrangement.

period for the two estimates coincide, for example when setting the rate of return prior to the next access arrangement.

700. The averaging periods for the future annual updates should be nominated in advance, with the dates then remaining confidential. This is to ensure that the resulting estimates are not biased by opportunistic behaviour. The Authority will require DBP to nominate the averaging periods for 2017 to 2020 as soon as practicable around the time of release of this Final Decision, albeit expected within two weeks. The Authority does not require that the nominated averaging period for each of the four years be identical periods, only that they occur in the period 1 June to 31 October.

701. In summary, averaging periods are required for each year of the regulatory period, in order to facilitate the annual update of the DRP for the tariff variations to occur on 1 January in 2017, 2018, 2019 and 2020. The Authority requires DBP to nominate all four averaging periods as soon as possible, consistent with the following averaging period criteria. Each of the four averaging periods:

- is required to be 20 consecutive Sydney trading days;
- needs to fall in the period between 1 June and 31 October – in the year prior to the year which the resulting forward looking estimate of the DRP first contributes to the hybrid trailing average estimate of the return on debt;
- does not need to be over the same dates as that in the other years.

The term of the DRP

702. The Authority set out in the Draft Decision a requirement for, and DBP accepted, a 10 year term for the estimates of the DRP.[491]

The credit rating for the benchmark efficient entity

703. The Guidelines proposed a credit rating in the BBB/BBB/BBB+ band for the benchmark efficient entity.

704. DBP accepted this rating for the purposes of estimating the return on debt.[492] Therefore, the BBB/BBB/BBB+ band is retained for this Final Decision.

The method for developing the estimator of the DRP

705. The Authority evaluated two approaches for estimating the 10 year DRP in the Draft Decision:

- the RBA credit spread estimates; and
- the Authority's revised bond yield approach, which was augmented to allow estimation of a yield curve.

491 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 99.

492 DBNGP Transmission Pty Ltd, Proposed Revisions DBNGP Access Arrangement 2016 – 2020, Rate of Return - Supporting Submission: 12, 31 December 2015, p. 13.

The RBA's corporate credit spread

706. The RBA's estimates of corporate credit spreads, at the targeted tenor of 10 years, are available for the A-rated and BBB credit rating bands.[493]

707. The RBA credit spreads are estimated with respect to both contemporaneous estimates of the return on Commonwealth Government Securities and Bank Bill Swap rates, at various target tenors.[494] They provide one potential approach to estimating the debt risk premium for the BBB band, at 10 year target tenor.

708. A starting point for the RBA's estimation approach is the development of the samples of Australian corporate bonds that are used to estimate the spreads for the A and BBB credit rating bands respectively. The RBA adopts the following selection criteria to filter the corporate bonds for each of the respective benchmark samples:[495]

- a credit rating of A-rated band or BBB-rated band;
- a remaining term to maturity of 1 year or longer;
- an amount at issuance of A$1 million or greater;
- inclusion of bonds denominated both in Australian dollars and foreign currencies; including US dollars and Euros;
- inclusion of bullet bonds and bonds with embedded options, such as callable bonds; and
- all bonds identified by Bloomberg that were outstanding after 1 January 1990 and were issued by non-financial corporates (**NFCs**) incorporated in Australia.[496]

709. Once the benchmark sample is developed, the RBA estimates the aggregate credit spreads for A-rated and BBB-rated Australian NFCs given the desired target tenor, based on the weighted average of the Australian dollar equivalent credit spreads over the swap rate. The method is applied to the cross-section of bonds in the sample that have the desired credit rating.

710. The RBA estimates are determined by the Gaussian Kernel method. This approach assigns a weight to every observation in the bond sample – informed by the distance of the observation's residual maturity from the target tenor – according to a Gaussian (normal) distribution centred at the target tenor.[497] The RBA notes that this method recognises that the observed spreads on bonds with residual maturities close to the target tenor contain more information about the underlying spread at

493 Reserve Bank of Australia, Interest rates: aggregate measures of Australian corporate bond spreads and yields, Table F3, www.rba.gov.au/statistics/tables/index.html.

494 Reserve Bank of Australia, 'New Measures of Australian Corporate Credit Spreads', Bulletin, December quarter 2013.

495 Reserve Bank of Australia, 'New Measures of Australian Corporate Credit Spreads', Bulletin, December quarter 2013.

496 Non-financial corporations are identified based on their classification by Bloomberg in a group other than banking, commercial finance, consumer finance, financial services, life insurance, property and casualty insurance, real estate, government agencies, government development banks, governments regional or local, sovereigns, supranationals and winding-up agencies.

497 Reserve Bank of Australia, *'New Measures of Australian Corporate Credit Spreads'*, *Bulletin*, December quarter 2013, p. 20.

that tenor than spreads on bonds with residual maturities further away. The RBA also argues that:[498]

> The advantage of the Gaussian Kernel over parametric methods that have been popularised in the literature on the estimation of government yield curves, is its simplicity. Also, it does not impose a particular functional form on the credit spread curve but allows the observed data to determine its shape.[499]

711. Formally, the Gaussian Kernel average credit spread estimator $S(T)$ at target tenor T (say, 5 years) for a given broad rating (say, BBB-rated bonds) and date is given by (10):

$$S(T) = \sum_{i=1}^{N} w_i(T;\sigma) \times S_i \qquad (10)$$

where

$w_i(T;\sigma)$ is the weight for the target tenor T of the i^{th} bond in the sub-sample of bonds with the given broad rating; and

S_i is the observed spread on the i^{th} bond in the sub-sample of N bonds with the given broad rating.

σ (sigma), which is measured in years, controls the weight assigned to the spread of each observation based on the distance between that bond's residual maturity and the target tenor. Sigma is the standard deviation of the normal distribution used to assign the weights. It determines the effective width of the window of residual maturities used in the estimator, with a larger effective window producing smoother estimates.

498 Reserve Bank of Australia, '*New Measures of Australian Corporate Credit Spreads*', *Bulletin*, December quarter 2013, p. 20.

499 A number of estimation methods were investigated. These methods produced very similar estimates of credit spreads across tenors and broad credit ratings. These methods included a range of parametric models estimated by least squares regressions applied to the cross-section in each period. In particular, the Nelson and Siegel (1987) method was examined in detail owing to its wide use in practice for estimating government yield curves (BIS 2005); this method has also been adapted for the estimation of corporate bond yield and spread curves (Xiao 2010). However, the RBA notes that in its sample these models displayed spurious statistical properties, producing very high model fit but largely statistically insignificant coefficients. Other studies have also found evidence of possible over-fitting of the data using parametric methods, particularly in the case of the Nelson and Siegel model.

712. The weighting function is as follows in (11).

$$w_i(T;\sigma) = \frac{K(T_i - T;\sigma) \times F_i}{\sum_{j=1}^{N} K(T_j - T;\sigma) \times F_j} \quad (11)$$

where

$K(T;\sigma)$ is the Gaussian Kernel function giving weight to the i^{th} bond based on the distance of its residual maturity from the target tenor $(|T_i - T|)$.

F_i is the face value of the i^{th} bond.

713. The Gaussian Kernel may then be defined as below in (12).

$$K(T_i - T;\sigma) = \frac{1}{\sqrt{2\pi}\,\sigma} \exp\left[-\frac{(T_i - T)^2}{2\sigma^2}\right] \quad (12)$$

714. The Gaussian Kernel method provides for a degree of flexibility in weighting the observations around the target tenor through the choice of the value of the smoothing parameter, σ.

715. The RBA then selects a smoothing parameter of 1.5 years for both A-rated bonds and BBB-rated bonds.

716. The RBA concluded that the Gaussian Kernel method produces effective weighted average tenors that are very close to each of the target tenors. The exception is the 10 year tenor, where the effective tenor is currently 8.6 years. The RBA argues that this difference reflects the dearth of issuance of bonds with tenors of 10 years or more.

717. The Authority considers that the estimates developed by the RBA are not the best means to deliver on the allowed rate of return objective.

718. First, the Authority is of the view that there is a need for consistency in the term estimates (that is, the estimates for the target tenors). The Authority notes that the RBA approach does not necessarily achieve this outcome, particularly at the 10 year target tenor. As noted above, the RBA method produces an estimate that is 8.6 years. The Authority recognises that methods are available to adjust the target tenor, which while less than ideal, are able to circumvent this problem.

719. Second, the Authority notes that the RBA estimates are only available for the BBB and A bands. However, Australian economic regulators, including the Authority, have adopted various other combinations of credit ratings for their regulatory decisions. The Authority considers it should not be constrained in its credit rating evaluation by a limited set of estimates of the related debt risk premia, as this may not be consistent with the requirements of the NGR, or the allowed rate of return. If the Authority determined to use a different credit rating it would use a different bond

sample (as indeed it does for its rail decisions). The Authority considers that this flexibility is important.

720. Third, the RBA estimates are reported as the month-end estimates of the debt risk premium using relevant swap rates or Commonwealth Government Security (**CGS**) rates. The resulting estimates are less than ideal because Australian regulatory practice is to adopt an average over a period between 20 or 40 trading days, so as to avoid significant fluctuation of the estimates on any particular day. The Authority recognises that interpolation may be used to approximate daily rates, but considers that its own estimation will not require approximation, which has statistical advantages (see paragraph 723 below).

721. On this basis, the Authority remains of the view that it is more appropriate to develop its own yield estimates. To this end, the Authority revised its bond yield approach with two additions: (i) the benchmark sample was extended to recognise the importance of Australian bonds denominated in foreign currencies; and (ii) various curve fitting techniques are adopted to allow the estimation of the debt risk premium at various tenors.

Revised bond yield approach

722. The revised bond yield approach allows for the specification of bond selection criteria for a given credit rating band. A regulator or Network Service Provider (**NSP**) employing the approach therefore has the flexibility to assess the impact of employing criteria that differ to (or are the same as) that used by the RBA. In a scenario where few bonds are available under a given set of criteria, less restrictive criteria can be specified to produce yield estimates that can serve as a robustness check.

723. The Authority views the interpolation of a point estimate between two 1 day estimates to approximate 20 or 40 day averages to be less representative of yields prevailing in the averaging period in question and subject to a higher degree of statistical noise. Two observations represent a very small sample and it is entirely possible that the two observations could differ substantially to those prevailing throughout the averaging period.

724. Additionally, the Authority considers its approach to be more transparent than using RBA corporate credit spreads because the sample of bonds underlying the bond yield approach estimates are published.

725. The Authority is of the view that the revised bond yield approach:

- provides flexibility in sampling bonds within a particular credit rating bands;
- directly addresses the issue of the effective tenor of the Reserve Bank of Australia (**RBA**) corporate credit spread estimates being less than 10 years; and
- is more robust to anomalous market yields by virtue of using 20 to 40 days of yield observations than using methods based on one day of observations;

Extending the benchmark sample for the bond yield approach

726. In its bond yield approach discussion paper in December 2010, the Authority considered the trade-off between the ‘market relevance’ and the ‘accuracy’ of the approach to be adopted in estimating the proxy for the cost of debt/the debt risk

premium for a benchmark sample of Australian corporate bonds.[500] The Authority considered that a bond price (or its observed yield) is determined by the markets, not by the companies or the regulators. As a result, the Authority was of the view that relying on market data will provide the best means of estimating the proxy for the cost of debt. This means that observed bond yields play a fundamental role in the method of estimation.

727. In addition, the Authority places emphasis on market relevance. This takes account of the fact that new bond issuers consider the prevailing market conditions prior to the issuance of the bonds. In particular, issuers will consider issuing longer term bonds in a 'normal' market situation, whereas shorter term bonds may be more appropriately issued during very unstable market conditions. As a result, the observed yields of bonds currently traded in the market will reflect the nature of the prevailing market conditions prior to the issuance of the bonds.

728. The Authority notes that firms are increasingly choosing to issue Australian bonds denominated in offshore markets and currencies.[501] As long as the majority of bond issuances of the various markets and currencies can be captured, then the associated outcomes are 'market relevant', and ideally should be included in the benchmark sample.

729. The decision to issue bonds in the Australian or overseas financial markets lies with businesses. There may be a cost advantage in issuing bonds overseas taking into account all possible risks associated with the process such as exchange rate risk. Alternatively, it may be more convenient to issue longer term bonds and/or bonds with larger amounts at issuance in overseas markets given the Australian financial market is generally considered a smaller market in comparison with the US, European, and UK markets.

730. An initial search on the Bloomberg terminal, as at 18 June 2014, indicated that Australian corporate bonds are largely denominated either in Australian dollars, US dollars (**USD**), Euros, or British pounds (**GBP**).

500 Economic Regulation Authority, *Measuring the debt risk premium: bond-yield approach*, 30 November 2010.

501 Reserve Bank of Australia, *'New Measures of Australian Corporate Credit Spreads'*, *Bulletin*, December quarter 2013, p. 16.

Table 10 Australian corporate bonds denominated in various currencies

Currency	No of bonds	Percentage	Amount (in relevant currency)	Exchange rate as at 18 June 2014	Amount (in A$)	Percentage
AUD	74	39%	20,531,775,500	1.0000	20,531,775,500	21%
CAD	2	1%	521,370,000	1.0148	513,766,259	0.52%
CHF	3	2%	492,910,000	0.8399	413,995,109	0.42%
EUR	14	7%	10,805,920,000	0.6893	15,676,657,479	15.81%
GBP	12	6%	6,196,342,000	0.5504	11,257,888,808	11.36%
JPY	2	1%	109,813,500	95.4700	1,150,241	0.0012%
NZD	3	2%	771,090,000	1.0778	715,429,579	0.72%
SGD	1	1%	217,903,000	1.1704	186,178,230	0.19%
USD	78	41%	46,539,000,000	0.9337	49,843,632,859	50.28%
		100%	86,186,124,000		99,140,474,063	100%

Source: Authority analysis based on data obtained from Bloomberg and the RBA (for exchange rate), June 2014

731. The above table indicates that if only Australian corporate bonds denominated in Australian dollars are included in the benchmark sample, then only 39 per cent (in terms of number issued) and 21 per cent (in terms of value at issuance) of bonds are covered. However, when foreign currencies such as USD; Euros; and GBP are included, the benchmark sample captures relevant information relating to 93 per cent of all debt (in terms of the number of bonds issued) and 98 per cent of all debt (in terms of the amount at issuance).

732. It is clear then that the majority of Australian corporate bonds are denominated in foreign currencies.[502] Furthermore, overseas markets have assumed greater importance for the longer end of the yield curve.

733. In conclusion, the Authority considers that Australian corporate bonds denominated in selected foreign currencies should be included in the benchmark sample, given the changing nature of debt markets, and the clear trend to foreign issuance. Doing so will increase the sample size of the benchmark sample, which leads to a more robust estimate of the DRP.

734. The Authority notes that DBP considers that the criteria filtering bonds of less than two year remaining term is less relevant given that yield curve estimation is used.[503] However, the Authority considers that bonds of less than two years can introduce bias due to thin trading as bonds approach maturity. However, DBP have not taken issue with this criteria and follow it, so the Authority does not consider this matter further.

735. The Authority will include Australian bonds denominated in USD; Euros; and GBP in the benchmark sample under its revised bond yield approach. The Authority

[502] Reserve Bank of Australia, *'New Measures of Australian Corporate Credit Spreads'*, *Bulletin*, December quarter 2013, p. 17.

[503] DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Regulatory Period Rate of Return Supporting Submission: 12, p. 21.

notes that as at August 2014, bonds denominated in AUD; USD; Euros and GBP covered the majority of debt issued by Australian corporates. Should the debt market evolve in the future and other currencies play a more significant role, the choice of currencies may need to change. The Authority considers that provided the bond sample covers at least 90 per cent of both the number of bonds and the amount at issuance, then its estimates are likely to be sufficiently representative of actual debt issuing practices.

736. As a further consideration, the Authority notes that it is standard practice to exclude firms operating in the financial sector, because these firms have a different capital structure.[504] Exclusion of bonds issued by firms in the financial sector may reduce the sample size. However, given the approach to include bonds denominated in foreign currencies, this reduction in the sample size does not have an effect on the robustness of the estimates.

737. In summary, the Authority considers that it is appropriate to include Australian corporate bonds denominated in key foreign currencies in the benchmark sample, as well as domestic issuance in Australian dollars. The Authority also considers it appropriate to exclude bonds issued by financial entities.

738. The revised bond yield approach criteria are outlined in Table 11.

Table 11 Bonds in Draft Decision Sample with Country of Risk other than Australia

Criteria	Authority's approach
Remaining term	>= 2 years
Amount at issuance	N/A
Denominated currency	AUD, USD, EUR and GBP
Industry of issuers	Non-financial corporates only
Country of Risk	Australia
Maturity Type	Bullet, Callable and Putable
Exclude	Perpetual, inflation linked, called instruments
Consolidate	Duplicate issues

Source Bloomberg and ERA Analysis

739. The country of risk criteria ensures that yields and credit spreads estimated on the bonds issued are reflective of risks primarily linked to economic and financial market conditions in Australia. Perpetual, inflation linked and called instruments are excluded. This is because these instruments appear infrequently in sampling and require additional complexity in calculating yields that are comparable to those of the other instruments. The additional benefit of including such instruments does not justify the additional complexity of including them. Duplicate issues such as those that are reported by Bloomberg as both privately placed and publically issued are excluded to avoid double counting their yields in the sample.

740. The sample of bonds as at 10 June 2016 includes 101 instruments which are outlined in Table 24 in Appendix 4B. These bonds are used for the purpose of developing the DRP estimate.

[504] The Authority notes that the RBA estimates exclude financial sector bonds.

Techniques to estimate the debt risk premium

741. The Authority in the Draft Decision investigated methods for the purpose of estimating the cost of debt at tenors beyond 5 years.

742. The Authority notes that there are different curve fitting techniques that could be used for this purpose. However, the following three techniques are widely used:

- the Gaussian Kernel;
- the Nelson-Siegel methodology; and
- the Nelson-Siegel-Svennson methodology.

743. Each of these techniques is discussed in turn below.

Gaussian Kernel

744. This methodology was discussed in detail above under the discussion of the RBA's approach.

745. For the Authority's Gaussian Kernel estimates, bond issue amounts expressed in foreign currencies are converted to Australian dollar amounts before being applied as weights in the Gaussian Kernel estimates.[505] Consequently, where a bond is issued in a foreign currency the weighting in the Gaussian Kernel estimates uses the principal amount converted into an Australian dollar amount. The currency conversion uses the closing exchange rate on the date of the bond's issue.

The Nelson-Siegel methodology

746. The Nelson-Siegel methodology assumes that the term structure of the yield curve has the parametric form shown in (13):

$$y_t(\tau) = \beta_{0t} + \beta_{1t}\frac{1-e^{-\lambda\tau}}{\lambda\tau} + \beta_{2t}\left(\frac{1-e^{-\lambda\tau}}{\lambda\tau} - e^{-\lambda\tau}\right) \quad (13)$$

Where

$y_t(\tau)$ is the credit spread (debt risk premium) at time t for maturity τ ; and

$\beta_{0t}, \beta_{1t}, \beta_{2t}, \lambda$ are the parameters of the model to be estimated from the data.

747. The Nelson-Siegel methodology uses observed data from the bond market to estimate the parameters $\beta_{0t}, \beta_{1t}, \beta_{2t}, \lambda$ by using the observed yields and maturities for bonds. With the estimated parameters $\beta_{0t}, \beta_{1t}, \beta_{2t}, \lambda$, a yield curve is produced by substituting these estimates into the above equation and plotting the resulting estimated yield $\hat{y}(\tau)$ by varying the maturity τ. $\hat{y}(\tau)$ has the interpretation of being the *estimated* yield for a benchmark bond with a maturity of τ for a given credit rating.

505 ATCO Gas Australia, Response to the Authority's Draft Decision on required amendments to the Access Arrangement for the Mid-West and South-West Gas Distribution System, 27 November 2014, Appendix 9.2, p. 72.

The Nelson-Siegel-Svennson methodology

748. The parametric from of the Nelson-Siegel-Svennson curve used by the Authority is that specified in Svennson's 1994 paper.[506] The notation for this parametric form is shown in equation (14).

$$\hat{y}_t(\tau) = \beta_{0t} + \beta_{1t}\frac{1-e^{-\tau/\lambda_1}}{\tau/\lambda_1} + \beta_{2t}\left[\frac{1-e^{-\tau/\lambda_1}}{\tau/\lambda_1} - e^{-\tau/\lambda_1}\right] + \beta_{3t}\left[\frac{1-e^{-\tau/\lambda_2}}{\tau/\lambda_2} - e^{-\tau/\lambda_2}\right] \quad (14)$$

where

$\hat{y}(\tau)$ is the credit spread (debt risk premium) at time t for maturity τ ; and

$\beta_{0t}, \beta_{1t}, \beta_{2t}, \beta_{3t}, \lambda_1, \lambda_2$ are the parameters of the model to be estimated from the data.

749. The Nelson-Siegel-Svennson methodology is estimated in the same way as the Nelson-Siegel method, except uses a different parametric form.

750. DBP employed Esquant Statistical Consulting (**Esquant**) to apply and critique the revised bond yield approach. Esquant appear to have replicated the revised bond yield approach following the steps outlined in the Draft Decision, in so far that it produced similar results to that it derived from an implementation in R statistical software.[507] Its view was that the revised bond yield approach has two substantial weaknesses:

- it does not control for the effects of different credit ratings of bonds within the BBB band; and
- the Nelson-Siegel-Svennson curve is over-parameterised and so is difficult to fit and suffers from multi-collinearity.

751. With respect to controlling for the effect of credit ratings the Authority is of the view that controlling for credit ratings in the way proposed by Esquant requires additional complicating assumptions, for example whether or not the effect of all three bands are equally weighted and whether the effect of each band can be reliably quantified with the data available. The Authority's preference is to allow the market data determine the outcome without too much reliance on approach, that is, as if the bonds were all shared the same rating. Indeed, preference for market data controlling outcomes instead of choice of method is why the Authority opted for three conventional approaches to estimating 10 year yields.

752. On the issue of over-parameterisation of the Nelson-Siegel-Svennson curve, the Authority is of the view that the benefit of obtaining a third estimate from a well-accepted model to serve as a reference outweighs the econometric weaknesses outlined.

506 L. Svennson, *Estimating and Interpreting Forward Interest Rates: Sweden 1992-1994*, Institute for International Economic Studies, University of Stockholm, Seminar Paper No 579, p. 6.

507 Esquant Statistical Consulting, *drpr package*, 22 February 2016, p. 7.

753. In any case, DBP submits that they agree with the DRP estimation methods and bond selection criteria employed in the Authority's revised bond yield approach as outlined in the Draft Decision.

Using the Authority's revised bond yield approach to estimate the regulated debt risk premium

754. On the basis of the above considerations, the Authority uses its revised bond yield approach for the purpose of estimating the regulated DRP for this Final Decision.

755. To estimate the regulated DRP, the Authority:

- extends the benchmark sample under the bond yield approach to: (i) include Australian corporate bonds denominated in domestic currency (**AUD**) and foreign currencies including USD; Euros; and British pounds; and (ii) exclude bonds issued by financial sectors including banks, duplicates, inflation linked, called and perpetual instruments;
- converts the yields into hedged Australian Dollar equivalent yields inclusive of Australian Swap rates;
- averages AUD equivalent bond yields across the averaging period for each bond (for example, where a 20 trading day averaging period applies, each bond will have a single 20 day average yield calculated for it);
- estimates yield curves on this data – applying the Gaussian Kernel, Nelson-Siegel and Nelson-Siegel-Svennson techniques;
- uses the simple average of these 3 yield curve's 10 year cost of debt estimate to arrive at the market estimate of the 10 year cost of debt;[508]
- estimates the regulated debt risk premium for the purposes of estimating the regulated cost of debt.

756. DBP highlight that they propose to apply the Authority's revised bond yield approach in using different software (R instead of Excel) and different data (Thomson-Reuters instead of Bloomberg) in order to check the Authority's DRP estimates.[509]

757. While the Authority sees no benefit in constraining the application of the revised bond yield approach to particular data providers and software per se, differences in outcomes will provide no basis for the Authority reviewing its estimate unless it can be shown that an operator error in its Excel application exists.

758. The following sections summarise the above steps in more detail.

Step 1: Determining the benchmark sample

759. The criteria set out in the Rate of Return Guidelines to determine the benchmark sample in the Authority's bond yield approach have been revised. The following

[508] The Authority intends to adopt the average, because there is no strong evidence to suggest that one approach outperforms the others. It is likely that the average will show less variability under a range of prevailing conditions.

[509] DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 73.

characteristics will be applied to select corporate bonds to be included in the benchmark sample:[510]

- credit rating of each bond must match that of the benchmark efficient entity, as rated by Standard & Poor's;
- time to maturity of 2 years or longer;
- bonds issued where the country of risk is Australia (except by the financial sector[511]) and denominated in AUD; USD; Euros; and GBP;[512]
- inclusion of both fixed bonds[513] and floating bonds;[514]
- inclusion of both bullet and callable/ puttable redemptions;[515]
- at least 50 per cent of observations for the averaging period is required (that is, 20 yield observations over the required averaging period of 40 trading days are required);[516] and
- are not called, perpetual, a duplicate or inflation linked.

760. The inclusion of the last criteria in paragraph 759 above ensures the exclusion of duplicates, called, perpetual and inflation linked instruments. Employing these criteria in the Bloomberg search function ensures a consistent sample with that employed by the Authority.

761. The sample of bonds as at 10 June 2016 – used for the 2016 estimate – included the 101 international instruments which are outlined in Appendix 4B.

Step 2: Conversion of yields into AUD equivalents

762. Under the finalised approach for conversion of yields into Australian dollar equivalents only hedged Australian dollar equivalents yields (as opposed to spreads) are reported. The spread to an Australian dollar swap is calculated as a single estimate based on the observed cost of debt on the entire sample of bonds, as opposed to downloading individual swap spreads.

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510 Economic Regulation Authority, Discussion Paper – Measuring the Debt Risk Premium: A Bond Yield Approach, December 2010, p. 11.

511 As classified by Bloomberg Industry Classification System level 1.

512 Country of risk is based on Bloomberg's methodology using four factors listed in order of importance; management location, country of primary listing, country of revenue and reporting currency of issuer. This criteria allows for the largest sample of bonds that reflect an Australian risk premium.

513 This is a long term bond that pays a fixed rate of interest (a coupon rate) over its life.

514 This is a bond whose interest payment fluctuates in step with the market interest rates, or some other external measure. Price of floating rate bonds remains relatively stable because neither a capital gain nor capital loss occurs as market interest rates go up or down. Technically, the coupons are linked to the bank bill swap rate (it could also be linked to another index, such as LIBOR), but this is highly correlated with the RBA's cash rate. As such, as interest rates rise, the bondholders in floaters will be compensated with a higher coupon rate.

515 A callable (putable) bond includes a provision in a bond contract that give the issuer (the bondholder) the right to redeem the bonds under specified terms prior to the normal maturity date. This is in contrast to a standard bond that is not able to be redeemed prior to maturity. A callable (putable) bond therefore has a higher (lower) yield relative to a standard bond, since there is a possibility that the bond will be redeemed by the issuer (bondholder) if market interest rates fall (rise).

516 The Authority notes that there is a tendency for fewer bonds to be available on the long end of the yield curve. If circumstances arise where this criteria results in a paucity of bonds such that curve fitting is impractical the Authority may exercise judgement to determine whether exclusion of bonds based on this criteria is appropriate.

763. The Authority's finalised approach for conversion into Australian dollar equivalents does not require estimates of a conversion factor as it utilises Bloomberg Swap Manager facilities directly. The Authority believes this approach is transparent and replicable - anyone with access to a Bloomberg terminal can enable the functionality will get the same hedged Australian dollar equivalent yield for any given bond, provided they use the same date, currency, payment frequency and deal type.

Step 3: Averaging yields over the averaging period

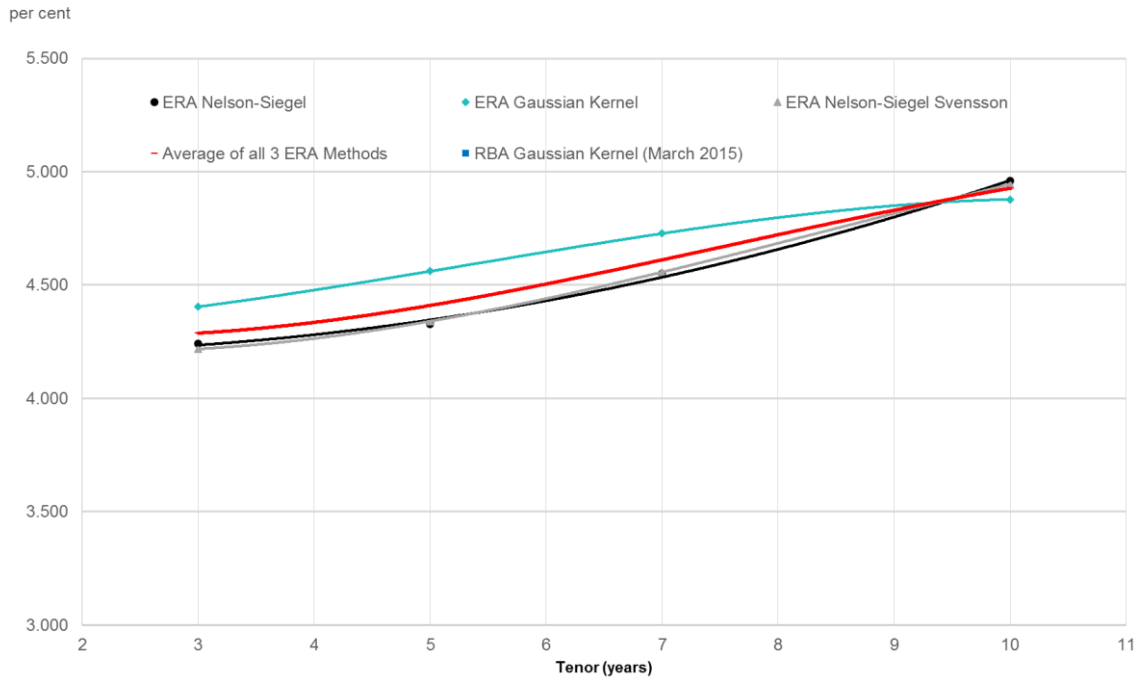
764. Under the finalised approach for conversion of yields into Australian dollar equivalents only hedged Australian dollar equivalent yields (as opposed to spreads) are reported. The averaging period results in 20 hedged Australian dollar equivalent yields for each bond. The days are based on Australian eastern states trading days and are counted back from and include the determination date for the DRP calculation.

765. The observations on these days are then averaged to create one 20 day average observation for each bond. The spread to an Australian dollar swap is calculated as a single estimate based on the observed cost of debt estimated using all three techniques on the entire sample of bonds.[517]

Step 4: Apply curve fitting techniques

766. The results of the three curve fitting techniques applied to the sample of bonds listed in Appendix 4B are plotted in Figure 13.

Figure 13 Estimated Effective Annual Spot Yield Curves for the Cost of Debt for the Averaging Period up to 10 June 2016



Source: Bloomberg, Reserve Bank of Australia and ERA Analysis, June 2016.

767. The parameters and constraints for the fitted curves are reproduced in Table 12 and Table 13.

[517] As opposed to downloading individual swap spreads.

Table 12 Nelson-Siegel-Curve Fitted Parameters and Constraints

Parameter	Value	Constraints
β_{0t}	7.825	> 0
β_{1t}	-3.165	
β_{2t}	-6.066	
$\beta_{0t} + \beta_{1t}$	4.660	> 0
λ_1	0.24365	> 0

Source: Authority Analysis

Table 13 Nelson-Siegel-Svennson Curve Fitted Parameters and Constraints

Parameter	Value	Constraints
β_{0t}	7.846	>=0
β_{1t}	1.140	
β_{2t}	-8.469	
β_{3t}	-8.436	
λ_1	0.78631	>=0
λ_2	3.88670	>=0
$\beta_{0t} + \beta_{1t}$	8.986	>=0

Source: Authority Analysis

768. The 10 year Gaussian Kernel estimate shown in Table 14 on the Authority Gaussian Kernel estimate curve is the extrapolated 10 year estimate using the method outlined in paragraph 837 below. This changes the annualised 10 year Gaussian Kernel estimate from 4.838 to 4.878 per cent. The specific yields at each tenor for the various methods are shown in Table 14.

Table 14 Estimated effective annual spot yields at each tenor for the cost of debt as at 10 June 2016 (per cent)

Years	3	5	7	10
RBA Gaussian Kernel (May 2016)	4.346	4.622	4.817	5.055
Authority Gaussian Kernel	4.404	4.561	4.727	4.878
Authority Nelson-Siegel	4.241	4.329	4.549	4.959
Authority Nelson-Siegel Svennson	4.218	4.340	4.557	4.944
Average of all 3 Authority Methods	4.288	4.410	4.611	**4.927**

Source: Bloomberg, Reserve Bank of Australia and Authority Analysis

Step 5: Estimate the regulatory debt risk premium

769. For the purposes of calculating the 10 year DRP for the calendar year 2016, which is used as the cost of debt for calendar 2016 in this Final Decision, the Authority will use the 10 year cost of debt estimate of 4.927 per cent based on the average of all three methods, estimated as at 10 June 2016.

770. The 20 day average of the 10 year Australian dollar swap rate as at 10 June 2016 expressed as an annual effective yield was 2.404 per cent.[518]

771. Subtracting the 10 year swap rate of 2.404 per cent from the 10 year cost of debt gives a spread to swap of 2.523 per cent. The Authority will therefore apply a DRP of 2.523 per cent as the spot estimate for the 2016 year for the purposes of the Final Decision.

772. The foregoing method will be used to annually update the forward looking DRP, consistent with the 'automatic formula' requirement of NGR 87(12). The automatic formula is set out at Appendix 4C. The Authority notes that DBP has expressed a preference for estimation using the R package.[519] However, the Authority has elected to use Excel for transparency; for example, it is amenable to the write up in Appendix 4C. The Authority therefore requires estimation in Excel.

Method of applying weights

773. The trailing average estimate of the DRP weights the past 10 years of estimates of the annual DRP, consistent with the average term of debt issued by the benchmark efficient entity and its staggered debt portfolio.[520]

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518 The 20 day average fixed rate for 'ADSWAP10 Curncy' was 2.390 per cent which is paid semi-annually.

519 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Regulatory Period Rate of Return Supporting Submission: 12, p. 74.

520 Analysis in the Rate of Return Guidelines supported a term at issuance for the benchmark efficient entity of around 10 years. (Economic Regulation Authority, *Appendices to the Explanatory Statement for the Rate of Return Guidelines: Meeting the Requirements of the National Gas Rules*, December 2013, p. 39).

774. The resulting 10 year trailing average is proposed to be updated annually, adding in the most recent estimate of the DRP, according to its weight, and dropping the estimate from 10 years ago. This replicates the cost of debt for the benchmark efficient entity under a strategy whereby it rolls over 10 per cent of its debt each year.

775. The weights for a simple hybrid trailing average DRP estimate would be 10 per cent for each year's estimated of the DRP over the most recent relevant 10 years.

776. The benchmark efficient entity could then replicate a simple 10 year trailing average by issuing one tenth of its debt each year. While a simplification of likely practice in reality, this would closely proxy the cost of debt under the observed financing strategies of benchmark efficient entities.

777. In the Draft Decision, the Authority considered whether to overlay capital expenditure (**capex**) weights on the simple trailing average, but determined not to accept DBP's proposal for capex weights. DBP partially accepted this.

778. The Authority's consideration of DBP's revised capex weighting approach is discussed in the section on 'Capex weights', at paragraph 784 below.

The simple equally weighted trailing average

779. A first step in developing weights is to establish the formula for the equally weighted trailing average. This develops the weights to each of the DRP annual estimates for the nine past regulatory years, plus the 'current' estimate, that would contribute to the hybrid trailing average DRP estimate for each current regulatory year.

780. The following equation in (15) specifies the formula for estimating the simple equally weighted 10 year trailing average of the DRP to apply in any regulatory year:

$$TA\,DRP_0 = \frac{\sum_{t=0}^{-9} DRP_t}{10} \qquad (15)$$

Where

$TA\,DRP_0$ is the equally weighted trailing average of the DRP to apply in the following year as the annual update of the estimate used in the current year; and

DRP_t is the DRP estimated for each of the 10 regulatory years t = *0, -1, -2…. , -9*.

781. All years are in the same year convention as year *0*. For example, if year *0* is the next regulatory year 2016 for which the $TA\,DRP_0$ is being calculated, t = *-9* is the calendar year 2007 because 2016 is a calendar year in this Access Arrangement. Using the same logic if year *0* is regulatory year 2014-15, t = *-9* is the financial year 2005/2006.

782. So for example, in (16) the DRP trailing average estimate for the calendar 2016 regulatory year will be:

$$TA\,DRP_{2016} = 0.1 \times DRP_{2016} + 0.1 \times DRP_{2015} + 0.1 \times DRP_{2014} + 0.1 \times DRP_{2013} + 0.1 \times DRP_{2012} + 0.1 \times DRP_{2011} + 0.1 \times DRP_{2010} + 0.1 \times DRP_{2009} + 0.1 \times DRP_{2008} + 0.1 \times DRP_{2007} \quad (16)$$

783. In terms of the notation used by the Australian Energy Regulator (but in the Authority's case applying just to the DRP trailing average), the foregoing TA DRP for the 2016 calendar year may be written as follows in (17):[521]

$$_{2015}kd_{2016} = 0.1 \times {}_{2006}R_{2007} + 0.1 \times {}_{2007}R_{2008} + 0.1 \times {}_{2008}R_{2009} + 0.1 \times {}_{2009}R_{2010} + 0.1 \times {}_{2010}R_{2011} + 0.1 \times {}_{2011}R_{2012} + 0.1 \times {}_{2012}R_{2013} + 0.1 \times {}_{2013}R_{2014} + 0.1 \times {}_{2014}R_{2015} + 0.1 \times {}_{2015}R_{2016} \quad (17)$$

Capex weights

784. In the Draft Decision, the Authority considered whether to overlay capital expenditure weights on the simple trailing average, consistent with DBP's initial proposal. However, the Authority determined not to accept DBP's proposal. DBP partially accepted this.

785. First, DBP now does *not* propose for capex weights to apply to the historic estimates in the 2016 trailing average:[522]

> DBP agrees with the trailing average approach the ERA has utilised for the DRP, using data extending back to 2005, and with the use of annual averages using the RBA index for data pre 2015. DBP also agrees with the use of tranches equal to one-tenth the value of the RAB for all historical data. Finally, DBP agrees with the weighting process for past debt and current debt in the transition year of 2016, discussed in paras 609 to 18 (pp 126 to 30) in the Draft Decision.

786. However, second, DBP continues to propose capex weights, going forward, albeit above a certain threshold.[523]

> In respect of future tranches of debt, DBP proposes to use capex weights rather than equal-sized tranches, where forecast capex exceeds ten percent of the value of the RAB. Since the annual update sets the cost of debt for a new tranche over the course of the coming year, we propose our approach be based upon forecast capex rather than actual capex over the previous year. Further, since DBP does not propose any capex during the AA4 period which exceeds ten percent of the RAB, in practical terms, our approach matches that of the ERA.

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521 Australian Energy Regulator, *Draft Decision: Jemena Gas Networks (NSW) 2015-20*, November 2014, Attachment 3, p. 3-288.

522 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 22.

523 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 74.

787. In its evaluation of whether to accept the simple hybrid trailing average approach in the Draft Decision, the Authority determined that there are costs and benefits associated with the capex weighting overlay.[524]

788. First, the Authority accepted in the Draft Decision that weighting the trailing average to account for new capex can be a means to ensure that the marginal cost of investment for new capex reflects the Authority's most recent forward looking estimate of the prevailing DRP. This efficiency consideration is a key concern of the Authority, given the requirements of the NGL and NGR.

789. However, in deciding to adopt the trailing average approach for the Draft Decision, the Authority recognised the difficulty of distinguishing between the on the day and the trailing average approaches with regard to prediction performance. While there is some evidence for the on the day approach in the available data, it is very limited. This outcome is relevant; if the annually updated trailing average performs as well as the annually updated 'on the day' approach in predicting the forward looking DRP, then there would be no gain in adopting capex weights.

790. Second, the Authority noted the potential for actual capex undertaken by the service provider to diverge from forecast capex. This might be in response to changing financial conditions, and therefore may be an efficient response. For example, the DRP might rise sharply for a period, causing the service provider to delay a capital expenditure program.

791. However, the capex weights method would lock in a sharply higher return on debt into the trailing average for the remainder of the regulatory period, which did not reflect actual costs.

792. PTRM weightings also could feasibly add incentives to game the capex estimates and their timing under some circumstances. For example:

- if the DRP was expected to rise over the initial part of the access arrangement period, then there would be an incentive to shift scheduled capex to that period in the forecasts, all other things equal;
- where the expected increase in the DRP did not eventuate as expected, but instead was delayed, it could pay the service provider to defer some of the scheduled initial period capex to the end of the access arrangement, knowing that the weighting would be 'trued up' for actual capital expenditure at the next access arrangement reset through the capex weights adjustment (see Appendix 4F).

793. Third, the Authority noted the significant complexity involved in developing a capex weights overlay within the PTRM. It creates the need for a complex series of adjustments at each access arrangement revision, which increases the potential for error (see Appendix 4F of the Draft Decision).

794. In conclusion, the Authority carefully considered the PTRM weights approach, given its potential ability to improve the efficiency of the incentives for new capex. On balance, however, the Authority was not convinced that limited evidence for the benefits of the capex weighted approach outweigh the clear regulatory costs in terms of the additional complexity.

[524] Economic Regulation Authority, Draft Decision on Proposed Revisions to the Access Arrangement for the Dampier to Bunbury Natural Gas Pipeline, 22 December 2016, Appendix 4, p. 118.

795. DBP contends, in arguing for capex weights going forward, that:

- the current estimate of the DRP is 'closer to the prevailing rate over the next 12 months much of the time, providing superior signals for investment' (quoting the Draft Decision);[525]
- the capex weighting method is not complex;[526]
- the Authority's concern about the potential to game the weighting method is misplaced.[527]

796. In response, the Authority noted the first point in the Draft Decision, but considered that the benefits were outweighed by the costs of the second and third points, as outlined above. The only evidence DBP brings to bear are selective quotes in support from the Draft Decision.[528] However, DBP does not address the Authority's weighing of the costs and benefits:[529]

> …the Authority notes the potential benefits of capex weights in aligning the marginal cost of investment for the benchmark efficient entity with the forward looking estimate of the prevailing rate. However, in deciding to adopt the trailing average approach for this Draft Decision, the Authority has recognised the difficulty of distinguishing between the on the day and the trailing average approaches with regard to prediction performance.[530] While there is some evidence for the on the day approach in the available data, it is very limited. This outcome is relevant; if the annually updated trailing average performs as well as the annually updated 'on the day' approach in predicting the forward looking DRP, then there would be no gain in adopting capex weights.

797. Second, the Authority remains of the view that the capex weighting method does add complexity – and this complexity would be even more if DBP's proposed 'solution' for the third point (gaming) was implemented (see the next point).

798. Third, DBP suggests that gaming could be prevented as follows:[531]

> One approach the regulator might use to prevent gaming is to require the regulated firm to indicate whether or not capital expenditure forecast at the outset of the regulatory period actually went ahead during the previous year each time it does its annual update to see whether or not the firm was sticking with its forecast. It could then update the capex weights based on what was actually spent going forward. That is, it would check last years' forecast and change the forward-looking values for that

525 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 77.

526 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 80.

527 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 77.

528 DBP quotes 'the on the day approach appears to deliver a DRP that is closer to the prevailing rate over the next 12 months much of the time, providing for superior signals for investment' (Economic Regulation Authority, *Draft Decision on Proposed Revisions to the Access Arrangement for the Dampier to Bunbury Natural Gas Pipeline*, 22 December 2016, Appendix 4, p. 92) and 'trailing average approaches can be weighted by new capex, overcoming this shortcoming, albeit at the cost of some complexity' (ibid).

529 Economic Regulation Authority, Draft Decision on Proposed Revisions to the Access Arrangement for the Dampier to Bunbury Natural Gas Pipeline, 22 December 2016, Appendix 4, p. 118.

530 As noted… this recognition has led the Authority to accept the hybrid trailing average approach over the on the day approach, both annually updated.

531 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 77.

tranche of capex from this year onwards, but would not attempt to claw-back any under or overspend.

Thus, for example, at the end of 2016 in the example above, the regulator could check and see whether the $100 million the firm said it would spend during 2016 was actually spent or not. If it was not spent, then the weighting for the year 2016 for the DRP estimate in 2017 would reflect a RAB of $1 billion, not $1.1 billion.[532] Thus, if the firm was seeking to game a declining DRP by putting off forecast capital expenditure, this strategy would provide limited returns because the relatively high DRP in 2016 would be applied to a lower RAB in the 2017 DRP allowance, wiping out the gains…

Adjusting the weights every year in this manner is likely to be highly intrusive, and raises additional problems; if the firm actually did spend $500 million not $100 million, for example, would the regulator then need to assess the efficiency of that additional spending? Fortunately, the same principle as noted above in respect to the limited gains from gaming applies if the capital expenditure forecast for the last AA period is assessed prior to the next AA period commencing, which is what regulators already do.

This is shown in Table 8 overleaf. In this case, the base is capital expenditure happening exactly as forecast. Where it deviates, the firms pay the actual capital costs incurred during 2016 to 2019 (delaying investment is not free; the firm pays the DRP during the year when the investment happens, rather than when it was forecast), and then the allowed DRP in the years 2021 to 2025 (no new capital spending happens during this second AA period in our simple example) is based upon when the capital spending actually happened during 2016-20. This has the same effect as noted above; if the firm does obtain a gain from deferring expenditure from a high to a low DRP year, it loses later on because the RAB upon which the DRP is based going forward once the reconciliation is done is smaller during the high DRP year. The net effect, even without any kind of clawback mechanism, is almost no effect at all.

Table 8: Gains from gaming the capex weights – with five-yearly review

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Average	Diff (from base)
Base - increasing DRP	256.29	255.17	259.98	264.37	278.49	288.43	302.04	319.67	341.74	368.67	293.49	
Base - decreasing DRP	256.29	255.17	247.86	243.03	230.30	222.36	212.79	201.75	189.37	175.80	223.47	
Shift out 2017 capex in 2016 - increasing DRP	256.29	255.17	257.12	268.38	281.65	291.20	304.41	321.65	343.32	369.86	294.91	0.484%
Shift out 2017 capex in 2016 - decreasing DRP	256.29	255.17	252.12	239.73	227.69	220.08	210.84	200.12	188.07	174.83	222.49	-0.438%
Capex abandoned in 2016 - increasing DRP	256.29	255.68	260.59	264.92	279.40	289.22	302.70	320.21	342.15	368.96	294.01	0.180%
Capex abandoned in 2016 - decreasing DRP	256.29	255.68	247.87	243.04	229.86	221.98	212.46	201.46	189.14	175.62	223.34	-0.060%
capex doubled in 2016 - increasing DRP	256.29	254.75	259.45	263.91	277.69	287.75	301.46	319.20	341.37	368.42	293.03	-0.155%
capex doubled in 2016 - decreasing DRP	256.29	254.75	247.84	243.02	230.68	222.70	213.09	202.00	189.58	175.96	223.59	0.053%
divest $100 mil in 2016 - increasing DRP	256.29	256.30	261.32	265.56	280.46	290.14	303.47	320.84	342.63	369.30	294.63	0.390%
divest $100 mil in 2016 - decreasing DRP	256.29	256.30	247.89	243.05	229.35	221.53	212.07	201.13	188.87	175.41	223.19	-0.127%
$500 mil investment in 2016 not $100 mil - increasing DRP	256.29	253.83	258.25	262.85	275.83	286.13	300.10	318.10	340.52	367.83	291.97	-0.515%
$500 mil investment in 2016 not $100 mil - decreasing DRP	256.29	253.83	247.82	243.01	231.57	223.49	213.77	202.58	190.06	176.34	223.88	0.180%

For this reason, there is no legitimate concern as to gaming, and capex weighting ought to be allowed.

799. However, as noted by DBP, adjusting weights is highly intrusive, raising additional problems. It is also clearly complex. Further, DBP's example in Table 8 suggests that there are clear potential gains to be had by shifting capex (refer 'shift out 2017

[532] [DBP's footnote] More specifically, the initial RAB line, depreciating from 2015 until 2075 would remain at $1 billion each time, and the capex line for 2016 (starting in 2016 and depreciating until 2076) would be zero from 2017 onwards, not $100 million (and subsequent depreciated values).

capex in 2016' – where it is as much as 0.484 per cent difference in returns), so it is perplexing that DBP suggests there is 'almost no effect at all'.

800. On that basis, the Authority is not convinced that it should adopt capex weights going forward in the weighting of the trailing average, because:

- the Authority does not consider that there is strong evidence that the annually updated trailing average performs less well – as compared to the annually updated 'on the day' approach – in predicting the forward looking DRP, implying there is little to gain in adopting capex weights;
- the capex weights add complexity;
- there is potential for gaming.

801. The Authority therefore does not accept DBP's capex weighting approach for the above reasons.

802. The Authority determines not to include capex weights in the DRP trailing average for this Final Decision.

Estimates of the DRP prior to the current on the day estimate

803. The Authority has determined to adopt the simple hybrid trailing average of the DRP. The calendar year 2016 trailing average of the DRP, that is used as the estimate for this Final Decision, requires annual estimates of the DRP for past years – back to 2007 – to combine with the Authority's forward looking annual estimates of the DRP (the first of which – as at 10 June 2016 – is set out above).[533]

804. The Authority endeavoured to obtain historic bond data to estimate the historic annual DRP estimates through its revised bond yield approach. However, while the Authority was able to access historic BBB credit band bond yields from Bloomberg back to 2005, the resulting bonds did not provide a large enough sample to estimate the return on debt in all years.[534]

805. The Authority therefore determined to adopt a third party source for the DRP estimates in past years, for incorporation in the trailing average to be used in this Final Decision. A number of potential options are available which could provide historic estimates of the DRP:

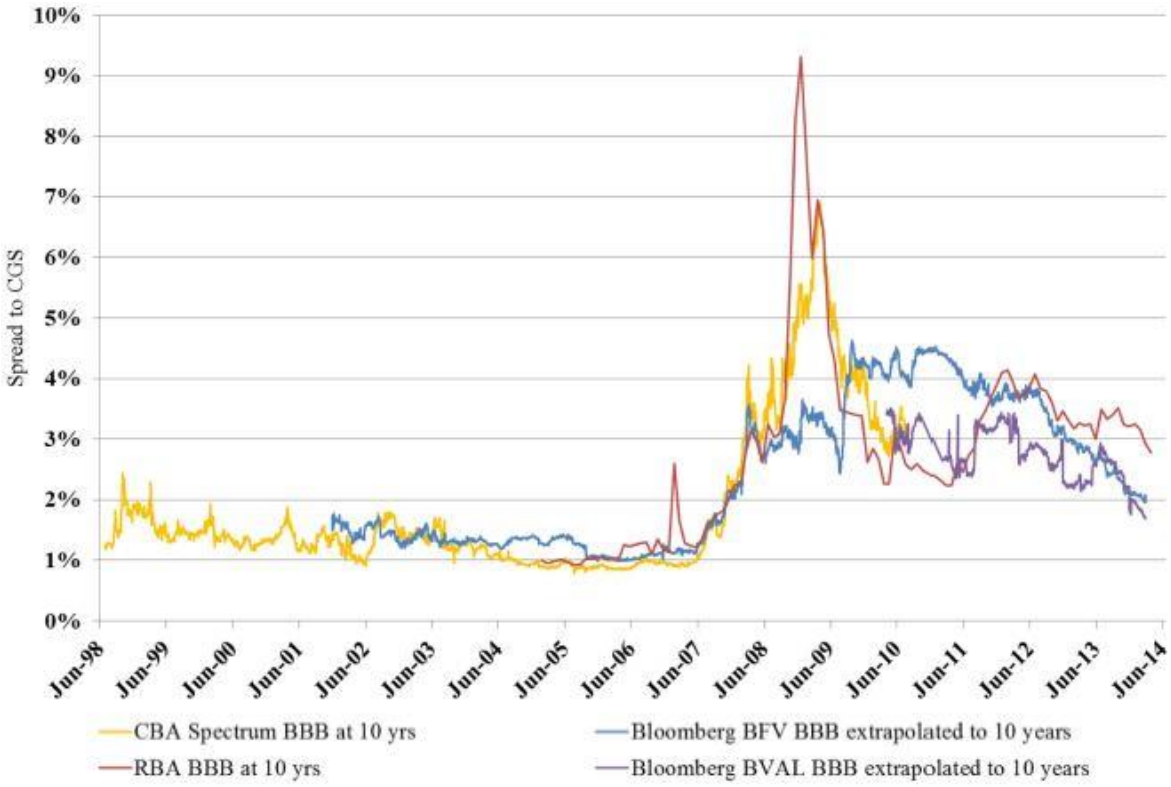
- the RBA's credit spread estimates;
- Bloomberg's FVC estimates; and
- Bloomberg's BVAL estimates.

806. The Authority notes that these sources give different estimates for the period in question (Figure 14).

[533] The calendar year 2015 *indicative* estimate set out here will be updated for calendar year 2016 for the Final Decision, based on DBP's nominated averaging period in early 2016. The overall method for determining that revised calendar year 2016 estimate will follow that set out here.

[534] The RBA have been able to acquire larger sample sizes by combining UBS historic bond data with the Bloomberg historic bond data.

Figure 14 Estimates from alternative historical DRP data series (spread to CGS)



Source: Competition Economists Group, *Memorandum to ActewAGL*, 24 May 2014, p. 5.

807. The Bloomberg BVAL series does not go back past 2010 so does not provide a consistent series over the entire period. The Authority considers that it should overlook this series for this reason.

808. It is clear from the relative performance of the two remaining series – the RBA and Bloomberg FVC series – that there is considerable variation in the estimates post June 2008, leading to uncertainty as to the best data series to adopt. An option to overcome this issue could be to average the two series. However, given the Authority's intention to use an annual average of the available data for the whole year of each of the past nine years (see below), and also to adopt a simple weighting scheme for each of those nine years (see below), there are limited differences between adopting one or the other series, or an average of the two.[535]

809. The Bloomberg FVC also does not include foreign bonds, which raises a clear point of departure from consistency with the Authority's preferred approach. The RBA series, however, includes foreign bonds.

[535] This may be confirmed by simple inspection of the areas between the RBA series and the FVC series – unders tend to offset overs. CEG confirm this, noting 'that even though the RBA and Bloomberg estimates differ materially through some periods in the last 10 years these differences tend to cancel each other out – with the RBA estimates being higher in some periods and the Bloomberg estimates higher in other periods. The net difference over the period January 2005 to October 2014 is only 6 basis points – with the Bloomberg average being higher' (ATCO Gas Australia, *Response to the Authority's Draft Decision on required amendments to the Access Arrangement for the Mid-West and South-West Gas Distribution System*, 27 November 2014, Appendix 9.2, p. 63).

810. A further advantage of the RBA data is the smaller extrapolation that is generally required (commonly between 1 and 2 years) as opposed to the three or more for the Bloomberg FVC (which only goes to tenors of 7 years in more recent times).

811. The Authority therefore considers that adopting the RBA series is fit for purpose for estimating past DRP returns, particularly given the uncertainties, and that averaging the two series is unlikely to deliver any material improvement to the historic estimates.

812. Over time, the historic RBA estimates will be progressively replaced in the trailing average by the Authority's own forward looking estimates.

813. DBP accepts this approach, which was set out in the Draft Decision.[536]

Use of the RBA estimates

814. The RBA data provides an available source of historic credit spreads for 10 year non-financial corporate bonds.

815. Issues that arise in using the RBA estimates are:

- the averaging period to apply – whether to align with that adopted for the current 2015 estimate or some other averaging period;
- whether to apply capex weighting to the historic estimates; and
- the extrapolation issue – estimating the DRP to match the 10 year term assumed for this Final Decision.

816. These issues are discussed in what follows.

Aligning with the averaging period dates

817. DBP's proposed revised access arrangement covers the period 1 January 2016 to 31 December 2020 (the AA4 period).

818. The averaging period dates for the Authority's current forward looking return on debt estimate, made prior to the release of this Final Decision, were the 20 business days ending 10 June 2016. The resulting 'current' ('t=0') estimate will be included in the trailing average estimate to apply for the 2016 calendar year.

819. An issue arises whether the historic DRP estimates for inclusion in the hybrid trailing average should be based on the same averaging period in each of the historic years, that is for example, aligning with the period ending 10 June. This would require interpolation of the RBA monthly estimates to allow a corresponding annual estimate to be made in each previous year. However, those dates may not relate to business days in past years. It may also result in changing estimates for the historic years in the trailing average, depending on whether the averaging period changes.

820. A better alternative is to average the 12 available months of RBA data, such that the estimated DRP reflects the average DRP in whole of each past year. The Authority prefers the latter approach for the following reasons.

[536] DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 74.

821. First, the Authority in this instance is not trying to develop an estimator for the year ahead. Rather, it is trying to develop an estimate for the past, which can be actual outcomes. That points to use of the whole year average.

822. Second, it is not clear when the benchmark efficient entity raised its capital in the past. For the future, the benchmark efficient entity could align its debt issuance with the averaging periods for issuing new debt. However, in the past, it may have issued debt at any time of the year. Accordingly, the best estimate of the DRP relating to debt raised at an unknown point in a past year will be the annual average.

823. The Authority therefore adopts the annual average of the DRP estimate from the RBA data. Each annual DRP estimate will be derived as the RBA 10 year BBB spread to swap, extrapolated to 10 years (see below for a summary of the method for extrapolating the RBA data), for the year which ends concurrent with the final year in the trailing average.[537]

824. DBP accepts this approach, which was set out in the Draft Decision.[538]

Composition of the hybrid trailing average estimates of the DRP

825. The Authority's has determined to adopt the simple equally weighted ten year trailing average for this Final Decision, which may be recalled has the following automatic formula (refer to paragraph 780):

$$TA\ DRP_0 = \frac{\sum_{t=0}^{-9} DRP_t}{10} \qquad (15)$$

Where

$TA\ DRP_0$ is the equally weighted trailing average of the DRP to apply in the following year as the annual update of the estimate used in the current year; and

DRP_t is the DRP estimated for each of the 10 regulatory years t = *0, -1, -2…. , -9*.

826. For the 2016 calendar year estimate (which is used for the return on debt for this Final Decision), the following estimates are included in the trailing average:

- t=-9: January to December 2007 : simple average of (interpolated daily) RBA DRP estimates for the period;
- t=-8: January to December 2008 : simple average of (interpolated daily) RBA DRP estimates for the period;
- t=-7: January to December 2009 : simple average of (interpolated daily) RBA DRP estimates for the period;

[537] So for example, for the 2016 calendar year, the 9 historic averages to be included in the trailing average estimate would be for the 2015, 2014 and so on back to 2007 calendar years.

[538] DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 74.

- t=-6: January to December 2010 : simple average of (interpolated daily) RBA DRP estimates for the period;
- t=-5: January to December 2011 : simple average of (interpolated daily) RBA DRP estimates for the period;
- t=-4: January to December 2012 : simple average of (interpolated daily) RBA DRP estimates for the period;
- t=-3: January to December 2013 : simple average of (interpolated daily) RBA DRP estimates for the period;
- t=-2: January to December 2014 : simple average of (interpolated daily) RBA DRP estimates for the period;
- t=-1: January to December 2015 : simple average of (interpolated daily) RBA DRP estimates for the period;
- t=0: January to December 2016: an average of daily DRP estimates (interpolated daily) comprising RBA DRP estimates for the period 1 January to 31 May 2016 and the Authority's current 'on-the-day' DRP estimate (interpolated daily to the prior RBA 31 May 2016 estimate).

827. The Authority's on-the-day 10 June 2016 estimate contributes to the t=0 estimate in the 2016 DRP hybrid trailing average estimate, for the period from 10 June 2016 to 31 December 2016. (prior to that month, RBA actual data is available).

828. This estimate is also used to estimate the return on debt for the Final Decision rate of return for calendar years 2017, 2018, 2019 and 2020.

829. For 2017, the Authority will estimate the t=0 DRP estimate, based on the nominated 20 trading days in the five month window 1 June to 31 October 2016, as per the averaging period requirement. For the 2017 calendar year, the Authority will adopt the following estimators:

- t=-9: January to December 2008 : simple average of (interpolated daily) RBA DRP estimates for the period;
- t=-8: January to December 2009 : simple average of (interpolated daily) RBA DRP estimates for the period;
- t=-7: January to December 2010 : simple average of (interpolated daily) RBA DRP estimates for the period;
- t=-6: January to December 2011 : simple average of (interpolated daily) RBA DRP estimates for the period;
- t=-5: January to December 2012 : simple average of (interpolated daily) RBA DRP estimates for the period;
- t=-4: January to December 2013 : simple average of (interpolated daily) RBA DRP estimates for the period;
- t=-3: January to December 2014 : simple average of (interpolated daily) RBA DRP estimates for the period;
- t=-2: January to December 2015 : simple average of (interpolated daily) RBA DRP estimates for the period;
- t=-1: t=0 estimate in 2016 outlined in paragraph 826; and

- t=0: January to December 2017: 100% the automatic formula (t=0) DRP estimate.

830. For 2018, the Authority will estimate the t=0 DRP estimate, based on the nominated 40 trading days in the five month window 1 June to 31 October 2017, as per the averaging period requirement. For the 2018 calendar year, the Authority will adopt the following estimators:

- t=-9: January to December 2009 : simple average of (interpolated daily) RBA DRP estimates for the period;
- t=-8: January to December 2010 : simple average of (interpolated daily) RBA DRP estimates for the period;
- t=-7: January to December 2011 : simple average of (interpolated daily) RBA DRP estimates for the period;
- t=-6: January to December 2012 : simple average of (interpolated daily) RBA DRP estimates for the period;
- t=-5: January to December 2013 : simple average of (interpolated daily) RBA DRP estimates for the period;
- t=-4: January to December 2014 : simple average of (interpolated daily) RBA DRP estimates for the period;
- t=-3: January to December 2015 : simple average of (interpolated daily) RBA DRP estimates for the period;
- t=-2: t=0 estimate in 2016 outlined in paragraph 826;
- t=-1: January to December 2017 : 100% the automatic formula (t=-1) DRP estimate;
- t=0: January to December 2018 : 100% the automatic formula (t=0) DRP estimate.

831. For 2019, the Authority will estimate the t=0 DRP estimate, based on the nominated 40 trading days in the five month window 1 June to 31 October 2018, as per the averaging period requirement. For the 2019 calendar year, the Authority will adopt the following estimators:

- t=-9: January to December 2010 : simple average of (interpolated daily) RBA DRP estimates for the period;
- t=-8: January to December 2011 : simple average of (interpolated daily) RBA DRP estimates for the period;
- t=-7: January to December 2012 : simple average of (interpolated daily) RBA DRP estimates for the period;
- t=-6: January to December 2013 : simple average of (interpolated daily) RBA DRP estimates for the period;
- t=-5: January to December 2014 : simple average of (interpolated daily) RBA DRP estimates for the period;
- t=-4: January to December 2015 : simple average of (interpolated daily) RBA DRP estimates for the period;
- t=-3: t=0 estimate in 2016 outlined in paragraph 826;

- t=-2: January to December 2017 : 100% the automatic formula (t=-2) DRP estimate;
- t=-1: January to December 2018 : 100% the automatic formula (t=-1) DRP estimate;
- t=0: January to December 2019 : 100% the automatic formula (t=0) DRP estimate.

832. The last annual update for the AA4 period will occur as part of the 1 January 2020 tariff variation. For 2020, the Authority will estimate the t=0 DRP estimate, based on the nominated 40 trading days in the five month window 1 June to 31 October 2019, as per the averaging period requirement. For the 2020 calendar year, the Authority will adopt the following estimators:

- t=-9: January to December 2011 : simple average of (interpolated daily) RBA DRP estimates for the period;
- t=-8: January to December 2012 : simple average of (interpolated daily) RBA DRP estimates for the period;
- t=-7: January to December 2013 : simple average of (interpolated daily) RBA DRP estimates for the period;
- t=-6: January to December 2014 : simple average of (interpolated daily) RBA DRP estimates for the period;
- t=-5: January to December 2015 : simple average of (interpolated daily) RBA DRP estimates for the period;
- t=-4: t=0 estimate in 2016 outlined in paragraph 826;
- t=-3: January to December 2017 : 100% the automatic formula (t=-3) DRP estimate;
- t=-2: January to December 2018 : 100% the automatic formula (t=-2) DRP estimate;
- t=-1: January to December 2019 : 100% the automatic formula (t=-1) DRP estimate;
- t=0: January to December 2020 : 100% the automatic formula (t=0) DRP estimate.

833. A summary of the automatic formulas for the trailing average calculations, and the actual (calendar year 2015) indicative estimate of the DRP for 2016, are set out in Appendix 4C.

Method for estimating the 10 year term DRP from the RBA data

834. The Gaussian Kernel method used by the RBA for estimating the return on debt results in the effective tenor of the DRP estimates varying between years, depending on the sample of bands and their relative weighting in the estimate. In recent times, the actual effective tenor of the estimates has been less than the specified tenor of ten years.

835. The Authority has overcome this problem in its own estimates by extrapolating the Gaussian Kernel estimates out to a 10 year term (see paragraph 768 above).

836. To be as consistent as possible, the Authority has adjusted the RBA estimates from their effective tenors to be the targeted 10 year tenor. The method follows the simple

extension technique laid out by Lally.[539] It utilises the slope of the yield curve between the two observed tenors (say the effective 7 and 10 year tenor spread to swap estimates, or '7e' and '10e' tenors respectively), to linearly extrapolate the spread to swap at an exact 10 year tenor. The formula used by the Authority is analogous to that set out by Lally as follows:[540]

$$RBA(10) = RBA(10e) + Base(10) - Base(10e) + \left[\frac{DRP(10e) - DRP(7e)}{10e - 7e}\right](10 - 10e) \quad (18)$$

Where

$$RBA(10) = Base(10) + DRP(10)$$

$$DRP(10) = RBA(10e) - Base(10e) + \left[\frac{DRP(10e) - DRP(7e)}{10e - 7e}\right](10 - 10e)$$

$$DRP(10) = DRP(10e) + (10 - 10e)/(10 - 7e) \times [DRP(10e) - DRP(7e)]$$

837. The Authority also interpolates the monthly RBA estimates to daily estimates. The formula for achieving this step shown in (26):

$$y_t = yield_{start} + \left(\frac{yield_{end} - yield_{start}}{Date_{end} - Date_{start}}\right) x\ (t - Date_{start}) \quad (19)$$

Where

y_t is the interpolated yield for any given date t;

$yield_{start}$ is the first available yield in any given month;

$yield_{start}$ is the last available yield in any given month;

$Date_{start}$ is the date when first yield was available;

$Date_{end}$ is the date when the last available yield is available; and

t is the date for which the yield is being interpolated.

838. The Authority considers that the Lally method set out above is easily implemented within its spreadsheet based approach. The Authority notes that under certain circumstances the method exhibits less bias, which is desirable. The Authority also notes that any lack of precision is likely to be diluted, as the Gaussian Kernel approach contributes only one third of its final estimate.

539 M. Lally, *Implementation Issues for the Cost of Debt*, 20 November 2014, p. 38. The Authority notes that DBP proposed a comparable method (DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Regulatory Period Rate of Return Supporting Submission: 12, p. 23).

540 M. Lally, Implementation Issues for the Cost of Debt, 20 November 2014, p. 39.

839. The Authority also annualises the RBA resulting annual data, as the RBA estimates may be generally interpreted as semi-annual rates. To do this, RBA basis point estimates are converted to percentage point numbers and then annualised:

$$\text{Effective annual rate} = 100^* (1 + \text{yield in basis points}/100/200)^2 - 100$$

The estimate of the DRP for 2016

840. Utilising the RBA monthly data and the Authority's t=0 (10 June 2016) estimates of the DRP delivers the following.

- The estimate of the simple trailing average DRP for calendar year 2016 is 2.716 per cent (Appendix 4C, paragraph 1028).

841. More detail on the automatic formulas and contributing DRP estimates to these trailing averages are set out in Appendix 4C.

Debt raising and hedging costs

842. In the gas Rate of Return Guidelines, the Authority provided an allowance for debt raising costs of 12.5 basis points per annum (**bppa**) and hedging costs of 2.5 bppa, to be included in the return on debt estimate. DBP proposed these costs in its initial proposal.

Debt raising costs

843. The Guidelines considered the estimate of debt raising costs of 12.5 bppa in depth. The Guidelines noted that the debt raising cost estimate covered:[541]

- gross underwriting fee: including management fees, selling fees, arrangement fees and the cost of an underwriter for the debt;
- legal and road show fee: this includes fees for legal documentation and fees involved in creating and marketing a prospectus;
- company credit rating fee: a credit rating is generally required for the issue of a debt raising instrument, a company is charged annually by the credit rating agency for the services of providing a credit rating;
- issue credit rating fee: a separate credit rating is obtained for each debt issue;
- registry fee: the maintenance of the bond register; and
- paying fee: payment of a coupon and principal to the security holder on behalf of the issuer.

844. The Guidelines estimates were based on the Allen Consulting Group's 2004 study, supported by updated estimates developed by the Authority.[542]

845. DBP initially proposed this Guidelines estimate, however, in response to the Draft Decision it has now submitted a revised provisional value of 17.84 bppa.[543] For

541 Economic Regulation Authority, *Explanatory Statement for the Rate of Return Guidelines*, 16 December 2013, p. 199.

542 Economic Regulation Authority, *Explanatory Statement for the Rate of Return Guidelines*, 16 December 2013, p. 205.

543 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, pp. 81 – 82.

these estimates, DBP draws on a report by Incenta.[544] The Incenta report was commissioned by Jemena, which DBP notes has a similar Regulated Asset Base size as DBP.[545] DBP therefore considers that Incenta's estimated costs – of 17.84 bppa – are provisionally transferable to its situation. The Incenta estimated costs are comprised of:[546]

- 9.0 bppa for the costs of issuing bonds in an assumed debt portfolio of $1,750 million;
- 5.6 bppa for Standard & Poor's liquidity requirement; and
- 3.2 bppa for the three month ahead re-finance requirement.

846. First, with regard to the costs of issuing bonds, the Authority accepts that the DBNGP debt portfolio is somewhat larger than the average portfolio assumed in the Guidelines.[547] However, the Authority is of the view that a single benchmark estimate – of 12.5 bppa – is reasonable for all the gas benchmark efficient entities that it regulates. The estimate was reported by the Authority in its Guidelines, based on up to date information as at December 2013. The Authority observed that the estimate was consistent with or exceeded those from a range of other studies, including by the Australian Competition and Consumer Commission, the Allen Consulting Group in 2004 and PwC in 2011.[548]

847. The Authority sees no compelling reason to change that estimate for the duration of the current Guidelines' life. Such an approach has the advantage of saving on regulatory costs. For the same reason the Authority rejects, at this time, DBP's proposal to re-estimate such costs every time other time dependent variable are updated.[549] However, the Authority will revisit this matter at the next review of the Guidelines.

848. Second, with regard the liquidity reserves requirement and three month ahead re-finance requirement, DBP submit:[550]

> In respect of debt-raising costs, the ERA has proposed a value of 12.5 bps. The main difference between this and the figure of 20 bps suggested in Table 9 above is that the latter includes Standard & Poors' liquidity requirement and Standard & Poors' requirement to finance three months ahead (DD, para 634 p133). The ERA rejects both on the basis of discussions it has had with finance providers who have suggested to the ERA that, under normal liquidity conditions, both would add only roughly one bps to costs (DD para 636, p133). No indication is provided as to who these finance providers are or what basis they provide for their conclusions, making it very difficult for these claims to be investigated further; we are left merely to accept that the ERA has looked into this matter and reached a conclusion.

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544 Incenta, *Debt raising transactions costs – updated report*, report for Jemena, April 2015. The Incenta estimate updates the Allen Consulting Group estimate from 2004, using the same method.

545 The Jemena estimated transactions costs are based on issuing 7 bonds, each of $250 million, therefore to the value of $1,750 million, which is just less than its RAB of $1,787 million. DBP has a debt portfolio of around $2,100 billion, which would require issuing 8 bonds of around the standard $250 million size.

546 Incenta, *Debt raising transactions costs – updated report*, report for Jemena, April 2015, p. 4.

547 The Guidelines estimate relied on regulatory precedence, but was supported by updated estimates of around three standard issuances of $250 million – that is, a debt portfolio of $750 million.

548 Economic Regulation Authority, Explanatory Statement for the Rate of Return Guidelines, 16 December 2013, pp. 199 – 205.

549 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 81.

550 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 81.

> Both of these costs are costs associated with Standard & Poors, and it is not clear why the ERA has not conferred with Standard & Poors to ascertain the veracity of the claimed amounts. Incenta (2015, p2-3) has done so and, moreover (ibid p14-19) has examined Standard & Poors' liquidity requirements and the costs of meeting them and has confirmed that Standard & Poors does require firms to refinance three months ahead of expiry (ibid p9) and estimated the costs of meeting this requirement (ibid pp20-1).85 The ERA has nowhere shown any error in what Incenta has done, nor given any indication that the calculations are inaccurate, beyond reference to "discussions with finance providers".

849. Chairmont Consulting advises the Authority that:

- while 'most companies will use committed but undrawn bank facilities as their external Liquidity Reserve, there is no universally used formula for the amount of the reserve… Similarly, the cost of the Liquidity Reserve is also dependent on the situation. At times a company will simply rely on having a larger than needed bank loan facility';[551] and
- liquidity reserve and early refinancing 'increase the amount of debt facilities'.[552]

850. The liquidity reserve and cost of financing ahead is capitalised in the debt facility. That implies that, technically, it is not a transaction cost per se (Chairmont refutes Incenta for saying this). Rather, the servicing costs of that capital reserve are associated with the cost of debt:[553]

> However, costs such as commitment fees for standby lines of credit or interest costs on excess liquidity are part of financing costs, i.e. the cost of debt.

851. However, Chairmont also says that these are reasonable direct costs.[554]

852. Further, Chairmont notes that the Authority's simplification of the debt being 60 per cent of the RAB means that it has not included these servicing costs in its return on debt per se. In principle, these specific cost components are part of a set of (plus and minus) costs, depending on the way the finance is structured, which the Authority has not taken into account in its 'simplification'. For example, Chairmont notes, with regard to the finance ahead requirement:[555]

> A current example of this occurred this month, May 2016. SA Power Networks, a regulated network service provider, issued a series of bonds in the USPP market with a funding date of August 2016. SAPN explained that the new issuance was to repay maturing USPP debt in September and October 2016. The result is a guaranteed funding source approximately four to five months before a debt maturity, while only having to carry excess liquidity for one to two months.
>
> If the debt raising is funded near the commitment date, the cost will be a negative interest spread between the borrowed funds and the equivalent investment. Using the simplified portfolio assumptions for regulated service providers, the rate difference will be equal to the credit spread (DRP over swap) of the newly issued bond which has been swapped to floating base rates. This assumes that they are able to re-invest in a 3-month bank bill, thereby neutralising the BBSW part of the first period swapped bond costs.
>
> Early rollovers do not incur additional transaction costs, i.e. the same amount of debt would have to be raised. It is only the timing which is varied.

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551 Chairmont Consulting, *ERA Hedging Costs in the Cost of Debt,* 13 May 2015, p. 9.

552 Chairmont Consulting, *ERA Hedging Costs in the Cost of Debt,* 13 May 2015, p. 14.

553 Chairmont Consulting, *ERA Hedging Costs in the Cost of Debt,* 13 May 2015, p. 8.

554 Chairmont Consulting, *ERA Hedging Costs in the Cost of Debt,* 13 May 2015, p. 7.

555 Chairmont Consulting, *ERA Hedging Costs in the Cost of Debt,* 13 May 2015, p. 10.

> The differing means of achieving the 3-month ahead refinancing requirement highlight the problem of how ERA should provide an allowance. The simplified portfolio approach was established by long and intensive negotiation with the industry, whereas there has been no process for agreeing on a refinance allowance. As Chairmont has noted elsewhere in this report, it is difficult to justify special treatment for just one aspect of portfolio simplification without addressing other simplifications. Factors which could be relevant in conjunction with an Early Refinancing cost include the timing of the rate measurement window, and the term of the debt raised.

853. Chairmont considers it remiss to pick out just two components without taking account of the others, some of which may be offsetting. Chairmont points out that there are other components and offsets that are not taken into account in the 'simplification':[556]

> It may be reasonable to add these two contentious components back into the calculation only if other excluded components of the debt portfolio were also included.,, Choosing to re-introduce some components of the costing model without considering potential offsetting (or additional) simplifications may be counterproductive to achieve that overall aim. They may or may not offset; however the deciding factor for their re-introduction should be in the context of the complete model.

854. With regard to the liquidity reserve, Chairmont notes:[557]

> Different companies may employ different liquidity ratios, depending on their strategic plans at a particular time, corporate structure, the condition of financial markets generally, and specifically debt markets at the time. While most companies will use committed but undrawn bank facilities as their external Liquidity Reserve, there is no universally used formula for the amount of the reserve, although it is recognised that some industries, e.g. banking, have adopted standards, such as Basel III.
>
> Similarly, the cost of the Liquidity Reserve is also dependent on the situation. At times a company will simply rely on having a larger than needed bank loan facility. This allows them to have excess liquidity without establishing a separate facility and thereby avoid having any separate establishment costs as the costs are rolled up into the overall borrowing cost.
>
> Commitment Fees and other costs depend on the context of the liquidity and the type of business the corporate has with the bank, and they will change over time for new facilities.

855. Similarly, with regard to the cost of financing ahead, Chairmont highlights that :[558]

> The differing means of achieving the 3-month ahead refinancing requirement highlight the problem of how ERA should provide an allowance. The simplified portfolio approach was established by long and intensive negotiation with the industry, whereas there has been no process for agreeing on a refinance allowance. As Chairmont has noted elsewhere in this report, it is difficult to justify special treatment for just one aspect of portfolio simplification without addressing other simplifications. Factors which could be relevant in conjunction with an Early Refinancing cost include the timing of the rate measurement window, and the term of the debt raised.

856. On balance, the Authority is not convinced by the evidence presented by DBP. As noted in the Authority's Draft Decision, the Authority's own discussions with finance providers suggest the costs associated with these aspects are small, approaching as little as 1 basis point under normal liquidity conditions – provided that debt requirements are packaged efficiently. As highlighted by Chairmont, 'packaged

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556 Chairmont Consulting, *ERA Hedging Costs in the Cost of Debt,* 13 May 2015, p. 9.

557 Chairmont Consulting, *ERA Hedging Costs in the Cost of Debt,* 13 May 2015, p. 9.

558 Chairmont Consulting, *ERA Hedging Costs in the Cost of Debt,* 13 May 2015, p. 10.

efficiently' means that a range of elements need to be taken into account, not just two specific elements, that have been picked out to present a favourable case.

857. The Authority will therefore provide 12.5 basis point per annum for debt raising costs for this Final Decision.

Hedging costs

858. Interest rate swaps are derivative contracts, which typically exchange – or swap – fixed-rate interest payments for floating-rate interest payments. They provide a means to hedge and manage risk. Investment and commercial banks with strong credit ratings are swap market-makers.

859. Hedging costs involved in converting from typical 10 year fixed debt to the regulated 5 year fixed rate will involve four legs:

- swapping 10 year fixed for a base floating rate at the time of issuance – paying floating and receiving 10 year fixed;
- swapping the base floating rate at the time of the regulatory reset for 5 year fixed – receiving floating and paying 5 year fixed.

860. For each set of two legs, the following costs may be incurred:

- a credit and capital charge – relates to the risk of the counterparty, and will depend on the credit rating and the potential default loss;
- an execution charge – compensates the swap intermediary for the costs associated with transacting the swap.

861. The benchmark efficient entity would potentially engage in four different transactions in hedging the base of its portfolio of debt:[559]

- 5-year floating to fixed AUD swaps at the start of AA for full amount of debt portfolio;
- bond issuance potentially made up of three different issue types and hence requiring three different swap considerations:
    - foreign currency bonds – requiring a cross-currency swap into floating AUD;
    - fixed-rate AUD bonds – requiring a fixed-float AUD swap;
    - floating rate AUD notes – no swap will be required.

862. The QCA has been awarding swaps costs for swapping from 10 year fixed debt to shorter term (typically, although not always) 5 year fixed debt, since 2010, utilising estimates made by Evans & Peck. A recent cost estimate is 13 basis points per annum (**bppa**) (Table 15).

[559] Chairmont Consulting, *ERA Hedging Costs in the Cost of Debt*, 13 May 2015.

Table 15 Hedging transactions costs for four legs, BBB credit rating

Estimate	10 year fixed to floating (basis points per annum)	Floating to 5 year fixed (basis points per annum)	Total (basis points per annum)
Evans & Peck[a] (12 January 2015)	8.0	5.0	13.0
UBS[b] (November 2014)			23
Jemena[c] (June 2013)			7.9 – 9.4

Source *a) Evans & Peck, reported in Incenta, WACC parameters for GAWB Price Monitoring Investigation 2015-20 – Draft Report, February 2015, p. 32 (swapping 10 for 5; $250 m debt; BBB; to mid-rate; as at 12 January 2015);*

b) UBS, reported in Transgrid, Revised revenue proposal, 13 January 2015, Appendix R, p. 6 (BBB+ credit rating).

c) Jemena, Rate of Return Guidelines – Consultation Paper: Submission, 21 June 2013, p. 22 (BBB+ credit rating).

863. Other recent estimates include those reported by Jemena and UBS (Table 15):

- The Jemena range is based on quotes from two separate banks for BBB+ swaps for 10 year fixed to 5 year fixed.[560]
- The UBS estimate is comprised of the AUD interest rate swap credit, capital and execution costs for a BBB+ rated entity (quoted at 5 basis points) and cross-currency interest rate swap credit, capital and execution costs for a BBB+ rated entity (quoted at 18 basis points).[561] A similar report by UBS was submitted by DBP in its response to the Issues Paper.[562]

864. The Authority notes that DBP provided the Authority with updated estimates from UBS, which are consistent with the estimates set out above.[563]

865. CEG, using evidence from Table 15, estimated a range for hedging costs of 15.5 to 23 bppa, based on an Evans & Peck estimate from 4 February 2013 and the UBS estimate (in Table 15):[564]

> Based on the evidence surveyed above, swap transaction costs have been estimated to be in the order of 15.5bppa to 23bppa – consistent with the QCA's stated range of

560 As part of its investigation of this issue, the Authority approached a local bank, which confirmed estimates similar to Jemena's, as at March 2015, for a swap of 10 year fixed for 5 year fixed debt.

561 The Authority does not include other swaps costs estimated by UBS. The tracking risk and deferral cost estimates are 'a quantification of risks associated with an inability to fully hedge to the regulatory allowance even when using swaps' (ATCO, *Re: Estimating the return on debt: ATCO Gas Australia's response to the Authority's Discussion Paper*, 25 March 2015, Attachment, p. 8.).

562 The Authority does not accept DBP's contention that it has ignored conversion costs (DBP, *Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Regulatory Period Response to ERA Issues Paper Submission 26*, 2 June 2015, p. 10). See Appendix 5.

563 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Regulatory Period Response to ERA Issues Paper Submission 26, 2 June 2015, Appendix B.

564 ATCO, Re: Estimating the return on debt: ATCO Gas Australia's response to the Authority's Discussion Paper, 25 March 2015, Attachment, p. 9.

15bppa to 20bppa. The lower/upper end of this range is based on the swap costs estimated by Evans & Peck/UBS and are themselves based on domestic/foreign debt issues. To the extent that foreign issued debt is relied on then somewhere towards the upper end of this range is appropriate.

866. However, in its ATCO Final Decision, the Authority did not agree with this estimate. The Authority engaged Chairmont to advise on the costs of undertaking swaps. Chairmont estimates the following costs for each of the components, based on the data in Table 15 and its own enquiries:[565]

- 5-year swaps at the start of the AA. The different submissions provide a range of estimated costs, i.e. Evans and Peck (2015) 5bp; UBS <5bp; Jemena <5bp (i.e. less than half of the total 8-10bp, as a 5-year swap costs less for capital and credit charges). This suggests approximately 4bppa is appropriate. This is also supported by informal discussions held by Chairmont with two banks in late 2014.
- Cross-currency swaps. There was only one estimate provided and that was by UBS which reported 18bp. Chairmont's discussions with the banks suggest that this estimate is at the high end of costs and is likely to overstate a swap in relation to a new issuance. It is important to understand that banks tend to be more aggressive on swap pricing when linked to other business. A lower level of 10bp appears to be reasonable, so for further calculation a mid-point of 14bp is used.
- 10-year AUD fixed-floating swaps. The submissions are Evans and Peck (2015) 8bp; UBS 5bp; Jemena and Authority (implied) 5-7bp. Taking a mid-point such as 6bp appears reasonable for this component.

867. Only a proportion of debt is raised overseas, thereby requiring overseas credit and executions costs. For example, CEG presents evidence that regulated energy companies had around 65 per cent of debt issued in AUD in 2013, with the remainder in foreign currencies.[566,567] Further, CEG identifies that 24 per cent of debt amounts outstanding is already floating, typically bank loans.[568]

868. On the basis that CEG's estimates remain valid, the Authority calculated the weighted cost of hedging, for its Draft Decision, using Chairmont's estimates set out above, as the sum of:

- 5 year swap floating for fixed for the full amount of debt = 4 bppa x 100 per cent = 4.0 bppa; plus
- 10 year cross currency swaps for (100 – 65 =) 35 per cent of debt issuance = 14 bppa x 35 per cent = 4.9 bppa;
- 10-year fixed-float AUD swaps for (65 – 24=) 41 per cent of debt issuance = 6 bppa x 41 per cent = 2.5 bppa.

869. That sum gives a total cost of hedging of 11.4 bppa (rounded to the nearest bppa).

870. However, with regard to hedging costs, DBP considers that the Authority's allowance of 11.4 bppa is too low. Nonetheless, DBP revises its figure from 26.5

565 Chairmont Consulting, Authority Hedging Costs in the Cost of Debt, 13 May 2015.

566 Competition Economists Group, *Debt strategies of utility businesses*, June 2013, p. 23.

567 This proportion exceeds that of issuance of corporate bonds by Australian corporates, more generally (see Table 10 at p. 274, which reports that only 20 per cent of corporate bonds were issued in AUD as at June 2014).

568 Competition Economists Group, *Debt strategies of utility businesses*, June 2013, p. 22.

bppa in its initial proposal, down to 14.8 bppa. This revised estimate is based on the following components:[569]

- a cost of foreign hedges of 18 bppa (based on the values in the UBS report), which give a cost of (18*0.35=) 6.3 bppa, on the assumption set out in the Draft Decision – which DBP accepts – that foreign debt comprises 35 per cent of the debt portfolio;
- a cost of risk free rate hedges of 8.5 bppa.

871. DBP offers no reasoning as to why the Authority's estimate of 11.4 bppa is wrong:

- First, DBP simply re-states its UBS estimate that cross-currency swaps cost 18 bppa. As noted above, Chairmont, considers that the UBS estimate of 18 bppa is 'at the high end of costs'.
- Second, the vanilla AUD swap legs contribute a combined 6.5 bppa to the Authority's estimate. That is lower than DBP's estimate of 8.5 bppa, which is based on the UBS estimate. DBP provides no further information in its response to the draft decision as to why it considers the 6.5 bppa is not reasonable.

872. Effectively, DBP is relying, it is a single bank's view (UBS) – based on work undertaken at the behest of a service provider – against Chairmont's broader ranging and objective view based on discussions with banks (plural). So for example, Chairmont reports that, with regard to cross-currency swaps:[570]

> There was only one estimate provided and that was by UBS which reported 18bp. Chairmont's discussions with the banks suggest that this estimate is at the high end of costs and is likely to overstate a swap in relation to a new issuance. It is important to understand that banks tend to be more aggressive on swap pricing when linked to other business. A lower level of 10bp appears to be reasonable, so for further calculation a mid-point of 14bp is used.

873. Given that DBP has not presented any new evidence, the Authority rejects its revised proposal.

874. For the foregoing reasons, the Authority considers that the estimate of hedging costs of 11.4 bppa is reasonable, and therefore retains it for this Final Decision.

New issue premium

875. DBP in its initial proposal submitted that a 'new issue premium' be added to the return of debt. Based on a report by CEG, DBP argued that the new issue premium measures the difference between the price at which a network business can roll over its debt portfolio and prices from secondary markets where the debt is resold. DBP submitted that the current estimate of the new issue premium is 0.27 per cent.[571]

876. The Authority did not accept DBP's proposal. The Authority is of the view that CEG's estimate of the new issue premium is not robust.

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569 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56, 24 February 2016, p. 81.

570 Chairmont Consulting, *ERA Hedging Costs in the Cost of Debt,* 13 May 2015, p. 6.

571 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Regulatory Period Rate of Return Supporting Submission: 12, p. 21.

877. In its response to the Authority's Draft Decision, DBP maintains that the new issue premium does reflect a valid cost faced by the benchmark efficient entity, and should be included in the final estimate of the cost of debt.[572]

878. DBP considers that the Authority's theoretical arguments address points made by CEG about transactions costs and imperfect information:[573]

> DBP responds that any transactions are covered in debt-raising costs, and that imperfect information would be a product of inefficient markets, which should therefore not be rewarded.
>
> In respect of transactions costs, we note (see paragraph 10.33) that 12.5 bps is too low, but that in any case that 12.5 bps is intended to account for a number of specific costs (see Guidelines para 144) and any new issue premium is not amongst them, so the ERA has not accounted for this cost.
>
> More importantly, the Rules require the ERA to reward efficient costs within the market, not within some theoretical paradigm. If a firm is inefficient, then this inefficiency should not be rewarded. However, if the market for debt is inefficient, and all efficient firms face this market inefficiency, then the ERA must reflect how the market operates, and not how a theoretical construct of the market might operate. The ERA therefore errs in respect to this theoretical argument.

879. In addition, in relation to the empirical arguments, DBP considers that the Authority appears to concede in this instance as the Authority does not conclude that the new issue premium is zero, then it is the Authority's task to determine the best estimate of that cost, and compensate service providers accordingly.[574] DBP argues that the Authority has not done so. DBP considers that the CEG study still remains the best estimate of the new issue premium in the Australian context and DBP, accordingly, maintains its support for it.

880. The Authority notes that DBP has not provided any compelling new evidence in support for its claim in relation to the new issuance premium in comparison with the evidence already considered by the Authority, in the Draft Decision. On the contrary, the evidence indicates that the Authority's return on debt allowance already appropriately compensates a benchmark efficient entity overall for its efficient financing costs. Accordingly, the Authority maintains its position for this Final Decision, to not provide an allowance for the new issue premium.

881. The Authority remains of the view that the resulting approach – which excludes an uplift for a new issue premium – contributes to the achievement of the allowed rate of return objective. The resulting estimate is commensurate with the efficient financing costs of a benchmark efficient entity.

882. The Authority's reasoning is provided below.

Theoretical considerations

883. The Authority notes that there is no theory to guide the existence of new issue premium (or the under-pricing of corporate bonds) in the literature. The price of newly issued bonds (or their yields) is a function of some key characteristics such as the issuer' credit rating; the industry; the term to maturity of the bond; the face

572 DBP, Revised Revisions DBNGP Access Arrangement 2016 – 2020 Regulatory Period Rate of Return Supporting Submission: 56, February 2016, p. 28.

573 DBP, Revised Revisions DBNGP Access Arrangement 2016 – 2020 Regulatory Period Rate of Return Supporting Submission: 56, February 2016, p. 81.

574 DBP, Revised Revisions DBNGP Access Arrangement 2016 – 2020 Regulatory Period Rate of Return Supporting Submission: 56, February 2016, p. 82.

value; the coupon rate; and the current yields on comparable investment options. The Authority is not aware of any theory which provides a reasonable explanation of under-pricing of corporate bonds (i.e. higher yields at issuance on a primary market in comparison with yields of currently traded bonds with similar characteristics in a secondary market).

884. The Authority is of the view that bonds are generally very sensitive to changes in interest rates because interest rates mainly and fundamentally determine the price of the bonds more than anything else. As such, any change in interest rates will lead to a change in the price of the bonds (or their yields) for both newly issued bonds and secondary market bonds.

885. The Authority notes that the existence of "imperfect information" and "transaction costs" in financial markets is generally used by CEG as a theory to support the view that a new issue premium does exist. CEG argued that this literature is not inconsistent with the simple observation that there are essentially two mechanisms as alternatives or in combination by which the seller of a new issue can convince the requisite number of buyers to participate in the sale process for a new issue (of debt or equity). The first mechanism is to conduct marketing of the issue in an attempt to provide information to potential buyers that raises the price those buyers are willing to pay for the issue. The second mechanism is to lower the price of the issue in order to make the investment value of the issue attractive to the requisite number of buyers.[575]

886. The Authority disagrees with CEG's view. The Authority agrees with the Australian Energy Regulator (**AER**) in this context that:[576]

> We consider that the market imperfections that may explain the new issue premium would result in avoidable costs, which a benchmark efficient entity would not incur. For example, to the extent that some issuers of investment grade debt might use less reputable investment banks, these issuers might be more likely to incur a new issue premium.[577] However, we consider a benchmark efficient entity would engage a reputable investment bank and our allowance for debt raising costs would sufficiently covers these costs.[578] To the extent that the majority of issuers of investment grade debt engage reputable investment banks, we agree that this would provide limited support for our position if investment grade debt still incurs a new issue premium on average.[579]

887. The Authority also agrees with the AER when it states:[580]

> We consider these [regulated entities'] notably stable cash flows would reduce the likelihood of a benchmark efficient entity incurring a new issue premium from asymmetric information regarding the performance of new investment grade issues on the secondary market. This is because the predictability of its cash flows would mean

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575 DBP, Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Regulatory Period Rate of Return Supporting Submission: 12, Appendix H, p. 22.

576 Australian Energy Regulator, Final decision: United Energy distribution determination - Attachment 3: Rate of return, May 2016, p. 3-348.

577 Fang, L.H., 'Investment Bank Reputation and the Price and Quality of Underwriting Services', *Journal of Finance*, Vol. 60, No. 6, December 2005, pp. 2729-2761.

578 We accepted service providers' proposed method for estimating arrangement fees, resulting in allowances of 7.11–15 bppa in our draft /preliminary decisions. This method is consistent with Incenta, Debt raising transaction costs—updated report for Jemena, February 2015, p. 1; PwC, Energy Networks Association: Debt raising costs, June 2013, pp. 14–19.

579 CEG, Critique of AER Analysis of New Issue Premium, December 2015, p. 6.

580 Australian Energy Regulator, Final decision: United Energy distribution determination - Attachment 3: Rate of return, May 2016, p. 3-349.

> that there is less uncertainty as to the performance of its new bond issues, which in turn implies that there would be less room for any information asymmetry regarding these issues. Second, due to the essential nature of the services it provides, we would expect a benchmark efficient entity to be followed more closely by analysts than most other issuers of investment grade debt, which would also have the effect of reducing any information asymmetry.

888. The Authority notes that debt raising cost of 12.5 bp has already been provided for efficient benchmark entities to cover their legitimate cost of raising debt. The Authority is not satisfied that underpricing (higher yields) is consistent with efficient debt financing by the benchmark efficient entity. The Authority considers that if underpricing of newly issued corporate bonds reflects a common practice in debt financing, then this practice is clearly inefficient and as a result, underpricing should not be compensated.

Empirical considerations

889. In order to support its view that the new issue premium exists, CEG has provided a list of eight different empirical papers. A brief summary of these academic papers is presented in Table 16 below.

890. Based on the evidence presented in Table 16, the Authority notes the following: (i) all of the above studies were conducted for the US financial market; (ii) there is mixed evidence in relation to whether or not a new issue premium does exist; and (iii) where studies found the presence of a new issue premium, the estimates vary significantly among studies.

891. The Authority also notes that evidence presented in Table 16 does not warrant a solid conclusion on the presence of the new issue premium for newly issued bonds even in the US financial markets. The Authority notes that some studies did confirm a presence of a new issue discount (overpricing) of newly issued bonds or failed to confirm the presence of a new issue premium.

892. The Authority notes that the AER concludes:[581]

> We consider there is mixed evidence on the new issue premium for investment grade debt in the papers that CEG originally surveyed. We do not agree with CEG's interpretation that, 'the dominant finding [in these eight papers] was for a positive NIP [new issue premium]'. Rather, we consider that half of the papers that CEG reviewed contradicted this finding.

893. On the basis of the foregoing evidence, the Authority concludes that the presence of the new issue premium is not supported by any economic theory or by empirical evidence.

CEG's 2014 study

894. The Authority is not aware of any pre-2014 Australian studies in relation to the presence of the new issue premium. As such, CEG's estimate (2014) appears to be the first study of this kind for the Australian financial market. Table 17 below presents a summary of the estimates by the CEG under various scenarios.

895. CEG considered that estimates of the new issue premium at longer measurement periods, where they are statistically significant, are likely to be more robust than estimates at shorter measurement periods. However, the Authority is not satisfied

[581] Australian Energy Regulator, Final Decision United Energy Distribution Determination 2016−2020 Attachment 3 − Rate of return, May 2016, p. 3-352.

that the estimates using the period from 8 weeks to 16 weeks represent the best estimates informing the conclusions of CEG.

Table 16 Estimates of the new issue premium

Authors (Year)	Data	Key findings
Ronn and Goldberg (2013)	• A sample of 1,494 non-finance investment grade bonds newly issued from 2008 to January 2012.	• The average new issue premium is 22.5 bp.
Cai, Helwege and Warga (2007)	• 439 IPOs and 2,536 SBOs for the period from 1995 and 1999.	• IPO (37bp) and SBO (2.7 bp) • Investment grade (as a group) is not statistically significantly different to zero.
Datta, Iskandar-Datta and Patel (1997)	• Corporate straight bond initial public offerings made between January 1976 and 1988.	• Underwriters do not, on average, under-price IPOs of straight debt.
Carayannopoulos (1996)	• The pricing of new 3-, 5-, 10-, and 30-year Treasury notes and bonds which were issued during the United States Treasury's regular refunding operation.	• The mean difference at the end of the issue month is -62 bp.
Weinstein (1978)	• Random samples of 412 outstanding bonds and 179 newly issued bonds during any period from June 1962 to July 1974.	• The new issue premium for the first month after issue is 38 basis points, which is not statistically significant. • While bonds are issued at prices below equilibrium, prices reach equilibrium by the end of the month.
Lindvall (1977)	• Bonds issued by electric, gas and water companies which were rated Moody's Aa or Standard and Poors Aa, had maturities of between 25 and 35 years and were at least $10 million in size.	• A range of new issue premiums from 45.3 bp (in periods of rising yields) to -8.0 bp (in periods of falling yields).
Ederington (1974)	• A sample of 611 nonconvertible public utility issues offered through competitive bidding between January 1, 1964 and March 1, 1971.	• The average new issue premium for 1964-1961 was 30.9 basis points, with a spread from -91 to +139 bp.
Connard and Frankena (1969)	• Aa corporate bonds from 1952-1962.	• An average of 16.7 bp using Moody's series and 9 bp using Moody and Homer series. • It took two to three months, on average, for the new issue premium to be eliminated.

Source: The Authority's analysis, December 2015.

896. Based on the CEG estimates of the new issue premium as presented in Table 17, the Authority notes the following:

- *First*, CEG's estimates vary significantly across 8 scenarios, ranging from 0 to 36 basis points.
- *Second*, once a different proxy is used to control for the general movement in interest rates, the estimates vary significantly. This view is supported by the estimates presented under Scenarios 1 and 2; and Scenarios 3 and 4. For example, a difference of 10 basis points or more arises when Bloomberg's fair value or swaps is adopted to control for the general movement in interest rates.
- *Third*, assuming that all estimates presented in Table 17 are robust, which is highly unlikely, then the possible range of the estimates varies between 4 basis points and 25 basis points.

Table 17 CEG (2014) estimates of the new issue premium

No.	Sample	Control for general movements in interest rates	Key findings	Mid point of the range
1	Full sample (A & BBB credit rating)	Bloomberg's Fair value	0 – 8 bp.	4 bp
2	Full sample (A & BBB credit rating)	Bloomberg's interest rate swaps	10 – 17 bp.	14 bp
3	Core sample (BBB-/BBB/BBB+ credit rating)	Bloomberg's Fair value	13 – 21 bp.	17 bp
4	Core sample (BBB-/BBB/BBB+ credit rating)	Bloomberg's interest rate swaps	16 – 36 bp.	21 bp
5	Exclusions of firms in finance and banking		1 – 16 bp	8 bp
6	Inclusions of only fixed bonds		3 – 24 bp	14 bp
7	Combination of Scenarios 6 and 7		2 – 25 bp	14 bp
8	Weighting of bonds by issue size			25 bp

Source: The Authority's analysis.

897. The Authority notes that interpolation and/or extrapolation has been adopted in CEG's analysis to ensure that a term of a particular bond matches that of the fair value or the swaps, which is used as a proxy to control for a general movement in interest rates, this process results in a significant approximation in the CEG study.

898. The Authority notes the evidence assembled by the AER which suggests that the empirical evidence assembled by CEG on the new issue premium is inconclusive.[582]

[582] Australian Energy Regulator, Final decision: United Energy distribution determination - Attachment 3: Rate of return, May 2016, p. 3-351 to 3-358.

899. On balance, the Authority is of the view that any positive new issue premium of newly issued bonds in the CEG's study may well fall within a margin of error of the estimates. This view is supported on the following key bases.

- *First*, CEG's study provides a wide range of estimates for the new issue premium and there is no clear guidance from both theoretical and empirical bases to select a superior estimate from all these available estimates.
- *Second,* a sample of bonds utilised in the CEG study may not be consistent with the benchmark sample used under the Authority's bond yield approach to determine the cost of debt. As such, the Authority is not satisfied that the CEG estimates of new issue premium is relevant for the purpose of estimating the cost of debt for a benchmark efficient entity. The Authority also notes that the AER has rejected the relevance of the CEG estimates of the new issue premium to the Bloomberg BVAL curves and RBA curves.
- *Third,* interpolation and extrapolation of the raw data will generally provide an approximation of the estimates. Unless the estimates under interpolation and extrapolation are consistently significant, the estimates may just simply be an error in this approximation.

Other issues

900. The Authority notes that the new issue premium may exist in particular financial markets at particular points in time. However, this existence does not imply that the Australian benchmark efficient entity should be compensated by incorporating a new issue premium into its allowed cost of debt. The Authority is of the view that this inclusion may only be possible if, and only if, it is proved that the efficient benchmark entity has been systematically undercompensated in relation to its allowed cost of debt.

901. In this Final Decision, the allowed cost of debt for the 2016 regulatory year is 5.06 per cent. The Authority is of the view that the allowed cost of debt is not underestimated. As a result, a new issue premium should not be included to compensate. This view is supported on the following two bases:

- *First*, the Authority notes that the Productivity Commission was of the view that the average regulatory cost of debt is 1.25 per cent higher than the estimated costs incurred by services providers.[583]
- *Second,* the term of debt of 10 years is used in the estimate of the allowed cost of debt even though the observed term of debt of an efficient benchmark entity appears to be trending to less than 10 years.[584] The Authority notes that the longer term debt is generally more expensive than the shorter term debt in normal market conditions.

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583 Productivity Commission, Electricity network regulatory framework, No. 62, Vol. 1, 9 April 2013, p. 207.

584 For example, Chairmont Consulting state (Chairmont Consulting, *ERA Hedging Costs in the Cost of Debt,* 13 May 2015, p. 9):

> Since 2007 and the Global Financial Crisis (GFC), a smaller proportion of debt with 10-year maturities or longer has been raised by Australian corporates, including utility companies. In early 2016, the post-GFC situation continues, where bank debt with three to five year maturities is the most utilised debt raising form of corporates. Furthermore, the quantitative easing practices of many foreign central banks in 2015-16 led foreign banks active in Australia to aggressively price those loans making them irresistible for corporate borrowers compared to loans by the Australian major banks or the bond markets. The result is a lower credit spread, or Debt Risk Premium (DRP), for corporates compared to the 10-year DRP.

Fixed principle for the return on debt

902. DBP is seeking a fixed principle:[585]

> DBP has also proposed an additional element to the estimation of the return on debt by way of the inclusion of a fixed principle which fixes the ERA's hybrid approach post 2020 when DBP is highly likely to find itself regulated by the AER. Given the AER currently applies a trailing average to the risk-free rate and has started a transition process already for the East Coast service providers, it is unlikely the AER will make a special case for WA firms. Absent of a fixed principle protecting the ERA's approach, DBP is likely to face costs unwinding its hedges in 2020, and will face additional risks from today due to the uncertainty amongst our financiers about just what the AER might do in respect of applying its trailing average approach to WA firms. The fixed principle is a simple way to avoid this aspect of regulatory risk which is a consequence only of a change of regulator.

903. However, the Authority's view is that it would be remiss to bind future outcomes. This is particularly given that the AER is likely to take on the future regulatory role.

904. The AER may prefer to move the DBNGP onto their full trailing average, to ensure regulatory consistency. In the event of that, DBP would simply be transitioned over 10 years to the full trailing average, just like its other east coast regulated businesses. Such a transition shouldn't create an issue for DBP, as the whole purpose of the AER's transition is to give the service provider an orderly means to unwind existing hedges.

905. On that basis, the Authority rejects DBP's proposal for a fixed principle which fixes the hybrid trailing average approach to estimating the return on debt post 2020.

The estimate of the return on debt for this Final Decision

906. The Authority's estimate for the return on debt for the 2016 calendar year (which is applied from 1 January 2016 to 31 December 2016 and also utilised for the other years of the tariff model) is 5.06 per cent. The resulting estimate is the sum of:

- the on the day 5 year swap rate of 2.100 per cent;
- a hybrid trailing average debt risk premium of 2.716 per cent;
- debt issuing costs of 0.125 per cent; and
- hedging costs of 0.114 per cent.

907. The automatic formula for updating the estimate of the DRP – which will then occur for 2017, 2018 and 2019 consistent with the requirements of NGR 87(12) – is set out at Appendix 4C.

908. The automatic formula for updating the estimate of the DRP – which will then occur for 2017, 2018 and 2019 consistent with the requirements of NGR 87(12) – is set out at Appendix 4C.

[585] DBP, *Proposed Revisions DBNGP Access Arrangement 2016 – 2020 Access Arrangement Period Supporting Submission: 56*, 24 February 2016, p. 28.

Final decision

909. The Authority's resulting estimate for the overall post tax nominal rate of return for the 2016 calendar year is 5.83 per cent (Table 18):

- this rate of return is applied from 1 January 2016 to 31 December 2019 in the tariff modelling for this Final Decision in order to establish the reference tariffs.

910. The 2017 through to 2019 rates of return will be progressively annually updated through the remaining years of the fourth access arrangement period. The resulting revised rate of return will be included in the relevant tariff variations which occur in each calendar year.

911. The process for implementing the annual update is as follows:

- For each annual update for 2017, 2018 and 2019, the Authority will estimate the updated DRP following the relevant annual averaging period, recalculate the rate of return, and then notify DBP of the outcomes as soon as practicable, in any event within 10 business days. This will allow DBP to check the rate of return estimate, prior to its incorporation in the proposed annual tariff variation to occur on 1 January in each year and each subsequent quarterly tariff variation in that year.
- Following that notification, DBP is required to respond on any issues as soon as practicable, in any event within 10 business days, in order to allow the updated DRP and rate of return estimates to be finalised prior to submission by DBP of its proposed annual tariff variation.
- In the event that there is a disagreement on the DRP annual update estimate, the Authority will work with DBP to ensure that any misapplication of the automatic formulas in Appendix 4C of this Final Decision are corrected in a timely manner.
- The updated annual rate of return based on the correct application of the DRP automatic update formulas is to be utilised for each relevant annual tariff variation.

912. The Authority is satisfied, based on the reasoning in this Appendix, that its allowed rate of return of 5.83 per cent (nominal vanilla), which is determined for this Final Decision, achieves the allowed rate of return objective. Specifically, the Authority is satisfied that this allowed rate of return is commensurate with the efficient financing costs of a benchmark efficient entity with a similar degree of risk as that which applies to DBP in providing reference services. The subsequent annual update of the allowed rate of return will further satisfy the allowed rate of return objective.

913. The Authority does not consider that DBP's proposed rate of return of 7.69 per cent for the 2016 calendar year has been determined such that it meets the allowed rate of return objective.

914. Accordingly, the Authority has determined to apply its allowed rate of return of 5.83 per cent for this Final Decision.

Table 18 Rate of return for the Final Decision

WACC as at 10 June 2016	for 2016
Nominal Risk Free Rate	**1.80%**
Real Risk Free Rate	0.36%
Inflation Rate	**1.43%**
Debt Proportion	60%
Equity Proportion	40%
Debt Risk Premium (10 year trailing average)	**2.716%**
5 year IRS (effective yield)	**2.100%**
Return on Debt; 5 year Interest Rate Swap Spread	0.300%
Return on Debt; Debt Issuing Cost (0.125%) + Hedging (0.114%)	0.239%
Return on debt	**5.07%**
Australian Market Risk Premium	**7.4%**
Equity Beta	**0.7**
Corporate Tax Rate	30%
Franking Credit	40%
Nominal After Tax Return on Equity	**6.98%**
Nominal After Tax WACC	**5.83%**
Real After Tax WACC	4.33%

Source ERA analysis, June 2016

Appendix 4A Updating beta estimates – the 31 May 2016 study

915. This Appendix reports updated estimates of beta for use in the SL-CAPM. To inform its analysis, the Authority engaged Pink Lake Analytics,[586] who utilised the same companies used by Henry in his 2014 update to the Australian Energy Regulator (AER), and which are currently trading.[587]

916. This reduces the sample of benchmark assets to four (Table 19). The companies Envestra Limited (ENV) and Hastings Diversified Utilities Fund (HDF) have ceased trading since the last update, and have been excluded from the analysis.

Table 19 List of trading gas infrastructure assets as at June 2016

Name	Bloomberg's ticker	From	To	Proportional Value Weighting
APA Group	APA	13/06/2000	31/05/2016	0.382
AusNet Services	AST,SPN	14/12/2005	31/05/2016	0.263
DUET Group	DUE	13/08/2004	31/05/2016	0.199
Spark Infrastructure Group	SKI	16/12/2005	31/05/2016	0.156

917. The price data recorded the last daily price for all stocks provided by the Australian Stock Exchange (**ASX**), acquired through the Bloomberg Terminal (ticker ASA30). Dividend data used in the study were gross dividends including cash distributions, but omitting unusual items such as stock distributions and rights offerings. The dividend was then added to the closing price on the Friday after the ex-dividend dates as this is the first day the price would reflect the payout of the dividend in the data.

918. Returns are expressed as continuously compounding values:

$$r_{it} = \ln\left(\frac{p_{it} + d_{it}}{p_{i,t-1}}\right) \qquad (20)$$

where r_{it} is the return on asset i at time t; p_{it} is the price; and, d_{it} the dividend. Both the AER and Henry found no evidence that β estimates derived from continuously or discretely compounded data are manifestly different.[588]

586 Pink Lake Analytics, *Variance of the ZBP estimator*, June 2016, Appendix G.

587 O.T. Henry, *Estimating β : An update*, Advice Submitted to the Australian Competition and Consumer Commission. April 2014.

588 AER, *Explanatory Statement: Electricity transmission and distribution network service providers*, Review of the Weighted Average Cost of Capital (WACC) Parameters, www.aer.gov.au, p. 200.

919. Henry outlined in his advice to the AER that beta is estimated by applying a regression analysis to the following equation:[589]

$$r_{it} = \alpha_{it} + \beta_i r_{mt} + \varepsilon_{it} \quad (21)$$

where

α_{it} is a time-varying intercept term including abnormal returns over and above the risk free rate;

β_i is the equity beta for asset i;

r_{mt} is the observed market returns; and

$\varepsilon_{it} \sim N\left(0, \sigma^2\right)$ are the residuals assumed to be identically and independently distributed normally, with a time-constant volatility measure σ^2.

920. The above version of the SL-CAPM, termed here as the Henry CAPM, may be estimated in a number of different ways. Ordinary least squares (**OLS**) was supported by the robust estimation methods in **LAD** (least absolute deviation), **MM** (robust regression with the MM estimator) and **T-S** (Thiel-Sen). In general, these robust methods provide regression estimates that are less influenced by outliers and heteroscedasticity in the ε_{it} term. Technical descriptions of these estimators may be found in Appendix 17 of the Rate of Return Guidelines.[590]

921. A further two methods for the estimation of β have been trialled by applying **ARIMAX** (autoregressive integrated moving average) and **GARCH** (generalised autoregressive conditional heteroskedastic) models to the data, and which are described in brief in Appendix 4C of the Draft Decision. The ARIMAX model accounts for serial autocorrelation in the returns. The ARIMAX is a special case of the GARCH model where the volatility measure σ^2 is treated as time constant (i.e., homoscedastic). GARCH extends ARIMAX by allowing σ_t^2 to be time-varying as well, to be modelled in the simplest case as an ARMA (autoregressive moving average) process.

922. Hence, ARIMAX and GARCH are simply alternative ways to robust methods in accounting for heteroscedasticity in the data, and differ by modelling the heteroscedasticity as an explicit, parameterised process. The ARIMAX and GARCH estimates were not used here to form a decision on β.

589 O.T. Henry, *Estimating* β, Advice Submitted to the Australian Competition and Consumer Commission, 2009, p. 2.

590 ERA, Appendices to the Explanatory Statement for the Rate of Return Guidelines: Meeting the requirements of the National Gas Rules, 16th December 2013, Appendix 17.

923. The potential advantage of ARIMAX and GARCH is to reduce the standard error values of the β estimate, while correcting the small bias in β that may exist by omitting autoregressive terms from the model.

924. All equity betas in the following analysis were de-levered using the relevant company's average gearing ratio over the period and re-levered using the 60 per cent assumption. The details of this de-levering/re-levering process can be found in Appendix 20 of the Rate of Return Guidelines.[591]

Results

925. For estimates of individual firms' β, the Authority considers that the sample period of 5 years with weekly intervals is appropriate as it reduces the possibility of long past structural breaks in the data set, whilst encompassing enough data points to estimate β with statistical accuracy.

926. In 2013, the Authority's analysis contained five portfolios corresponding to different 'epochs' defined by when the different assets were trading or not trading.[592] Here, only the latest epoch is considered, as it starts on 16/12/2005 when SKI enters the market (Table 19), long before the sample period starts on 1/06/2011. In this, portfolios are required to be recreated only when the constituents within the industry change (i.e., when a firm either leaves or enters the industry).

927. The key purpose of a portfolio analysis is to allow a single portfolio to be created and, as such, a single corresponding β value for that portfolio can be estimated as representative of the benchmark sample.

928. Two weighting scenarios were considered in this study, which is consistent with the approach adopted in Henry's 2014 study[593]: (i) equally-weighted portfolios (**EW**); and (ii) value-weighted portfolios (**VW**). Equally-weighted portfolios simply assigned a weight of ¼ to each of the four firms in the benchmark sample. To calculate a value-weighted portfolio the average market capitalisation was calculated for each firm. For each firm in the portfolio, its weight is determined by the ratio between the average of a single firm and the sum of the averages of all firms in each portfolio in terms of market capitalisation. The averages were taken over the sample period for all firms in each portfolio. The weights were then applied to their relevant firms in the portfolio. The construction of equally-weighted and value-weighted portfolios is reported in Appendix 21 of the Rate of Return Guidelines.[594]

929. There is no evidence of thin-trading in this sample, given the assets in the gas infrastructure assets traded on greater than 99.9% of the possible trading days over the last five years.[595]

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591 ERA, Appendices to the Explanatory Statement for the Rate of Return Guidelines: Meeting the requirements of the National Gas Rules, 16th December 2013, Appendix 20.

592 ERA, Explanatory Statement for the Rate of Return Guidelines: Meeting the requirements of the National Gas Rules, 16th December 2013, Table 23, p. 172.

593 O.T. Henry, *Estimating β : An update*, Advice Submitted to the Australian Competition and Consumer Commission. April 2014.

594 ERA, Appendices to the Explanatory Statement for the Rate of Return Guidelines: Meeting the requirements of the National Gas Rules, 16th December 2013, Appendix 21.

595 See Table 3 in Pink Lake Analytics, *Variance of the ZBP estimator*, June 2016, Appendix G, p. 20.

930. Table 20 reports estimates of each firm's beta across the different regression methodologies, with a data set from June 2011 to May 2016. Equally-weighted and value-weighted portfolios are also reported.

Table 20 Estimates of equity beta for individual firms and the two weighted portfolios as at May 2016 for different estimation methods

	APA	AST	DUE	SKI	Mean Assets	EW	VW	Mean Portfolios	Mean All
Gearing	0.440	0.562	0.627	0.277	0.476	**0.476**	**0.484**	0.48	0.477
OLS	0.682	0.671	0.170	0.716	0.56	**0.638**	**0.665**	0.652	0.591
LAD	0.662	0.705	0.243	0.724	0.584	**0.74**	**0.778**	0.759	0.642
MM	0.665	0.675	0.268	0.776	0.596	**0.703**	**0.715**	0.709	0.634
T-S	0.647	0.661	0.263	0.713	0.571	**0.669**	**0.681**	0.675	0.606
Mean OLS, LAD, MM, T-S	**0.664**	**0.678**	**0.236**	**0.732**	**0.578**	**0.687**	**0.71**	**0.636**	**0.574**
ARIMAX	0.683	0.636	0.164	0.690	0.543	**0.677**	**0.681**	0.679	0.606
GARCH	0.618	0.673	0.254	0.731	0.569	**0.687**	**0.71**	0.699	0.618
Mean All Methods above	**0.66**	**0.67**	**0.227**	**0.725**	**0.570**	**0.675**	**0.695**	**0.685**	**0.609**

Source Pink Lake Analytics, *Variance of the ZBP estimator*, June 2016, Appendix G.

931. The point estimate of β for purposes of the Authority's RoE evaluation is taken fro the mean β, averaged across the two weighted portfolios and the OLS, LAD, MM and T-S estimators. This results in a $\beta = 0.699$, rounded to $\beta = 0.7$ (Table 20)

932. The results in Table 20 show that, on average, the MM estimator produced a higher equity β, and the T-S estimator a lower equity β, for each firm. Little difference was observed on average between the OLS and LAD estimates.

933. However, LAD estimates were more than 0.1 higher for the equally- and value-weighted portfolios than OLS estimates. For the equally- and value-weighted portfolios the MM produced slightly higher and the T-S estimator slightly lower estimates of the equity β (from 0.03 to 0.06 higher). This would be indicative of the DUE asset reporting a much lower β estimate, and with any extreme values in its returns receiving a low weighting and likely being largely ignored by the robust estimators, thereby pushing up the LAD estimate.

934. The ARIMAX and GARCH models, which estimated a small negative auto-regression coefficient, produced estimates that were consistent with the MM and T-S estimators. Small negative auto-regression coefficients identify an oscillating autocorrelation process that dampens with time, indicative of an immediate selling response to positive price fluctuations, and a buying response to negative price fluctuations (i.e., demonstrative of price equilibrium).

935. Across the four firms β has increased on average from 0.368 to 0.578 from 2013 to 2016 across all estimators (OLS, LAD, MM, T-S). Hence, elasticity in the response of individual asset returns to market returns has increased within the gas

infrastructure sector during a period when mean market returns have decreased, consistent with the findings of CEG.[596]

936. Gearing on average has decreased from 2013 to 2015, from a mean value across the four assets of 0.584 to 0.476, as firms may be seeking to de-lever following lessons learned in the GFC. An across the board decrease in gearing may warrant a revision, if sustained, of the benchmark gearing level of 60% debt and 40% equity applied by Australian economic regulators to calculate equity.

937. Bootstrap simulations of the estimates were performed using the naïve non parametric approach outlined in Appendix 23 of the Rate of Return Guidelines,[597] where paired observations of asset and market returns are randomly sampled with replacement before applying the CAPM to the sampled dataset.

Table 21 Summary Bootstrap Simulated Statistics of OLS Estimators (B=10,000, n=261)

Model	Estimator	APA	AST	DUE	SKI	Mean Assets	EW	VW	Mean Portfolios	Mean All
OLS	$\hat{\beta}$	0.682	0.671	0.170	0.716	**0.560**	0.638	0.665	**0.652**	**0.591**
	Standard Error $\hat{\beta}$	0.082	0.074	0.072	0.114	**0.085**	0.066	0.064	**0.065**	**0.079**
	Bootstrap $\hat{\beta}$	0.683	0.670	0.171	0.713	**0.559**	0.637	0.665	**0.651**	**0.590**
	Bootstrap S.E. $\hat{\beta}$	0.082	0.075	0.090	0.112	**0.090**	0.073	0.070	**0.072**	**0.084**
	Bootstrap Bias	0.001	-0.001	0.001	-0.003	**-0.001**	-0.001	0.000	**-0.001**	**-0.001**
	Bootstrap LB 2.5%	0.523	0.522	-0.025	0.488	**0.377**	0.491	0.527	**0.509**	**0.421**
	Bootstrap Median	0.683	0.670	0.178	0.715	**0.562**	0.638	0.665	**0.652**	**0.592**
	Bootstrap UB 97.5%	0.845	0.817	0.325	0.925	**0.728**	0.779	0.804	**0.792**	**0.749**

Source Pink Lake Analytics, *Variance of the ZBP estimator*, June 2016, Appendix G.

938. All OLS estimates of β were statistically significant at the 5 per cent significance level, as evidenced by the bootstrapped 95 per cent confidence band excluding the value of zero (Table 22). Standard errors for the portfolios estimated through OLS were 0.007 higher on average on May 2016 than in October 2015, scaling with the increase in the estimated value of β over that period. The bootstrapped upper 97.5 per cent confidence bound was 0.728 when averaged across all four assets, and 0.792 for the mean of the portfolios (Table 22). The bootstrapped estimate of the standard error of β (0.072) was slightly higher than that of the standard error estimated from the Henry model (0.065) (Table 21).

[596] CEG state that there is a structural clear break in β values, and hence non-stationarity of the time series over recent years (Competition Economists Group, *Estimating beta to be used in the Sharpe-Lintner CAPM*, February 2016, Appendix F, Figures 7-8, p. 41).

[597] Economic Regulation Authority, Appendices to the Explanatory Statement for the Rate of Return Guidelines: Meeting the requirements of the National Gas Rules, 16 December 2013, Appendix 23.

Table 22 Summary of Bootstrap Simulated Statistics of Robust Estimators (B=10,000, n=261)

Model	Estimator	APA	AST	DUE	SKI	Mean Assets	EW	VW	Mean Portfolios	Mean All
LAD	$\hat{\beta}$	0.662	0.705	0.243	0.724	**0.584**	0.740	0.778	**0.759**	0.642
	Standard Error $\hat{\beta}$ [1]	-	-	-	-	**-**	**-**	-	**-**	-
	Bootstrap $\hat{\beta}$	0.654	0.677	0.258	0.789	**0.595**	0.747	0.748	**0.748**	0.646
	Bootstrap S.E. $\hat{\beta}$	0.114	0.077	0.066	0.158	**0.104**	0.110	0.084	**0.097**	0.101
	Bootstrap Bias	-0.028	0.006	0.088	0.073	**0.035**	0.109	0.082	**0.096**	0.055
	Bootstrap LB 2.5%	0.437	0.543	0.156	0.434	**0.392**	0.479	0.529	**0.504**	0.429
	Bootstrap Median	0.658	0.678	0.248	0.771	**0.589**	0.765	0.762	**0.764**	0.647
	Bootstrap UB 97.5%	0.873	0.847	0.415	1.089	**0.806**	0.896	0.870	**0.883**	0.832
MM	$\hat{\beta}$	0.665	0.675	0.268	0.776	**0.596**	0.703	0.715	**0.709**	0.634
	Standard Error $\hat{\beta}$	0.079	0.064	0.044	0.111	**0.074**	0.061	0.061	**0.061**	0.070
	Bootstrap $\hat{\beta}$	0.664	0.676	0.267	0.774	**0.596**	0.703	0.715	**0.709**	0.633
	Bootstrap S.E. $\hat{\beta}$	0.083	0.075	0.054	0.116	**0.082**	0.075	0.073	**0.074**	0.079
	Bootstrap Bias	-0.018	0.004	0.097	0.058	**0.036**	0.065	0.049	**0.057**	0.043
	Bootstrap LB 2.5%	0.505	0.531	0.161	0.537	**0.434**	0.555	0.571	**0.563**	0.477
	Bootstrap Median	0.664	0.676	0.267	0.775	**0.595**	0.703	0.716	**0.710**	0.633
	Bootstrap UB 97.5%	0.832	0.822	0.375	0.996	**0.756**	0.846	0.856	**0.851**	0.788
T-S	$\hat{\beta}$	0.647	0.661	0.263	0.713	**0.571**	0.669	0.681	**0.675**	0.606
	Standard Error $\hat{\beta}$ [1]	-	-	-	-	**-**	-	-	**-**	-
	Bootstrap $\hat{\beta}$	0.648	0.661	0.262	0.713	**0.571**	0.666	0.680	**0.673**	0.605
	Bootstrap S.E. $\hat{\beta}$	0.085	0.076	0.053	0.125	**0.085**	0.078	0.071	**0.074**	0.081
	Bootstrap Bias	-0.034	-0.011	0.092	-0.003	**0.011**	0.028	0.014	**0.021**	0.014
	Bootstrap LB 2.5%	0.481	0.508	0.156	0.460	**0.401**	0.510	0.533	**0.522**	0.441
	Bootstrap Median	0.647	0.662	0.263	0.713	**0.571**	0.668	0.681	**0.674**	0.606
	Bootstrap UB 97.5%	0.818	0.803	0.365	0.960	**0.737**	0.813	0.818	**0.815**	0.763

Notes 1) Standard errors of the estimate were either inconsistently returning solvable values (i.e., were not able to converge to a single value) for the LAD estimator, or there was no analytical solution for the T-S estimator. In these two cases the standard error of the estimate should be replaced by the bootstrapped standard error estimate.

Source Pink Lake Analytics, *Variance of the ZBP estimator*, June 2016, Appendix G.

939. Standard errors were inconsistently estimated for the LAD estimator, and cannot be derived by analytical means from the T-S estimator (Table 22). For the LAD and T-S estimators the bootstrapped standard error is therefore used in drawing inference about β. Standard errors of β were higher for the LAD estimator, and to a lesser degree the T-S estimator, and reasonably similar to the T-S and MM estimators, when compared with the OLS estimator.

940. The 97.5 per cent upper bound for the LAD estimator was greater, by up to 0.15 depending on the asset, than for the OLS estimates (Table 21, Table 22). Upper bound estimates for the MM and T-S were only marginally greater than the OLS asset

941. A bootstrap procedure was not implemented for ARIMAX or GARCH as these are time series models, and to simulate the data in this case a bootstrap procedure would be required to maintain the autocorrelation structure of the actual data themselves. Such procedures exist, such as variations of the block and sieve bootstraps, but these were not applied.

942. This confidence interval was simply the z-normal confidence band given by 1.96 standard errors either side of the β estimate. Significantly, the z-normal and bootstrapped upper bounds were similar for both OLS and MM to within 0.01 (i.e., where a standard error measure was given), and so it is not incorrect to hypothesise that the ARIMAX and GARCH bootstrapped upper bounds will likewise be similar to their z-normal upper bound. Both the ARIMAX and GARCH standard errors and upper bound estimates were slightly less than that of the OLS estimator (except for the GARCH estimate for the EW portfolio; Table 23)

Table 23 Summary Statistics of ARIMAX and GARCH Estimators

Model	Estimator	APA	AST	DUE	SKI	Mean Assets	EW	VW	Mean Portfolios	Mean All
ARIMAX	$\hat{\beta}$	0.683	0.636	0.164	0.690	**0.543**	0.620	0.651	**0.636**	0.574
	Standard Error $\hat{\beta}$	0.081	0.073	0.072	0.113	**0.085**	0.066	0.064	**0.065**	0.078
	Lower Bound 2.5%	0.524	0.494	0.023	0.467	**0.377**	0.491	0.525	**0.508**	0.421
	Upper Bound 97.5%	0.842	0.779	0.305	0.912	**0.710**	0.75	0.776	**0.763**	0.727
GARCH	$\hat{\beta}$	0.618	0.673	0.254	0.731	**0.569**	0.677	0.681	**0.679**	0.606
	Standard Error $\hat{\beta}$	0.076	0.070	0.036	0.098	**0.070**	0.068	0.062	**0.065**	0.069
	Lower Bound 2.5%	0.469	0.536	0.183	0.538	**0.431**	0.544	0.558	**0.551**	0.471
	Upper Bound 97.5%	0.768	0.810	0.325	0.923	**0.707**	0.810	0.803	**0.807**	0.740

Source Pink Lake Analytics, *Variance of the ZBP estimator*, June 2016, Appendix G.

Appendix 4B International bond sample

Table 24 Sample of Bonds with Australia as Country of Risk as at 10 June 2016

Bond	Ticker	ISIN
1	EI6849026 Corp	AU3CB0176485
2	EJ3377821 Corp	XS0822418686
3	EJ8660791 Corp	US68620YAC66
4	EI1562293 Corp	Not Available
5	EJ8818027 Corp	AU3CB0215457
6	EI8834174 Corp	AU3CB0186385
7	EJ7922069 Corp	AU3CB0212652
8	EH7350695 Corp	US980236AE37
9	EJ0949291 Corp	AU3CB0191815
10	EI6030205 Corp	XS0604462704
11	EI6204404 Corp	AU3CB0173201
12	EJ3879651 Corp	XS0841018004
13	EJ4265850 Corp	AU3CB0201697
14	EJ4333419 Corp	AU3CB0201747
15	EK5876389 Corp	AU3CB0225324
16	EK5989620 Corp	AU3CB0225480
17	EI0704078 Corp	US45326TAA60
18	EI1608021 Corp	Not Available
19	EI1592092 Corp	Not Available
20	EJ5984160 Corp	AU3FN0018354
21	EI2000491 Corp	US10510KAA51
22	EJ6468916 Corp	AU3CB0208122
23	EK2849330 Corp	AU3CB0221422
24	EJ6899243 Corp	XS0938014742
25	EK9545295 Corp	AU3CB0230209
26	EK9580078 Corp	AU3FN0027801
27	EI7021476 Corp	Not Available
28	EI3253362 Corp	AU3CB0155133

Bond	Ticker	ISIN
29	EJ7588209 Corp	AU3CB0211415
30	EJ7646361 Corp	AU3CB0211647
31	EI4044356 Corp	US980888AD39
32	EI4098048 Corp	US04363UAB26
33	EK5107249 Corp	AU3CB0224467
34	EJ8616397 Corp	XS0977502110
35	EJ8798880 Corp	AU3CB0214823
36	EJ6371623 Corp	XS0920705737
37	EJ8893137 Corp	AU3CB0215119
38	EJ9225768 Corp	XS0993259844
39	EI5615311 Corp	XS0589885960
40	EI4214900 Corp	US87124VAA70
41	EK1048710 Corp	AU3CB0219194
42	EK1306886 Corp	AU3CB0219681
43	EI6348474 Corp	US980888AF86
44	EI6641167 Corp	US980236AL79
45	EK2622026 Corp	XS1066869048
46	EK3117976 Corp	AU3CB0221141
47	EK3554137 Corp	AU3CB0222271
48	EI7486208 Corp	XS0650132318
49	EK4152378 Corp	XS1094768469
50	EI8144731 Corp	XS0680309191
51	EJ8598074 Corp	XS0976223452
52	EI8364461 Corp	US68620YAA01
53	EI8703494 Corp	US65120FAA21
54	EG0640763 Corp	AU3FN0001244
55	EK6279310 Corp	AU3CB0225910
56	EK8055148 Corp	XS1205616268
57	EK2690916 Corp	AU3CB0220929
58	EK3157451 Corp	XS1080343277
59	EJ2714362 Corp	XS0803234094

Bond	Ticker	ISIN
60	EJ3784331 Corp	US65120FAC86
61	EJ3906165 Corp	US00205GAA58
62	EG0219857 Corp	AU3FN0001251
63	EJ4317107 Corp	US52535PAA75
64	EJ4068577 Corp	US87124VAD10
65	EJ5962760 Corp	XS0907606379
66	EJ6105286 Corp	XS0910943983
67	EI6307918 Corp	US04363UAD81
68	EJ3849779 Corp	XS0836488485
69	LW2393780 Corp	AU3CB0237733
70	EJ8324406 Corp	XS0972735533
71	UV3027009 Corp	AU3FN0028205
72	EK1561159 Corp	XS1057783174
73	EK3156859 Corp	XS1028952312
74	EK4655081 Corp	XS1109744778
75	EK4685294 Corp	XS1111428402
76	EJ4508010 Corp	XS0858000606
77	EK6424791 Corp	AU3FN0025987
78	EK7758478 Corp	US980236AM52
79	EK8078215 Corp	US00205GAB32
80	EK8787450 Corp	US87124VAE92
81	EK9072910 Corp	AU3CB0229680
82	EK9118226 Corp	XS1239502328
83	UV8551672 Corp	XS1292950232
84	QJ2217868 Corp	US10510KAC18
85	JV3204296 Corp	XS1338157248
86	QJ4132016 Corp	US89400PAE34
87	JK8498749 Corp	US02343UAA34
88	JK8763837 Corp	US87124VAF67
89	JK9360021 Corp	XS1405797694
90	LW0777554 Corp	XS1418788599

Bond	Ticker	ISIN
91	EK8055387 Corp	XS1205616698
92	EK8055262 Corp	XS1205617829
93	EK8078397 Corp	US00205GAC15
94	EJ3049461 Corp	AU0000CTXHA4
95	EI8704930 Corp	US65120FAB04
96	QJ1896811 Corp	US055451AX66
97	QJ1928531 Corp	US055451AW83
98	JV5237112 Corp	XS1380286663
99	QJ1906909 Corp	XS1309436753
100	QJ1910778 Corp	XS1309437215
101	QJ1908806 Corp	XS1309436910

* In order of increasing remaining term to maturity

Source: Bloomberg and ERA Analysis

Appendix 4C Automatic updating formulas for the return on debt

943. This appendix sets out the method and automatic formulas for updating the debt risk premium (**DRP**) for each regulatory year. The annual update will contribute to the revised tariff that is published at each annual tariff variation. Annual tariff variations for DBP will occur on 1 January 2017, 1 January 2018, 1 January 2019 and 1 January 2020.

944. DBP raises a number of administrative issues in relation to subsequent annual updates of the return on debt. It submits that the Authority's checking mechanism is ill-defined in terms of timeframes and proposes that the Authority be required to provide its estimate of the cost of debt to be updated, along with relevant supporting information within a maximum of five working days following the end of each averaging period. It also submitted that supporting information should include the same information as at Appendix 4E of the Draft Decision, with the addition of the relevant ISIN codes for the bonds, rather than just their Bloomberg tickers.

945. The Authority accepts DBP's proposal to implement a clearly defined timeframe around its dissemination and DBP's review of the annual update to the DRP estimate. The Authority will provide its estimate of the annual update of the DRP (and resulting return on debt) along with relevant supporting information and the information outlined in Appendix 4B of this Final Decision, appended with ISIN codes for the bonds (where available), within a maximum of 10 working days.[598] The Authority accepts DBP's proposal for it to respond with an acceptance or challenge to the proposed numbers within a maximum of 10 working days.

946. The Authority has determined that the return on debt will be estimated as the sum of the:

- risk free rate;
- spread of the bank bill swap rate over the risk free rate (BBSW spread);
- DRP; and
- relevant debt raising and hedging transactions costs.

947. The risk free rate and BBSW spread are estimated with the same term as the regulatory period, that is, 5 years. These two components are estimated once every 5 years at the start of the regulatory period, so do not require annual updating.

948. The DRP is estimated using a 10 year trailing average consisting of a DRP for the current year and a DRP for each of the 9 prior years and so must be updated each year. The DRP for each yearly update is based on:

- a term to maturity of 10 years;
- a BBB band credit rating;
- the Authority's revised bond yield approach; and
- a corresponding 10 year bank bill swap rate estimation.

[598] This will not include BVAL or any other data downloaded from Bloomberg. The column format for the table in Appendix 4B follows that of the Reserve Bank of Australia's published bond sample used to construct Measures of Australian Corporate Bond Spreads and Yields - F3.

949. The revised bond yield approach uses international bonds that have their country of risk identified by Bloomberg as Australia to estimate the cost of debt each year. The DRP represents the risk spread of the cost of debt estimated over the 10 year bank bill swap rate estimation in any given year.

950. The debt raising and hedging transactions costs, like the 5 year risk free rate and swap spread, are estimated only once, at the start of the regulatory period, and so do not require annual updating.

Averaging period

951. The DRP estimates that are to be included the 2017, 2018 and 2019 tariff variations are to be based on an averaging period of 20 Sydney trading days.[599] This averaging period must fall within a window at least two months prior to, but no longer than seven months before the regulatory year. Therefore, the Authority requires that the nominated averaging period occur in the period 1 June to 31 October in each year. For example, the updated DRP for inclusion in the 1 January 2017 tariff variation will be based on an averaging period that falls within the window 1 June 2016 to 31 October 2016.

952. The averaging periods must be nominated in advance. The Authority requires DBP nominate the averaging periods for 2017 to 2020 as soon as practicable following the release of this Final Decision, in any event within 10 business days. The Authority does not require that the nominated 20 business day averaging period for each of the four years be identical periods, only that they occur in the period 1 June to 31 October.

Method for estimating the DRP

The simple equally weighted trailing average

953. The estimate of the DRP for each year will be a simple trailing average.

954. The trailing average estimate of the DRP will weight the most recent 10 years of annual DRP estimates, which have been estimated consistent with debt with a 10 year term in the BBB credit rating band.

955. Annually updating the resulting 10 year trailing average will involve adding in the most recent estimate of the DRP and dropping the estimate from 10 years ago. The weights for a simple hybrid trailing average DRP estimate will be 10 per cent each.

[599] With the trading days accounting for missed days due to the eastern states' public holidays.

956. The automatic formula for the equally weighted trailing average of the DRP to apply in any regulatory year as shown below:

$$TA\,DRP_0 = \frac{\sum_{t=0}^{-9} DRP_t}{10} \qquad (22)$$

where

$TA\,DRP_0$ is the equally weighted trailing average of the DRP to apply in the following year as the annual update of the estimate used in the current year; and

DRP_t is the DRP estimated for each of the 10 regulatory years t = *0, -1, -2…. , -9*.

957. All years are in the same year convention as year *0*. For example, if year *0* is the regulatory year 2016, *t = -9* is the calendar year 2007 because 2016 is a calendar year in this Access Arrangement. Similarly, if year *0* is the regulatory year 2017, *t = -9* is the calendar year 2008.

958. For example, the DRP trailing average estimate for the calendar 2016 regulatory year will be:

$$\begin{aligned} TA\,DRP_{2016} = {} & 0.1 \times DRP_{2016} + 0.1 \times DRP_{2015} + 0.1 \times DRP_{2014} \\ & + 0.1 \times DRP_{2013} + 0.1 \times DRP_{2012} + 0.1 \times DRP_{2011} \\ & + 0.1 \times DRP_{2010} + 0.1 \times DRP_{2009} + 0.1 \times DRP_{2008} \\ & + 0.1 \times DRP_{2007} \end{aligned} \qquad (23)$$

959. In terms of the notation used by the Australian Energy Regulator (but in the Authority's case applying just to the DRP trailing average), the foregoing TA DRP for the 2016 calendar year may be written as follows:[600]

$$\begin{aligned} {}_{2015}kd_{2016} = {} & 0.1 \times {}_{2006}R_{2007} + 0.1 \times {}_{2007}R_{2008} + 0.1 \times {}_{2008}R_{2009} \\ & + 0.1 \times {}_{2009}R_{2010} + 0.1 \times {}_{2010}R_{2011} + 0.1 \times {}_{2011}R_{2012} \\ & + 0.1 \times {}_{2012}R_{2013} + 0.1 \times {}_{2013}R_{2014} + 0.1 \times {}_{2014}R_{2015} \\ & + 0.1 \times {}_{2015}R_{2016} \end{aligned} \qquad (24)$$

960. Equivalently, where 't=0' specifies the year 2016 in this case:

$$\begin{aligned} {}_{-1}kd_0 = {} & 0.1 \times {}_{-10}R_{-9} + 0.1 \times {}_{-9}R_{-8} + 0.1 \times {}_{-8}R_{-7} + 0.1 \times {}_{-7}R_{-6} \\ & + 0.1 \times {}_{-6}R_{-5} + 0.1 \times {}_{-5}R_{-4} + 0.1 \times {}_{-4}R_{-3} \\ & + 0.1 \times {}_{-3}R_{-2} + 0.1 \times {}_{-2}R_{-1} + 0.1 \times {}_{-1}R_0 \end{aligned} \qquad (25)$$

600 Australian Energy Regulator, *Draft Decision: Jemena Gas Networks (NSW) 2015-20*, November 2014, Attachment 3, p. 3-288.

Post-March 2015 Estimates of the DRP for inclusion in the trailing average DRP estimate

961. The estimates of the DRP applying to each calendar year will be estimated using the Authority's revised bond yield approach. Resulting estimates of the DRP will be included in the trailing average.

962. The first estimate is that made for the 20 day period ending 10 June 2016, which has been included as the estimate of the DRP for calendar year 2016 included in this Final Decision.

963. The first annual update estimate that will be made for DBP will fall in the period 1 June to 31 October 2016, (DRP_{2017}), and will be incorporated in the trailing average DRP to apply in 2017 (that is, TA DRP_{2017}).

964. The following automatic formulas will apply, and will remain unchanged for the duration of the AA4 period, and hence will apply for the estimates made for DRP_{2017}, as well as for the estimates DRP_{2018}, DRP_{2019} and DRP_{2020}.[601]

Techniques to estimate the debt risk premium

965. The Authority's approach to estimating the debt risk premium (DRP) is designed so that a stakeholder can replicate the debt risk premium calculation implemented by the Authority. The process is outlined in sufficient detail such that replicating it should incur minimal research and development costs for stakeholders whilst maintaining transparency and removing discretion in the application. Once the approach has been established in Bloomberg and Excel for the first time the settings and spreadsheet templates do not need to be established again. The estimation process thereafter requires significantly less time and becomes mechanistic. ***The footnotes in this section provide assistance with Bloomberg commands.***

966. The Revised Bond Yield Approach consists of the following six processes.

- Determining the Benchmark Sample
  - Identifying a sample of bonds based on the benchmark sample selection criteria. This will comprise a 'cross section' of bonds.
- Collecting Data
  - Collecting data for those bonds over the averaging period in question, for example 20 trading days). This represents 'time series' data related to each bond.
- Converting Yields to Australian Dollar Equivalents
  - Converting yields for bonds denominated in foreign currencies into Australian dollar (**AUD**) equivalents so that all yields are expressed as an AUD equivalent.

[601] As part of the response to the consultation on the proposed changes to the ATCO Final Decision, the automatic formulas for the annual update in this section were amended. However, the Authority determined not to amend some aspects of the approach used to estimate the 2 April 2015 estimate of the DRP that was set out in the ATCO Final Decision (for example, the constraints on the Nelson-Siegel Svennson curve parameters). Therefore, applying the amended methods set out below will not reproduce the exact DRP estimated for the *indicative* return on debt (see paragraphs 755 to 772 in the main body for the 2 April 2015 value of the DRP and the method adopted to estimate it).

- Averaging Yields over the Averaging Period
  - Calculating an average AUD equivalent bond yield for each bond in the cross section across the averaging period. For example, where a 20 trading day averaging period applies, each bond will have a single 20 day 'average yield' calculated.
- Estimating 'Curves'
  - Estimating three yield curves based on different methodologies and using the average yield for each bond; its remaining term to maturity; and AUD face value.[602]
- Calculating the DRP
  - Calculating the DRP by subtracting the average of the 10 year AUD interest rate swap (**IRS**) rate from the 10 year cost of debt estimate, with the latter calculated as the average of the three estimated yield curves at the ten year tenor.

Step 1: Determining the benchmark sample

967. The benchmark sample of bonds should be identified as soon as practicable, but 24 hours after the date identified as the final trading day in the averaging period in order to allow the sample from Bloomberg to 'settle' to its final form.

968. The first step in determining the benchmark sample, or cross section of bonds is to identify the appropriate benchmark credit rating. For Gas Access Arrangements, the Standard & Poor's credit rating for the benchmark firm is outlined in the Economic Regulation Authority's Rate of Return Guidelines and is currently the BBB band.[603]

969. The Bloomberg search SRCH <GO> facility is used to conduct a search for bonds with a Standard & Poor's issue level (as opposed to issuer) rating that matches the benchmark firm's credit rating, and other criteria set out in Table 25.[604] This is carried out between 24 and 48 hours after the date that marks the final trading day in the averaging period in order to allow global markets to close. The exception here is where this 24 hour period overlaps a Western Australian non-trading day, in which case this process is carried out on the next Western Australian trading day.[605]

602 The three curves are based on the Gaussian Kernel, the Nelson Siegel and the Nelson Siegel Svennson methodologies. The Gaussian Kernel approach produces a series of point estimates as opposed to a curve. However, each point estimate can be seen as points that compose a curve.

603 Economic Regulation Authority, Explanatory Statement for the Rate of Return Guidelines: Meeting the Requirements of the National Gas Rules, 16 December 2013, pp. 44-52.

604 <GO> is the Bloomberg equivalent of hitting the enter key after entering commands in the top left hand corner of the screen to the left of <HELP>. For example, type SRCH and then hit the <GO> key.

605 Note that the revised bond yield approach is based on Eastern States trading days for consistency with Commonwealth Government Security data used in risk free rate and inflation calculations.

Table 25 Revised Bond Yield Approach Search Criteria – Bloomberg Search Structure

Criteria	Authority's approach
Country of risk	Australia
S&P Rating	BBB+ to BBB-
Currency	Australian Dollar, United States Dollar, Euro Currency and British Pound
Maturity Date	>= 2 years from now
Maturity Type	Bullet or Callable or Putable but not Perpetual
Security Type	Exclude Inflation Linked Note
Sector/Industry Group	Exclude 'Financials' (based on Bloomberg Industry Classification System Level 1 Sector Name)
Was Called	No

970. A screen shot of how this would look in the Bloomberg SRCH<GO> function is presented in Figure 15. The security status defaults to 'active'. It is important to note that in the top left hand corner of this figure the 'Asset Classes' criteria has been enabled to consolidate duplicate bond issues. The consolidation option is accessed by typing 11 in the top left hand corner to the left of <HELP> and then hitting <GO>. Ensure that *only* the 'Corporate' and 'Consolidate Duplicate Bonds' option is checked before clicking 'Update'. The remaining criteria are entered into the Bloomberg SRCH function as shown in Figure 15 by typing the keywords into the 'Field' column and hitting <GO> after each of the criteria are entered to add new criteria. The criteria in the Bloomberg search panel can be edited by clicking the pencil icon to the right of each criteria. [606]

[606] For the maturity date change the boundary condition to 'years from now' by selecting 'Y'.

Figure 15 Bloomberg 'SRCH' Function Populated with Sample Selection Criteria

Source: Bloomberg

971. The results of this bond search are exported into Microsoft Excel.[607] The only information that is collected from the search result output into Excel at this stage is the 'Bloomberg ID' or 'ticker' for each bond.[608] Each ticker needs to be appended with " Corp" so that formulas used in the next step can recognise them as a corporate bond. This can be carried out using the structure in Microsoft Excel below.[609]

Table 26 Appending Bloomberg Bond Tickers for use in Pricing Formulas– Microsoft Excel Template Structure

Attribute	Cell	Formula or entry
Pasted value of bond ticker (example)	A2 down	EXXXXXXXX Corp
Bond ticker appended with " Corp"	B2 down	=A2&" Corp"

972. The bond tickers in B2 down should be pasted as values (as opposed to Excel commands) into a separate worksheet for use in subsequent calculations.

607 Click the 'Results' button and in the resulting screen click 'Actions' and then 'Export to Excel'.

608 It is important to save a copy of this search for future reference if help is requested from Bloomberg Helpdesk.

609 It is recommended that formulas presented in these Excel structure tables are copy and pasted from an electronic copy of this document.

Step 2: Collecting Data and Conversion of yields into AUD equivalents

973. Data is collected between 24 and 48 hours after the date that marks the final trading day in the averaging period in order to allow global markets to close. The exception here is if a Western Australian non-trading day falls in this period, in which case this process is carried out on the next Western Australian trading day.[610]

974. Before data for each of the bond identifiers in the sample (established in the previous section) is retrieved, some 'pricing source defaults' need to be set in the Bloomberg terminal, to ensure that data sources are consistent and of similar quality. This determines the source that formula outlined further below use to draw bond pricing from.

975. Table 27 provides the 'pricing source defaults' for bonds issued in the relevant range of currencies.

Table 27 Pricing Waterfall Set in Bloomberg for Retrieving Bond Price Data

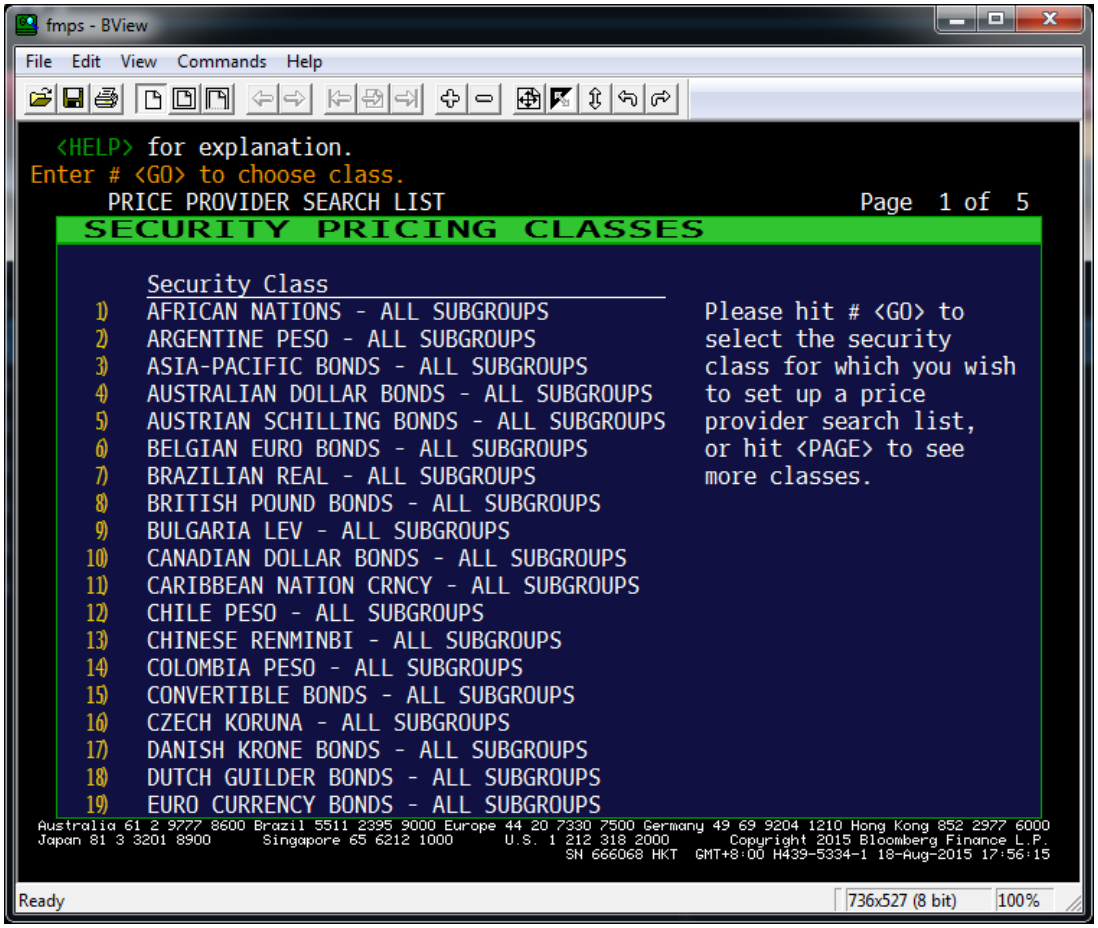
Currency of Issuance	1st Pricing Source	2nd Pricing Source
USD	BVAL	TRAC
EUR	BVAL	BGN
GBP	BVAL	BGN
AUD	BVAL	CBBT

976. To set these as the default sources in the Bloomberg terminal for each currency use FMPS <GO> shown in Figure 16.[611] Scroll down to reveal 'US Denominated Corporate Bonds – All Subgroups'. Select this and in the resulting window select US Denominated Corporate Bonds – All Subgroups' again.

610 Note that the revised bond yield approach is based on Eastern States trading days for consistency with Commonwealth Government Security data used in risk free rate and inflation calculations. The Authority will maintain a copy of the pricing sources used for each bond in the sample so that third parties can replicate the pricing sources for all bond yield observations retrospectively.

611 The Authority considers that in practice the BVAL pricing source will find pricing data in the majority of cases. If the first preference contains any observations of historical data FMPS ensures that all observations will rely on this one pricing source for consistency. Events such as US Federal public holidays can result in days within the averaging period where no prices will be returned from the first preference. In these rare cases the bond ticker is manually appended with "@PCS Corp" to hard code the preferred pricing source. For example in Table 28 further below the ticker would be modified to "EXXXXXXXX@BGN Corp" as second preference for Euro denominated bonds. If no pricing is available from the second preference the observation is left blank. The Authority will maintain a copy of the pricing sources used for each bond in the sample so that third parties can replicate the pricing sources for all bond yield observations.

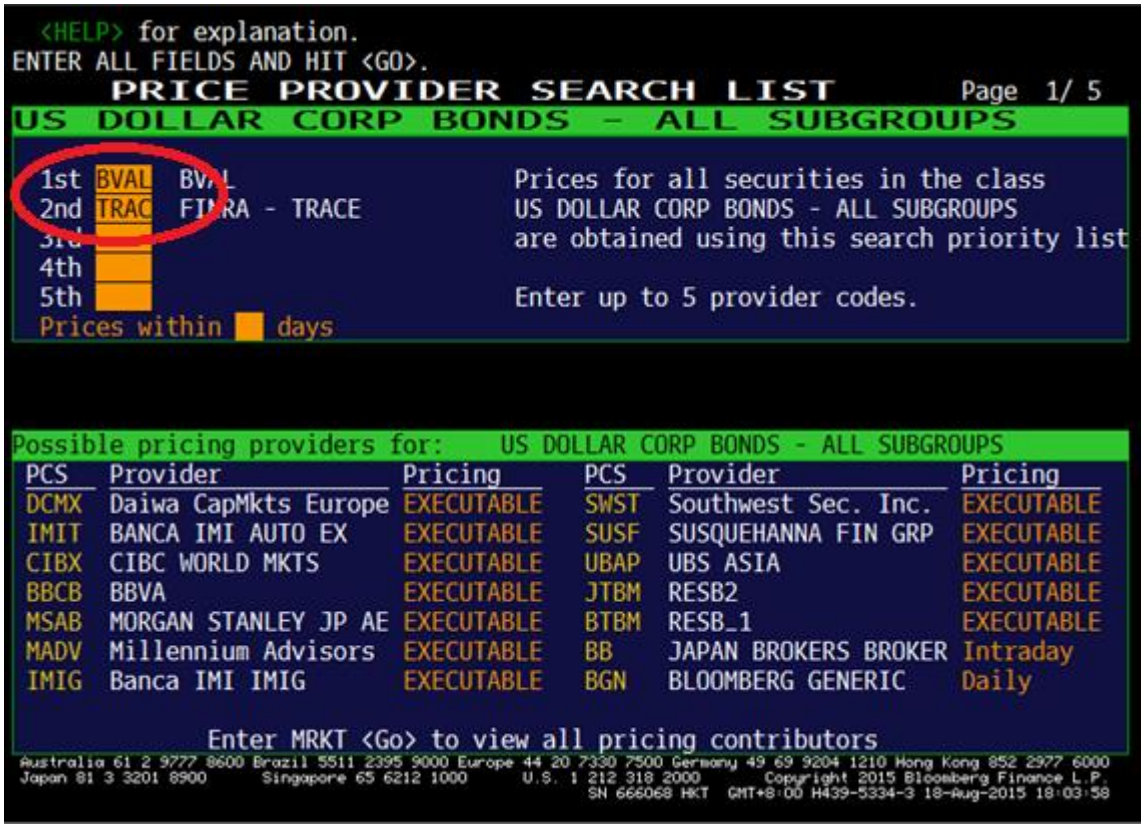
Figure 16 Security Pricing Classes List



Source: Bloomberg

977. Figure 17 shows where the pricing source settings in Table 27 should be entered in the pricing source window using the US dollar denominated bonds as an example. In particular, the first pricing source should be entered to the right of '1st' and the second pricing source to the right of '2nd'. Once this is complete select <GO> followed by 1 <GO> to save.

Figure 17 Pricing Source Window Default Setting - US Dollar Corporate Bond Example



Source: Bloomberg

978. Repeat the steps outlined in paragraphs 976 and 977 for the remaining currencies selecting:

- 'Euro Currency Bonds – All Subgroups' > 'Original EUR Issued Bonds and Other Redenominated Bonds' > 'Euro Currency Bonds – All Subgroups' for Euro denominated bonds;
- 'British Pound Bonds – All Subgroups' > 'British Pound Bonds – All Subgroups' for GBP denominated bonds; and
- 'Australian Dollar Bonds – All Subgroups' > 'Australian Dollar Bonds – All Subgroups' for AUD denominated bonds.

979. Data is collected through a Microsoft Excel spreadsheet that interfaces with Bloomberg through the Bloomberg Application Programming Interface (**API**). The 'tickers' identifying each bond in the sample selection step above are the key input into this spreadsheet. The bond tickers are appended with " Corp" so that they can be read by the "Bloomberg Data Point" (**BDP**) or "Bloomberg Data History" (**BDH**) function in Excel which then retrieves various attributes for each bond in question.[612] Once the pricing source defaults have been set, some key attributes are be exported into Excel:

- Maturity date (MATURITY);
- Currency (CRNCY);

[612] The space before " Corp" is intentional. BDP retrieves current values while BDH is used to retrieve historical data.

- Amount issued (AMT_ISSUED);
- Issue date (ISSUE_DT);
- Bid price for the bond (px bid);
- Ask price for the bond (px ask); and
- Asset swap spread bid (asset swap spd bid);
- Asset swap spread ask (asset swap spd ask);
- Australian dollar exchange rate with each bond's native currencyat date of issue (for example for the US/Australian dollar exchange rate; USDAUD Curncy).

980. The key formulas for exporting the Bloomberg data into Excel are provided in Table 28. All formulas B2 through to E2 should be filled downward in Excel to retrieve the attributes for the entire cross section of bonds.

981. Once these key attributes have been exported, the formulas in then convert the mid asset swap spread highlighted in K2 into a hedged Australian dollar equivalent. The formulas in Table 28 and should be contained in the same spreadsheet. All formulas P2 through to R2 should be filled downward in Excel to retrieve the converted yields for the cross section of bonds.[613]

982. The Excel worksheet based on the formulas in Table 28 and provides a template to calculate the hedged AUD bond yields for the entire cross section of bonds in the benchmark sample on any given trading day. Specifically, once a trading date is entered into cell A1, the hedged AUD bond yield is returned in cells R2 downward.[614] The hedged yields for the entire cross section of bonds are saved as values (rather than excel formulas) for each day in the 20 day averaging period.

Table 28 Formula to Retrieve Bond Prices and Attributes– Microsoft Excel Template Structure

Attribute	Cell	Formula or entry
Bond Ticker	From A2 down	EXXXXXXXX Corp
Trading day date	A1	mm/dd/yyyy
Currency to convert to	B1	AUD
Payment frequency	C1	Q
Issue date	B2 down	=BDP(A2,"ISSUE_DT")
Maturity date	C2 down	=BDP(A2,"MATURITY")
Currency of bond issue	D2 down	=BDP(A2,"CRNCY")
Amount issued –currency of issuance (bond face value)	E2 down	=BDP(A2,"AMT_ISSUED")

613 The Bloomberg Swaps Toolkit must be enabled so that these formulas can call the swap manager tool in the Bloomberg terminal through Excel. Further information and example templates can be found in the Swaps Toolkit under DAPI <GO> in the Bloomberg terminal.

614 Note that this process can take a few minutes to populate. It is important to ensure the yields have populated fully and without error each time the date is changed in cell A1. At times this may require restarting Excel.

Attribute	Cell	Formula or entry
Amount issued – Australian dollars (bond face value)	F2 down	=IF(D2="AUD",E2,E2*BDH(D2&"AUD Curncy","px_last",B2,B2))
Bid Price Label	G1	PX BID
Ask Price Label	H1	PX ASK
Bond bid price615	G2 down	=BDH(A2, "px bid", $A$1, $A$1, "QuoteType", "P","fill","P")
Bond ask price	H2 down	=BDH(A2, "px ask", $A$1, $A$1, "QuoteType", "P","fill","P")
Asset swap spread bid616	I2 down	=BDP(A2,"asset swap spd bid",$G$1,G2,"ASW_SWAP_CURRENCY",$B$1,"ASW_SWAP_PAY_RESET_FREQ",$C$1,"SETTLE_DT",TEXT($A$1,"YYYYMMDD"),"OAS_CURVE_DT",TEXT($A$1,"YYYYMMDD"))
Asset swap spread ask617	J2 down	=BDP(A2,"asset swap spd ask",$H$1,H2,"ASW_SWAP_CURRENCY",$B$1,"ASW_SWAP_PAY_RESET_FREQ",$C$1,"SETTLE_DT",TEXT($A$1,"YYYYMMDD"),"OAS_CURVE_DT",TEXT($A$1,"YYYYMMDD"))
Asset swap spread mid	K2 down	=AVERAGE(I2:J2)
Determination Date	$L$1 down	dd/mm/yyyy
Remaining term to maturity from determination date (dd/mm/yyyy)	L2 down	=YEARFRAC($L$1,C2,)

Source: ERA Research, Bloomberg

615 The Authority considers that the “fill” “P” option will not return values after the bond has matured, however will ensure a contiguous series whilst the bond is on issue.

616 The Authority considers that using the option adjusted spread curve date is an appropriate override in order to explicitly fix this curve date to the trading day date entered through Excel.

617 The Authority considers that using the option adjusted spread curve date is an appropriate override in order to explicitly fix this curve date to the trading day date entered through Excel.

Table 29 Formula for Converting to Hedged Australian Dollar Equivalent Yields– Microsoft Excel Template Structure (continued on from Table 28)

Attribute	Cell	Formula or entry
Payment frequency for fixed leg of swap (leg 1)	M1 down	Semiannual
Payment frequency for floating leg of swap (leg 2)	N1 down	Quarterly
Deal type (fixed float)	O1 down	FXFL
Deal Structure ID (called from Bloomberg terminal)618	P2 down	=BSTRUCTURE($O$1,"Leg[2].Currency",$B$1,"Leg[1].Currency",$B$1,"Leg[2].Spread",K2,"EffectiveDate",$A$1,"MaturityDate",C2,"Leg[1].PayFrequency",$M$1,"Leg[2].PayFrequency",$N$1,"Leg[2].ResetFrequency",$N$1)
Valuation ID (called from Bloomberg terminal)	Q2 down	=BPRICE(P2,"Target=Leg[1].FixedCoupon","Premium=0","Leg[2].Spread",K2,"ValuationDate",$A$1,"MarketDate",$A$1,"headers=false")
Australian dollar equivalent yield	R2 down	=BView(Q2,"Leg[1].FixedCoupon","headers=false")

Source: ERA Research, Bloomberg

Step 3: Averaging yields over the averaging period

983. The 20 day averaging period is based on eastern states trading days with the last day of the averaging period being on the DRP determination date. A table of AUD equivalent bond yields is established for the cross section of bonds in the sample with observations for every day across the averaging period.[619] To build up this time series, the date entered in cell A1 at Table 28 should be changed to each of the trading days in the averaging period. The series of observations for each bond is then assessed to ensure it has a number of observations equal to at least half of the averaging period. Bonds that do not meet this requirement are deleted from the sample. The sample of yields for each bond is then averaged. This results in one averaged observation for each bond.

984. The Excel worksheet for calculating the 20 day average bond yield for each bond in the benchmark samples is provided at Table 30.

618 The Authority considers that setting the effective date to the trading date is appropriate to ensure the tenor of the swap matches the remaining term to maturity of the bond.

619 This is done by cutting and pasting observations from cell R2 down in as values into B2 down in Table 30. To avoid 'overloading' the Excel API only one spreadsheet using the structure in should be run on a Bloomberg terminal at a time.

Table 30 Averaging Yields over the Averaging Period - Microsoft Excel Template Structure

Attribute	Cell	Formula or entry
Trading Day Dates	B1:U1	Each trading day date in the averaging period (20 dates for this Decision)
Bond Ticker	A2 down	EXXXXXXXX Corp
Australian dollar equivalent yields for first trading day	B2 down :U2 down	Bond values from R2 down in for the 1st trading day through to the 20th trading day.
Average of 20 day yields	V2 down	=AVERAGE(B2:U2)

Step 4: Apply curve fitting techniques

985. To improve the validity of the yield estimates, three techniques are used to fit curves as part of the automatic formula to estimate the 10 year cost of debt used in the calculation of the annually updated DRP. These are:

- the Gaussian Kernel Methodology;
- the Nelson-Siegel Methodology; and
- the Nelson-Siegel-Svennson Methodology.

986. For ease of replication by third parties only Microsoft Excel is used for processing the data. Each of these techniques is discussed in turn below.[620]

Gaussian Kernel Methodology

987. The Gaussian Kernel Methodology is consistent with the approach used by the Reserve Bank of Australia as published in 'New Measures of Australian Corporate Credit Spreads'.[621] The Excel worksheet that replicates the Gaussian Kernel Methodology is provided in Table 31.

988. Note that the inputs required for each bond in the benchmark sample are: remaining term to maturity; bond face value in Australian dollars; and Australian dollar equivalent yield. These are the outputs reported in cells L2 and F2 in Table 28 and cell R2 in respectively.

620 Microsoft Excel 2013 (15.0.4745.1000) 32 bit as part of Microsoft Office Professional Plus 2013 is the version currently used for these calculations.

621 Reserve Bank of Australia, 'New Measures of Australian Corporate Credit Spreads', Bulletin, December quarter 2013.

Table 31 Gaussian Kernel Point Estimation Methodology – Microsoft Excel Template Structure

Attribute	Cell	Formula or entry
Remaining term to maturity	A1 down	L2 as output in Table 28
Amount issued – Australian dollars (bond face value)	B1 down	F2 as output in Table 28
Australian dollar equivalent yield	C1 down	Values in V2 down in Table 30
Absolute deviation from target tenor	D1 down	=ABS(A1-$K$1)
Squared deviation from target tenor	E1 down	=(A1-$K$1)^2
Gaussian kernel	F1 down	=(EXP(-E1/(2*$K$4)))/$K$8
Joint Weighting	G1 down	=F1*B1
Sum of Joint Weighting	Last cell column G	=SUM(G1:GSecond last row)
Weight	H1 down	=G1/(GLast row)
Weighted yield	I1 down	=C1*H1
Weighted maturity	J1 down	=A1*H1
Sum weighted maturity (effective term to maturity)	Last cell column J	=SUM(J1:JSecond last row)
Target tenor	K1	Input target tenor (eg 10 for 10 years)
Smoothing parameter (sigma)	K2	1.5
Actual sigma	K3	=STDEV(A:A)
Sigma squared	K4	=K2^2
mean	K5	=AVERAGE(A:A)
pi	K6	=PI()
2 x Square root of pi	K7	=SQRT(2*K6)
2 x Square root of pi x smoothing parameter	K8	=K7*K2
Target tenor yield	K9	=SUM(I:I)

989. As the Gaussian kernel methodology is non-parametric, and thus requires no estimation of curves, the output for any target tenor input into cell K1 is instantly reported in cell K8.

990. The target tenor yields are calculated for 3, 5, 7 and 10 year terms. The associated effective term to maturity in the last cell of column J is also recorded for each tenor. A linear extrapolation out to an effective tenor of 10 years and interpolation to 7 years is performed using the following formula.

$$y_t(t) = y_t\left[et(7)\right] + \left(\frac{y_t\left[et(10)\right] - y_t\left[et(7)\right]}{et(10) - et(7)}\right)\left(t - et(7)\right) \quad (26)$$

Where:

t is the tenor to be interpolated or extrapolated to;

$y_t(t)$ is the semi-annual yield extrapolated out to 10 years;

τ is the input target tenor (for example in cell K1 above);

$y_t\left[\tau\right]$ is target tenor yield output from the Gaussian kernel method; and

$et(\tau)$ is the effective tenor output from the Gaussian kernel method.

991. The Excel Worksheet for calculating the target tenor yields is provided at Table 32 (below).

Table 32 Linear Interpolation and Extrapolation of Gaussian Kernel Estimates – Microsoft Excel Template Structure

Attribute	Cell	Formula or entry
Tenor	A1:D1	Values 3, 5, 7 and 10.
3 year target tenor yield (semi-annual basis)	A2	From cell K9 in Table 31.
5 year target tenor yield (semi-annual basis)	B2	From cell K9 in Table 31.
7 year target tenor yield (semi-annual basis)	C2	From cell K9 in Table 31.
10 year target tenor yield (semi-annual basis)	D2	From cell K9 in Table 31.
3 year effective tenor	A3	Last row of column J in Table 31.
5 year effective tenor	B3	Last row of column J in Table 31.
7 year effective tenor	C3	Last row of column J in Table 31.
10 year effective tenor	D3	Last row of column J in Table 31.
3 year target tenor annualized yield	A4	=((1+A2/200)^2-1)*100
5 year target tenor annualized yield	B4	=((1+B2/200)^2-1)*100
7 year target tenor annualized yield	C4	=((1+C2/200)^2-1)*100
10 year target tenor annualized yield	D4	=((1+D2/200)^2-1)*100
Interpolated 7 year yield (semi-annual basis)	E2	=C2+((D2-C2)/(D3-C3))*(7-C3)
Extrapolated 10 year yield (semi-annual basis)	F2	=C2+((D2-C2)/(D3-C3))*(10-C3)
Interpolated 7 year yield annualized	E4	=((1+E2/200)^2-1)*100
Extrapolated 10 year yield annualized	F4	=((1+F2/200)^2-1)*100

992. The value for F4 in Table 32 is the Gaussian Kernel cost of debt extrapolated to a tenor of 10 years. This value averaged with the 10 year cost of debt estimate from the other two methods is the Authority's final 10 year cost of debt estimate.

The Nelson Siegel method

993. The first step in the Nelson Siegel methodology involves the estimation of the value for the decay factor (λ) that provides the tenor at which the medium-term factor (β_{2t}) reaches its maximum influence. Diebold and Li (2006) propose that

30 months (2.5 years) is commonly used as a medium-term tenor.[622] Setting τ to 2.5 and substituting it into the weighting factor attached to β_{2t} in the Nelson Siegel specification gives:

$$Max\left(\frac{1-e^{-2.5\lambda}}{2.5\lambda}-e^{-2.5\lambda}\right) \quad (74)$$

994. The Excel worksheet and Excel solver settings that are used to determine the value of λ that maximises β_{2t} are provided at Table 33, Figure 18 and Figure 19 respectively. Note that the GRG non-linear solver is used to find the maximum point (or peak) on a non-linear function, hence the selection of 'GRG Nonlinear' and 'Max' in Figure 18.

Table 33 Nelson Siegel Decay Factor Estimation – Microsoft Excel Template Structure

Attribute	Cell	Formula or entry
β_{2t} weighting factor	A1	=(((1-EXP(-$A$3*A2))/($A$3*A2))-EXP(-$A$3*A2))
Tenor (maturity) τ	A2	2.5
Decay factor λ (Starting value used)	A3	0.00000000000001 (that is 1E-14)

622 F. Diebold and C. Li, 'Forecasting the term structure of government bond yields', *Journal of Econometrics,* vol.130, no.2, pp. 337-364.

Figure 18 Nelson Siegel Decay Factor Estimation – Microsoft Excel Solver Settings

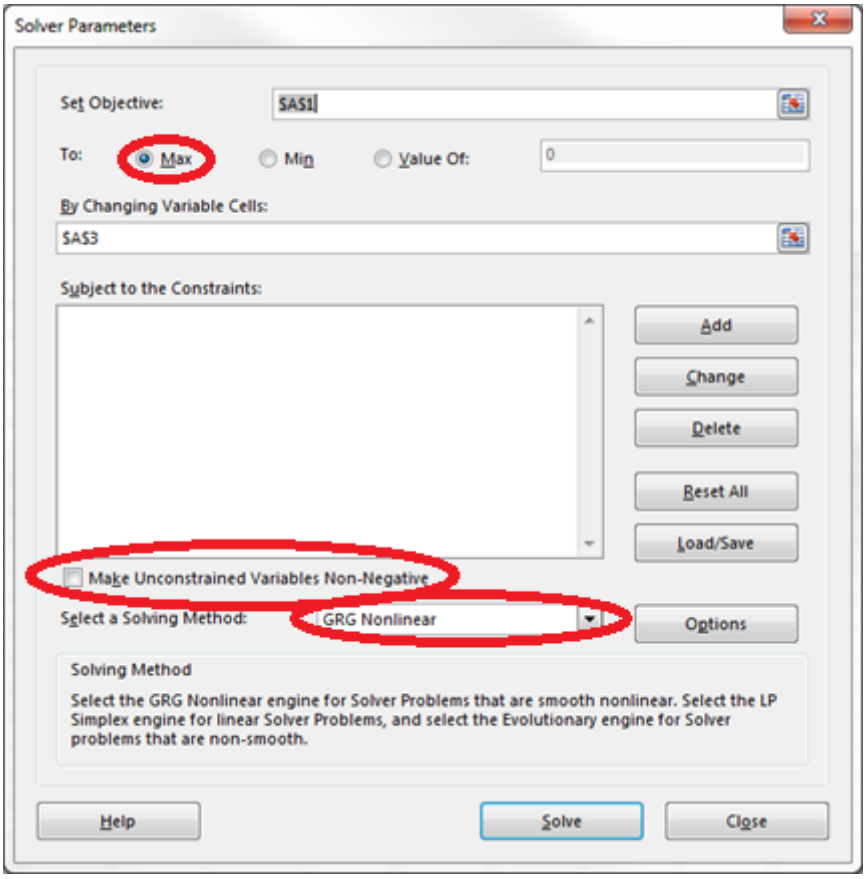
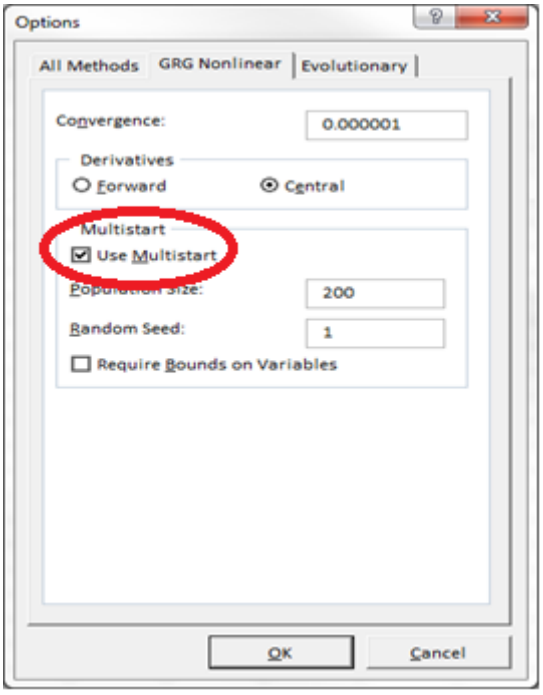


Figure 19 Microsoft Excel GRG Nonlinear Solver Settings



995. The convergence of 0.000001 is considered precise enough such that the solver will stop when the solution in the last iterations change by this amount.[623] To ensure

[623] Diebold and Li (2006) published their decay method to 4 decimal places.

the peak is a global maximum (as opposed to just local) the solver carries out the optimisation from many different random starting points on the function reflected by the selection of the 'Multistart' option in Figure 19. The number of different starting points is based on the 'Population size' field and setting the 'Random seed' to 'one' ensures that the random selection process is always based on the same seed each time the solver is used. The central difference derivative method is selected for the greatest accuracy. In this case the problem is unconstrained and so no bounds are required on variables.

996. This estimation process yields a value for λ of 0.71731 which will be used as a starting value in the final fitting of the NS yield curve.[624]

997. Starting values are still required for $\beta_{0t}, \beta_{1t}, \beta_{2t}$. These are obtained by:

- substituting the decay factor value (λ) as a constant into the terms attached to
  - $\beta_{1t}, \left(\frac{1-e^{-\lambda\tau}}{\lambda\tau}\right)$ and $\beta_{2t}, \left(\frac{1-e^{-\lambda\tau}}{\lambda\tau} - e^{-\lambda\tau}\right)$; (27)
- setting these terms as a function of each bond's remaining term to maturity as shown for cell L2 in Table 28, which will provide a β_{1t} weight and β_{2t} weight for every bond in the sample; and
- performing Ordinary Least Squares (**OLS**) regression using the Excel Data Analysis tools' 'Regression' function. The Excel structure for setting out the data to which the OLS regression is applied is shown in Table 34.

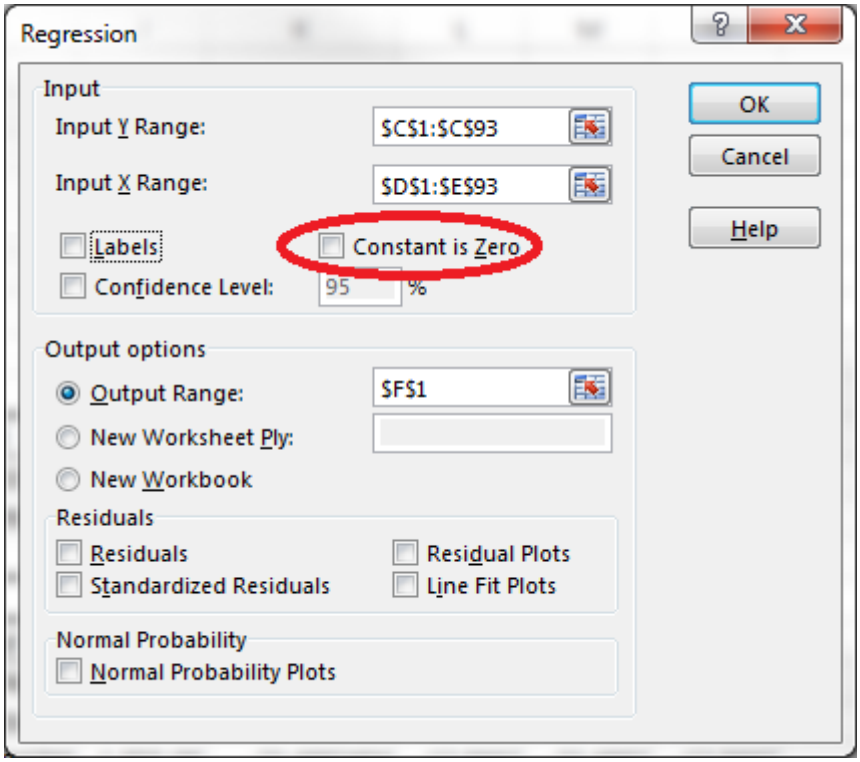
998. The Excel worksheet and regression settings are provided at Table 34 and Figure 20 respectively. The Y input values are the Australian dollar yield equivalents output for each bond as shown in cell R2 in . The X input values are the entire series of β_{1t} and β_{2t} weights associated with each of the bonds. Note that the 'Constant is zero' box shown in Figure 20 should be left unchecked so that an intercept term is included in the regression which will serve as a starting value for β_{0t}.

Table 34 Nelson Siegel Starting Value Regression – Microsoft Excel Template Structure

Attribute	Cell	Formula or entry
Decay factor λ	A1	Link to solution in cell A3 in Table 33.
Maturity (τ)	B1 down	The results of from cell L2 in Table 28
Australian dollar equivalent yield	C1 down	Values in V2 down in Table 30
β_{1t} weight factor	D1 down	=((1-EXP(-$A$1*B1))/($A$1*B1))
β_{2t} weight factor	E1 down	=(((1-EXP(-$A$1*B1))/($A$1*B1))-EXP(-$A$1*B1))

[624] This solution is output in cell A3 in Table 33 once the solver has found a solution.

Figure 20 Nelson Siegel Starting Value Regression – Microsoft Excel Regression Settings



999. The intercept, X Variable 1 and X Variable 2 that appear under the coefficients in the Excel regression output table are used respectively as the starting value estimates for β_{0t}, β_{1t} and β_{2t} in the Nelson Siegel curve fitting process while the value in cell A1 in Table 34 is used as the starting value for λ.[625]

1000. The Excel worksheet that replicates the Nelson Siegel curve fitting process is provided at Table 35.

[625] This is output into cells G17,G18 and G19 in the example set out above.

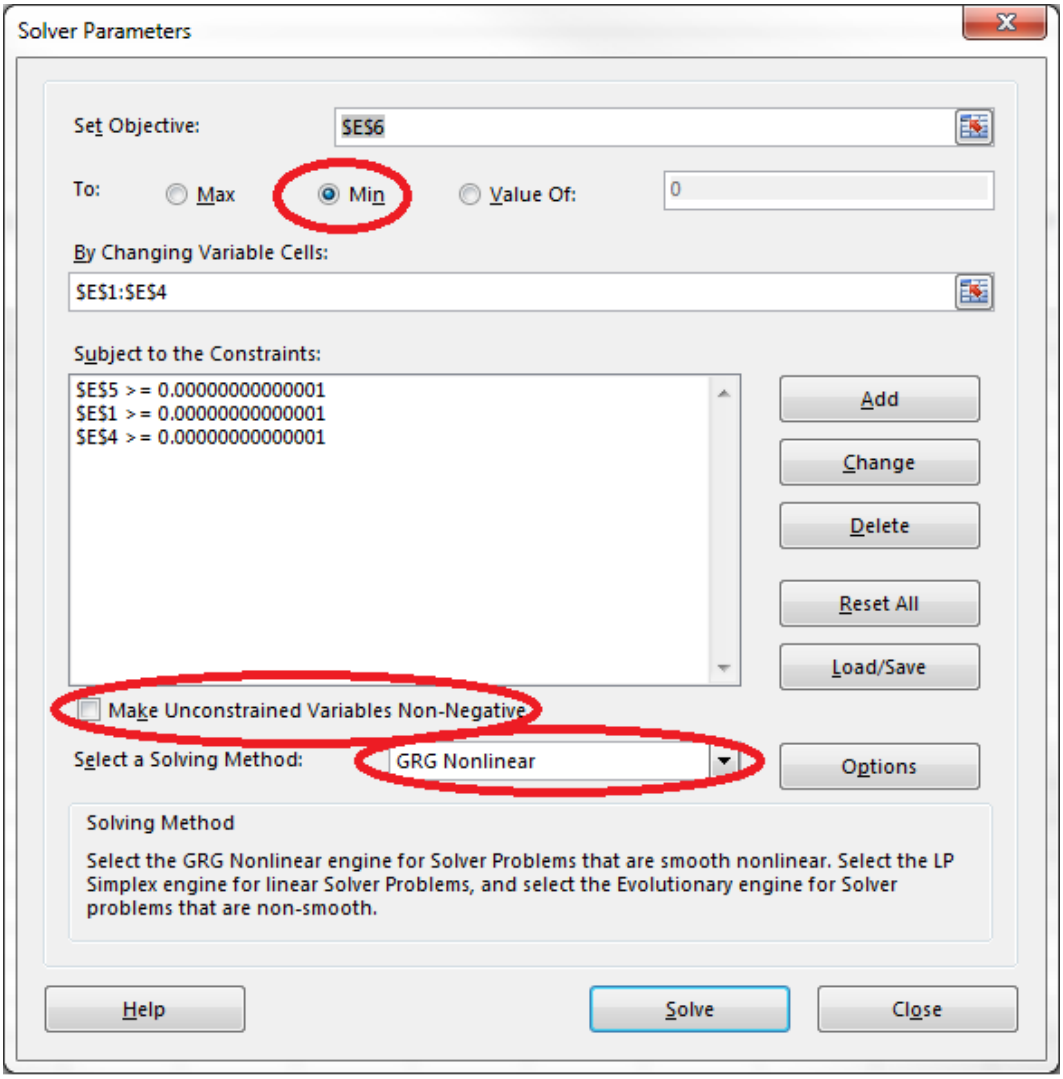
Table 35 Nelson Siegel Curve Fitting Methodology – Microsoft Excel Template Structure

Attribute	Cell	Formula or entry
Remaining Term to Maturity	A1	Values as calculated by cell L2 in Table 28
Australian dollar equivalent yield	B1	Values in V2 down in Table 30
NS Functional Form	C1 down	=$E$1+$E$2*((1-EXP(-$E$4*A1))/($E$4*A1))+$E$3*(((1-EXP(-$E$4*A1))/($E$4*A1))-EXP(-$E$4*A1))
Squared Residual	D1 down	=(B1-C1)^2
β_{0t}	E1	Starting value for β_{0t} calculated above
β_{1t}	E2	Starting value for β_{1t} calculated above
β_{2t}	E3	Starting value for β_{2t} calculated above
λ	E4	Starting value for λ calculated above[626]
$\beta_{0t} + \beta_{1t}$	E5	= E1+E2
Sum of Squared Residuals	E6	=SUM(D:D)

1001. The Excel solver settings (including constraints) that are required to minimize the sum of the squared residuals at cell E6 in Table 35 (by changing the values in the cells E1 through to cell E5) are provided in Figure 21. The associated GRG Nonlinear solver settings are provided at Figure 19.

[626] This cell is linked to the exact solution for the decay factor in order to avoid issues associated with truncating decimal places.

Figure 21 Nelson Siegel Parameter Constraints - Excel Solver Settings



1002. The final solutions for $\beta_{0t}, \beta_{1t}, \beta_{2t}$ and λ in cells E1 to E4 in Table 35 must be entered back into the Nelson Siegel functional form to obtain tenor yields for 3, 5, 7 and 10 year terms.

1003. The Excel Worksheet that calculates the semi-annual yields at each tenor (that is, as if bond interest payment are made every 6 months) is provided at Table 36. The additional Excel calculations that are required to annualise the output values for A2, B2, C2 and D2 in Table 36 (below) so that it represents an effective annual interest rate at each tenor is provided in Table 37 (below).

Table 36 Nelson Siegel Yield Estimation Methodology – Microsoft Excel Template Structure

Attribute	Cell	Formula or entry
Tenor	A1:D1	Values 3, 5, 7 and 10.
3 year AUD yield (semi-annual basis)	A2	=$E1+$E2*((1-EXP(-$E4*A1))/($E4*A1))+$E3*(((1-EXP(-$E4*A1))/($E4*A1))-EXP(-$E4*A1))
5 year AUD yield (semi-annual basis)	B2	=$E1+$E2*((1-EXP(-$E4*B1))/($E4*B1))+$E3*(((1-EXP(-$E4*B1))/($E4*B1))-EXP(-$E4*B1))
7 year AUD yield (semi-annual basis)	C2	=$E1+$E2*((1-EXP(-$E4*C1))/($E4*C1))+$E3*(((1-EXP(-$E4*C1))/($E4*C1))-EXP(-$E4*C1))
10 year AUD yield (semi-annual basis)	D2	=$E1+$E2*((1-EXP(-$E4*D1))/($E4*D1))+$E3*(((1-EXP(-$E4*D1))/($E4*D1))-EXP(-$E4*D1))
β_{0t}	E1	Solution for β_{0t} output in cells E1 Table 35.
β_{1t}	E2	Solution for β_{1t} output in cells E2 Table 35.
β_{2t}	E3	Solution for β_{2t} output in cells E3 Table 35.
λ	E4	Solution for λ output in cells E4 Table 35.

Table 37 Annualising Semi-Annual Bond Yields - Microsoft Excel Template Structure

Attribute	Cell	Formula or entry
3 year AUD yield (annual basis)	A3	=((1+A2/200)^2-1)*100
5 year AUD yield (annual basis)	B3	=((1+B2/200)^2-1)*100
7 year AUD yield (annual basis)	C3	=((1+C2/200)^2-1)*100
10 year AUD yield (annual basis)	D3	=((1+D2/200)^2-1)*100

1004. The value for D3 in Table 37 is the Nelson Siegel 10 year cost of debt estimate. This value averaged with the 10 year cost of debt estimate from the other two methods is the Authority's final 10 year cost of debt estimate.

The Nelson-Siegel Svennson Methodology

1005. The Nelson-Siegel Svennson Methodology assumes that the term structure of the cost of debt has the parametric form shown below:

$$\hat{y}_t(\tau) = \beta_{0t} + \beta_{1t}\left(\frac{1-e^{-\tau/\lambda_1}}{\tau/\lambda_1}\right) + \beta_{2t}\left(\frac{1-e^{-\tau/\lambda_1}}{\tau/\lambda_1} - e^{-\tau/\lambda_1}\right) + \beta_{3t}\left(\frac{1-e^{-\tau/\lambda_2}}{\tau/\lambda_2} - e^{-\tau/\lambda_2}\right) \quad (28)$$

where

$y_t(\tau)$ is the yield at time t for maturity τ ; and

$\beta_{0t}, \beta_{1t}, \beta_{2t}, \beta_{3t}, \lambda_1, \lambda_2$ are the parameters of the model to be estimated from the data.

1006. The Nelson-Siegel Svennson (**NSS**) methodology uses observed data from the bond market to estimate the parameters $\beta_{0t}, \beta_{1t}, \beta_{2t}, \beta_{3t}, \lambda_1$ and λ_2 by using the observed yields and maturities for bonds. A yield curve is produced by substituting these estimates into the above equation and plotting the resulting *estimated* yield $\hat{y}_t(\tau)$ by varying the maturity τ . $\hat{y}_t(\tau)$ has the interpretation of being the *estimated yield* for a benchmark bond with a maturity of τ for a given credit rating.

1007. The NSS methodology uses two decay factors λ_1 and λ_2 . At each annual update the starting values for these parameters are based on the previous years' final estimates. The first estimate will use the values 1.6416 and 4.5834 for λ_1 and λ_2 respectively. The values for these decay factors in the subsequent annual update will use the final values for the decay factors resulting from the process set out below, and so forth for the following years. An exception to this is if the previous years' yield curve estimates are determined to be non-robust as set out in Table 43. In this situation the decay factors λ_1 and λ_2 from the latest set of robust yield curve estimates will be used.

1008. Starting values are still required for β_{1t} , β_{2t} and β_{3t} . These are obtained by:

- substituting the decay factors (λ_1 and λ_2) as substitutes as constants into the terms attached to β_{1t} $\left(\frac{1-e^{-\tau/\lambda_1}}{\tau/\lambda_1}\right)$, $\beta_{2t}\left(\frac{1-e^{-\tau/\lambda_1}}{\tau/\lambda_1} - e^{-\tau/\lambda_1}\right)$ and β_{3t} $\left(\frac{1-e^{-\tau/\lambda_2}}{\tau/\lambda_2} - e^{-\tau/\lambda_2}\right)$;
- setting these terms as a function of each bond's remaining term to maturity as shown for cell L2 in Table 28. This will result in a β_{1t} weight, β_{2t} weight and β_{3t} weight for every bond in the sample.
- performing an Ordinary Least Squares (**OLS**) regression is carried out using the Excel Data Analysis tools' 'Regression' function. The Excel structure for

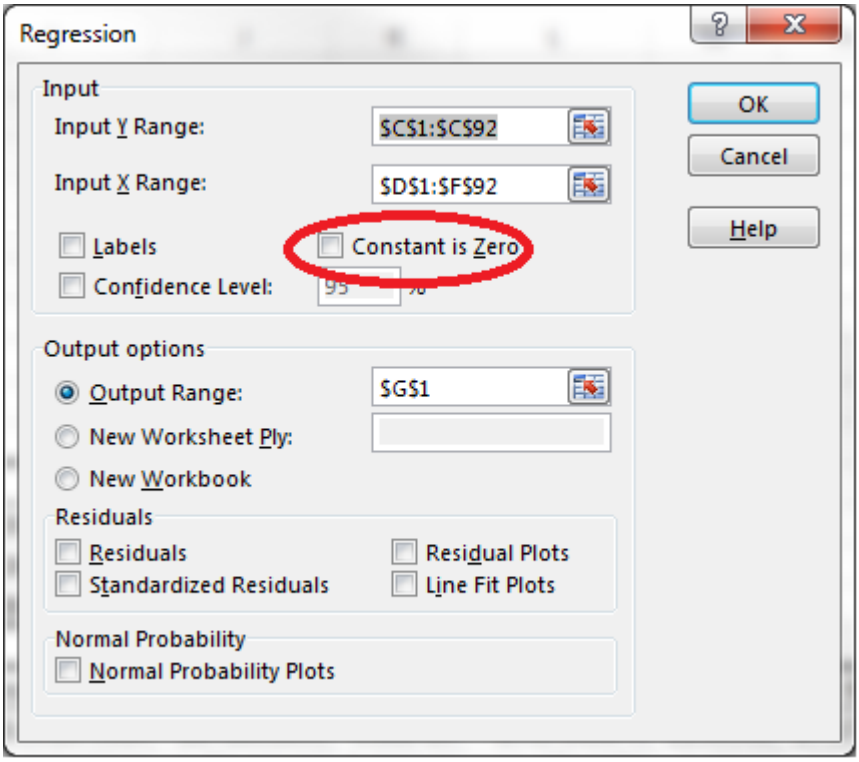
setting out the data to which the OLS regression is applied is shown in Table 38 (below).

Table 38 Nelson Siegel Svennson Starting Value Regression – Microsoft Excel Template Structure

Attribute	Cell	Formula or entry
Decay factor λ_1	A1	Last years' λ_1 .
Decay factor λ_2	A2	Last years' λ_2 .
Maturity (τ)	B1 down	The results of from cell L2 in Table 28
Australian dollar equivalent yield	C1 down	Values in V2 down in Table 30
β_{1t} weight factor	D1 down	=((1-EXP(-B1/$A$1))/(B1/$A$1))
β_{2t} weight factor	E1 down	=((((1-EXP(-B1/$A$1))/(B1/$A$1)))-(EXP(-B1/$A$1)))
β_{3t} weight factor	F1 down	=((((1-EXP(-B1/$A$2))/(B1/$A$2)))-(EXP(-B1/$A$2)))

1009. The Excel worksheet and regression settings are provided at Table 38 and Figure 22 respectively. The Y input values are the Australian dollar yield equivalents output for each bond as shown in cell R2 in Table 29. The X input values are the entire series of β_{1t}, β_{2t} and β_{3t} weight factors associated with each of the bonds. Note that the 'Constant is zero' box shown in Figure 22 should be left unchecked so that an intercept term is included in the regression which will serve as a starting value for β_{0t}.

Figure 22 Nelson Siegel Svennson Starting Value Regression – Microsoft Excel Regression Settings



1010. The intercept, X Variable 1, X Variable 2 and X Variable 3 that appear under the coefficients in the Excel regression output table are used respectively as the starting value estimates for $\beta_{0t}, \beta_{1t}, \beta_{2t}$ and β_{3t} in the Nelson-Siegel Svennson curve fitting process while the values in cell A1 and A2 in Table 38 are used as the starting values for λ_1 and λ_2.[627]

1011. The Excel worksheet that replicates the Nelson-Siegel Svennson curve fitting process is provided at Table 39 (below).

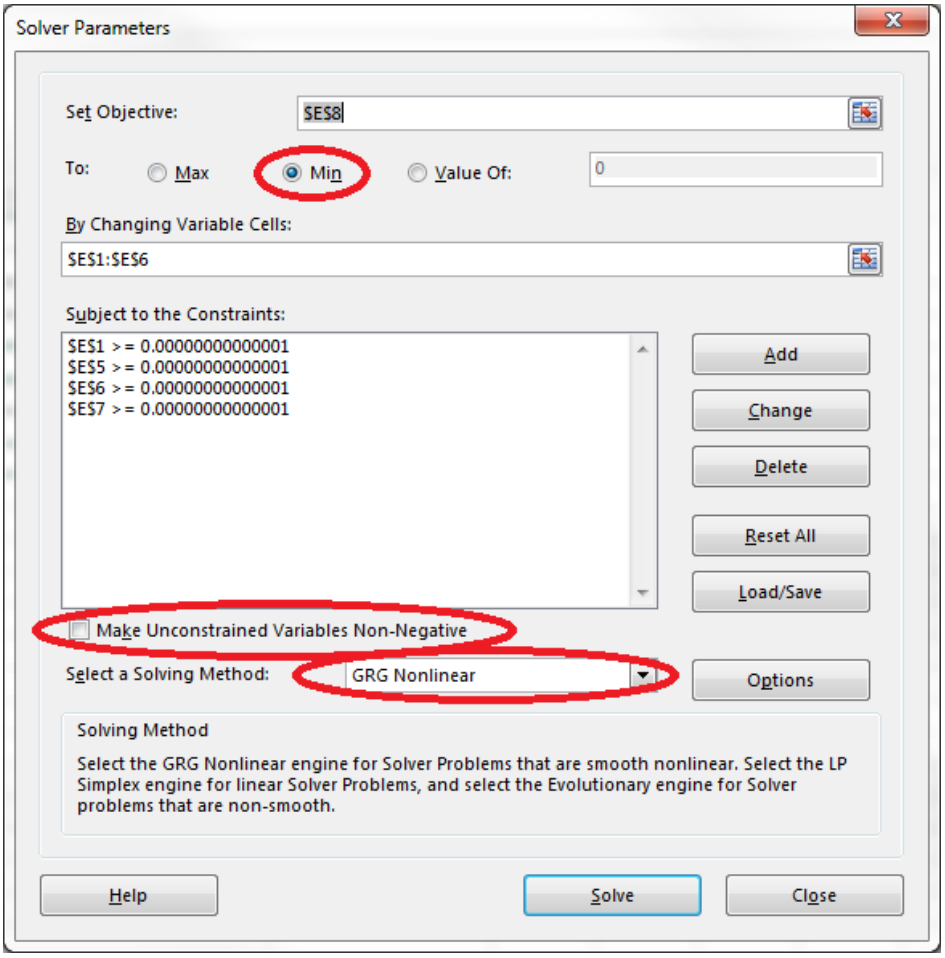
[627] This is output into cells H17, H18, H19 and H20 in the example set out above.

Table 39 Nelson Siegel Svennson Yield Curve Estimation Methodology – Microsoft Excel Template Structure

Attribute	Cell	Formula or entry
Remaining Term to Maturity	A1	Values as calculated by cell L2 in Table 28
Australian dollar equivalent yield	B1	Values in V2 down in Table 30
NSS Functional Form	C1	=$E$1+$E$2*((1-EXP(-A1/$E$5))/(A1/$E$5))+$E$3*((((1-EXP(-A1/$E$5))/(A1/$E$5)))-(EXP(-A1/$E$5)))+$E$4*((((1-EXP(-A1/$E$6))/(A1/$E$6)))-(EXP(-A1/$E$6)))
Squared Residual	D1	=(B1-C1)^2
β_{0t}	E1	Starting value for β_{0t} calculated above
β_{1t}	E2	Starting value for β_{1t} calculated above
β_{2t}	E3	Starting value for β_{2t} calculated above
β_{3t}	E4	Starting value for β_{3t} calculated above
λ_1	E5	Last years' λ_1 .
λ_2	E6	Last years' λ_2 .
$\beta_{0t} + \beta_{1t}$	E7	= E1+E2
Sum of Squared Residuals	E8	=SUM(D:D)

1012. The Excel solver settings (including constraints) that are required to minimize the sum of the squared residuals at cell E8 in Table 39 (by changing the values in the cells E1 through to cell E6) are provided in Figure 23. The associated GRG Nonlinear Solver Settings are provided at Figure 19.

Figure 23 Nelson Siegel Svennson Parameter Constraints – Microsoft Excel Solver Settings



1013. The final solutions for $\beta_{0t}, \beta_{1t}, \beta_{2t}, \beta_{3t}, \lambda_1$ and λ_2 output in cells E1 to E6 in Table 39 must be entered back into the Nelson-Siegel Svennson functional form to obtain tenor yields for 3, 5, 7 and 10 year terms.

1014. The Excel worksheet that calculates semi-annual yields at each tenor (that is, as if bond interest payment are made every 6 months) is provided at Table 40. The additional Excel Calculations that are required to annualise the output values for A2, B2, C2 and D2 in Table 40 (below), so that outputs represent an effective annual interest rate at each tenor, are provided at Table 41 (below).

Table 40 Nelson Siegel Svennson Yield Estimation Methodology – Microsoft Excel Template Structure

Attribute	Cell	Formula or entry
Tenor	A1:D1	Values 3, 5, 7 and 10.
3 year AUD yield (semi-annual basis)	A2	=$E1+$E2*((1-EXP(-A1/$E5))/(A1/$E5))+$E3*((((1-EXP(-A1/$E5))/(A1/$E5)))-(EXP(-A1/$E5)))+$E4*((((1-EXP(-A1/$E6))/(A1/$E6)))-(EXP(-A1/$E6)))
5 year AUD yield (semi-annual basis)	B2	=$E1+$E2*((1-EXP(-B1/$E5))/(B1/$E5))+$E3*((((1-EXP(-B1/$E5))/(B1/$E5)))-(EXP(-B1/$E5)))+$E4*((((1-EXP(-B1/$E6))/(B1/$E6)))-(EXP(-B1/$E6)))
7 year AUD yield (semi-annual basis)	C2	=$E1+$E2*((1-EXP(-C1/$E5))/(C1/$E5))+$E3*((((1-EXP(-C1/$E5))/(C1/$E5)))-(EXP(-C1/$E5)))+$E4*((((1-EXP(-C1/$E6))/(C1/$E6)))-(EXP(-C1/$E6)))
10 year AUD yield (semi-annual basis)	D2	=$E1+$E2*((1-EXP(-D1/$E5))/(D1/$E5))+$E3*((((1-EXP(-D1/$E5))/(D1/$E5)))-(EXP(-D1/$E5)))+$E4*((((1-EXP(-D1/$E6))/(D1/$E6)))-(EXP(-D1/$E6)))
β_{0t}	E1	Solution for β_{0t} output in cells E1 Table 39
β_{1t}	E2	Solution for β_{1t} output in cells E2 Table 39
β_{2t}	E3	Solution for β_{2t} output in cells E3 Table 39
β_{3t}	E4	Solution for β_{3t} output in cells E4 Table 39
λ_1	E5	Solution for λ_1 output in cells E5 Table 39
λ_2	E6	Solution for λ_2 output in cells E6 Table 39

Table 41 Annualising Semi-Annual Bond Yields - Microsoft Excel Template Structure

Attribute	Cell	Formula or entry
3 year AUD yield (annual basis)	A3	=((1+A2/200)^2-1)*100
5 year AUD yield (annual basis)	B3	=((1+B2/200)^2-1)*100
7 year AUD yield (annual basis)	C3	=((1+C2/200)^2-1)*100
10 year AUD yield (annual basis)	D3	=((1+D2/200)^2-1)*100

1015. The value at D3 in Table 41 is the NSS 10 year cost of debt estimate. This value averaged with the 10 year cost of debt estimate from the other two methods is the Authority's final 10 year cost of debt estimate.

Step 5: Estimate the regulatory debt risk premium

1016. The annualized 10 year cost of debt estimate from each of the three methodologies provided above is averaged to arrive at the Authority's final estimate of the 10 year cost of debt. Specifically, this is the simple average of cell F4 in Table 32, D3 in Table 37 and D3 in Table 41. The DRP is then calculated as the spread between the 10 year cost of debt and the average value of the AUD 10 year IRS rate averaged over the same averaging period used for the observed AUD equivalent bond yields above. The average value of the AUD 10 year IRS rate is obtained by downloading AUD 10 year IRS rate data from Bloomberg for each of the trading days in the averaging period; calculating the average of these observations; and then annualising assuming semi-annual payments. The Excel worksheet that calculates the Authority's final estimate of the 10 year cost of debt is provided at Table 42.

Table 42 Debt Risk Premium Calculation - Microsoft Excel Template Structure

Attribute	Cell	Formula or entry
Trading day date	A1 down	dd/mm/yyyy
AUD 10 year IRS rate[628]	B1 down	=BDH("ADSWAP10 Curncy","PX_LAST",A1,A1)
Average (20 day averaging period example)	B21	=AVERAGE(B1:B20)
Annualized average AUD 10 year IRS rate	B22	=((1+B21/100/2)^2-1)*100
10 year final cost of debt estimate	B23	=AVERAGE(Table 6!F4,Table 11!D3,Table 15!D3)[629]
10 year DRP	B24	=B23-B22

1017. The value at cell B24 in Table 42 is the Authority's final 10 year DRP estimate that is used in calculating the return on debt.

Contingency approaches to data related issues

1018. In the event that there are unexpected problems with the data or results of applying the automatic formulas, the Authority will adopt the following actions outlined in Table 43.

628 The Authority uses ADSWAP10 Curncy, PX_LAST data from the Bloomberg terminal. This is the average of the bid and ask rate on the 10 year Australian Dollar interest rate swap rate (mid rate). Further details are - Effective: T + 1, Floating side index: BBSW6M, Day Count ACT/365, payment and reset frequency semi-annual. Fixed side: Day Count ACT/365, payment frequency semi-annual. The default pricing source CMPN – the composite with a close time based on the New York market.

629 This formula assumes that the Excel worksheets have been named after the tables outlined above. For example, Table 6 Linear Interpolation and Extrapolation of Gaussian Kernel Estimates – Microsoft Excel Template Structure is a worksheet in Excel labelled "Table 6". Table 6!F4 makes reference to cell F4 in Table 6.

Table 43 Contingency approaches to data related issues

Event	Changes to Approach
A) No bonds in the sample – resulting from the application of the bond yield approach criteria in Table 1 – have a remaining term to maturity equal to or greater than 10 years (from the last day of the nominated averaging period).	A linear extrapolation will be carried out using the formula outlined below this table. The yield inputs into that formula will be the averages of all three methods (Gaussian kernel, NS and NSS) at: a 7 year tenor (where this means "effective tenor" when applied to the Gaussian kernel); and at the effective tenor (where this means "effective tenor" when applied to the Gaussian kernel) that is equal to the effective tenor that results from adopting a target tenor of 10 years in the Gaussian kernel method. The effective tenor is the weighted average tenor of the sample using the Gaussian kernel weights associated with the target tenor.
B) The number of bonds in the sample result in non-robust parametric curve estimates.	Non-robust is defined as the standard deviation between each of the three yield estimates using each method (Gaussian kernel, NS and NSS reported on a semi-annual basis) being equal to or greater than 105 basis points using the '=stdev' formula in Microsoft Excel.[630] Under this circumstance the averaging period will be extended back into the past by 20 trading day increments at a time, back from the earliest day in the averaging period. The averaging period will continue to be extended this way until the standard deviation between the three estimates falls under 105 basis points.
C) Bloomberg bond data becomes inaccessible.	The Reserve Bank of Australia (**RBA**) 'Aggregate Measures of Australian Corporate Bond Spreads and Yields' bond yield data for the BBB band credit rating will take the place of the Authority's estimates and will be extrapolated to 10 years using the equation outlined in paragraph 1019 below this table.

1019. The following formula allows interpolation to 10 years:

$$y_t(10) = y_t[7] + \left(\frac{y_t[et(10)] - y_t[7]}{et(10) - 7} \right)(10 - 7) \qquad (29)$$

where:

$y_t[et(10)]$ is the average of all three methods estimated cost of debt (as per event A in Table 43) or the RBA's data (as per event C in Table 43).

$et(10)$ is the effective tenor resulting from the 10 year target reported by the Authority's Gaussian kernel approach (as per event A in Table 43) or that

corresponding to the effective tenor corresponding the RBA's 10 year estimate (as per event C in Table 43).

$y_t[7]$ is the average of all three methods estimated cost of debt at a 7 year tenor (as per event A in Table 43) or the RBA's data at the target tenor of 7 years (as per event C in Table 43).[631]

Estimates prior to DRP_{2016}

1020. The Reserve Bank of Australia's (**RBA**) data provides an available source of historic credit spreads for 10 year non-financial corporate bonds. The Authority has determined to adopt the RBA credit spread estimates for the historic DRP estimates – up to 31 May 2016 – for incorporation in the trailing average for this Final Decision.[632]

1021. The RBA monthly estimates for the 10 year BBB spread (the series 'Non-financial corporate BBB-rated bonds – Spread to swap – 10 year') for the period January 2007 to May 2016 are used for estimating the past DRP, prior to the Authority's 10 June 2016 estimate.

1022. The monthly RBA estimates are interpolated to daily estimates, and a simple average of each year of daily observations is then made.

1023. In this case, the DRP_t is estimated as shown below:

$$DRP_t = \frac{\sum_{D=1}^{Days\ in\ year} DRP_D}{Days\ in\ year} \qquad (30)$$

Where

DRP_D is the DRP for day D in regulatory year t.

1024. So for example:

- the average of interpolated daily DRPs for the period 1 January 2007 to 31 December 2007 provides the estimated annual DRP for 2007, which gives the first term DRP_{2007} in the trailing average DRP estimate for 2016, $TA\ DRP_{2016}$;
- it may be noted here that given the automatic formula for the trailing average, the term DRP_{2007} in the trailing average DRP estimate for 2016 would drop out of the trailing average estimate for 2017, $TA\ DRP_{2017}$, and be automatically replaced by the term DRP_{2017};

630 The Authority has added further clarification on this contingency to ensure the yield estimates from the three different methods are used as inputs in the standard deviation formula.

631 Event A requires the procedure outlined above interpolate the cost of debt at the 7 year tenor for the Authority's Gaussian kernel approach. This is not required for the NS and NSS curve 7 year estimates.

632 Reserve Bank of Australia, *Aggregate Measures of Australian Corporate Bond Spreads and Yields - F3*, www.rba.gov.au/statistics/tables/index.html#interest-rates, updated monthly.

- the final term DRP_{2016} in the trailing average DRP estimate for 2016, $TA\ DRP_{2016}$, is given by the daily interpolated RBA estimates for the period 1 January 2015 to 31 May 2016, with daily estimates for the final period of the financial year for 10 June 2016 to 31 December 2016 given by the Authority's 10 June 2016 estimate of the DRP, which is 2.523 per cent. The resulting year of daily estimates is averaged to give the DRP estimate for 2016 for inclusion in the trailing average estimate to apply for calendar year 2016. This is shown in detail in the next section.

Composition of DRP estimators for the AA4 regulatory period

1025. As noted above, the annual update of the trailing average debt risk premium component of the rate of return in each year of the Access Arrangement Period is to be calculated by applying the following automatic formula:

$$TA\ DRP_0 = \frac{\sum_{t=0}^{-9} DRP_t}{10} \quad (31)$$

Where

$TA\ DRP_0$ $TA\ DRP_0$ is the equally weighted trailing average of the DRP to apply in the following year as the annual update of the estimate used in the current year; and

DRP_t is the DRP estimated for each of the 10 regulatory years $t = 0, -1, -2\ldots, -9$.

1026. For the 2016 calendar year estimate (which will apply from 1 January 2016 to 31 December 2016, before being superseded by the 1 January 2017 update), the following estimates are included in the trailing average:

- t=-9: January to December 2007: DRP_{2007}: simple average of (interpolated daily) RBA DRP estimates for the period, annualised;
- t=-8: January to December 2008: DRP_{2008}: simple average of (interpolated daily) RBA DRP estimates for the period, annualised;
- t=-7: January to December 2009: DRP_{2009}: simple average of (interpolated daily) RBA DRP estimates for the period, annualised;
- t=-6: January to December 2010: DRP_{2010}: simple average of (interpolated daily) RBA DRP estimates for the period, annualised;
- t=-5: January to December 2011: DRP_{2011}: simple average of (interpolated daily) RBA DRP estimates for the period, annualised;
- t=-4: January to December 2012: DRP_{2012}: simple average of (interpolated daily) RBA DRP estimates for the period, annualised;
- t=-3: January to December 2013: DRP_{2013}: simple average of (interpolated daily) RBA DRP estimates for the period, annualised;
- t=-2: January to December 2014: DRP_{2014}: simple average of (interpolated daily) RBA DRP estimates for the period, annualised;

- t=-1: January to December 2015: DRP_{2015}: simple average of (interpolated daily) RBA DRP estimates for the period, annualised;
- t=0: January to December 2016: an average of daily DRP estimates (interpolated daily) comprising RBA DRP estimates for the period 1 January to 31 May 2016 and the Authority's current 'on-the-day' DRP estimate (interpolated daily to the prior RBA 31 May 2016 estimate) , annualised.

1027. As noted above, the Authority's 10 June 2016 DRP estimate of 2.523 per cent contributes to the t=0 estimate in the DRP hybrid trailing average, for that period that falls after 31 May 2016 (prior to that date, RBA data is available).

1028. The DRP_t estimates, consistent with the above, contributing to the calendar 2016 trailing average DRP indicative estimate for this Final Decision (which is based on TA $DRP_{2016)}$, and which is estimated as being 2.716 per cent), are published here as follows:

calendar year 2007: DRP_{2007}: 1.130 per cent;

calendar year 2008: DRP_{2008}: 3.756 per cent;

calendar year 2009: DRP_{2009}: 4.624 per cent;

calendar year 2010: DRP_{2010}: 2.125 per cent;

calendar year 2011: DRP_{2011}: 2.379 per cent;

calendar year 2012: DRP_{2012}: 3.168 per cent;

calendar year 2013: DRP_{2013}: 3.043 per cent;

calendar year 2014: DRP_{2014}: 2.251 per cent;

calendar year 2015: DRP_{2015}: 2.070 per cent;

calendar year 2016: DRP_{2016}: 2.612 per cent.