REVIEW OF SUBMISSIONS ON IMPLEMENTATION ISSUES FOR THE COST OF DEBT

Dr Martin Lally
Capital Financial Consultants Ltd

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EXECUTIVE SUMMARY

The Australian Energy Regulator (AER) has recently proposed estimating the cost of debt using a simple average of the Bloomberg Valuation Service (BVAL) and Reserve Bank of Australia (RBA) indexes, extrapolated to ten years if required in accordance with a particular method, and the generation of daily values for the RBA index by interpolating over the adjoining end of month values reported by the RBA. These proposals have generated a number of contrary submissions. This paper has reviewed these submissions and assessed all of the proposals against a set of criteria drawn from the legislative requirements. The conclusions are as follows.

Firstly, of these contrary submissions, I agree only with some aspects of the submissions by Esquant. In particular, I agree that the AER's use of interpolation to produce daily estimates of the cost of debt for the RBA index will produce errors, but this point is already reflected in both my own and the AER's assessment of the pros and cons of the RBA index. Furthermore, the errors identified by Esquant are much less than claimed by them once it is recognized that the cost of debt is estimated through an averaging process. I also agree with Esquant's use of the root mean squared error (RMSE) criterion for assessing the relative merits of the AER and SAPN extrapolation methods to extend the RBA index out to ten years. However, once again, the errors are much less than claimed by Esquant once it is recognized that the cost of debt is determined through an averaging process. Furthermore, the effect of recognizing that averaging process is to promote the AER's extrapolation method from last to first place.

Secondly, the goodness of fit test proposed by CEG and others (which involves selecting bonds in accordance with particular criteria) in order to choose between the RBA and BVAL curves, and also between competing extrapolation methods, conflates the merits of those extrapolation methods with the merits of competing criteria for selecting bonds. It also effectively treats the JGN criteria as the best despite not being used by both the RBA and Bloomberg. Furthermore, if the results of CEG's test are applied to future periods, the period of data examined is too short to warrant such application. Alternatively, if CEG's test is repeated at subsequent points in order to identify the best curve fitting/extrapolation technique at each such point, this would involve various judgements and therefore contravene the requirement in Rule 6.5.2 (1) of the National Electricity Rules (NER) and Rule 87 (12) of the National Gas Rules (NGR) for the process of annually updating the cost of debt to be formulaic.

Thirdly, CEG's claim that Bloomberg has recently extended its cost of debt curve beyond seven years by simply adding the Commonwealth Government Securities (CGS) term spread is both refuted by Bloomberg and rebutted by an examination of BVAL data since Bloomberg extended its curve beyond seven years. In fact, over this period, the BVAL Debt Risk Premium (DRP) for ten-year bonds exceeds that for seven year bonds on every single day and also does so by more on average than does the RBA index.

Fourthly, the analysis undertaken by the QTC in order to choose between the AER and SAPN methods of extrapolating the RBA curve out to ten years bears some connection to the RMSE analysis in Esquant, but without any estimate of bias and an unsatisfactory method for estimating the standard deviation of the estimation errors. Esquant's analysis is therefore superior.

Fifthly, of the criteria for assessing methods for estimating the cost of debt that arise from the legislative requirements, the requirement in Rule 6.5.2 (1) of the NER and Rule 87 (12) of the NGR for a formulaic approach is clearly satisfied by the AER's approach. This requirement also precludes approaches that involve selecting bonds in accordance with particular criteria, and estimating their yields, at various future points in order to assess the best curve fitting/extrapolation method at each particular point in time, because both such steps involve the exercise of judgement.

Sixthly, the remaining criteria arising from the legislative requirements are essentially equivalent and require the cost of debt 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 the face of uncertainty about the true cost of debt of the benchmark entity, one should seek the best available estimate, and best is generally understood to mean minimum RMSE. This is best achieved by equally weighting the RBA and BVAL costs of debt. Esquant uses the same RMSE criterion in assessing competing methods for extrapolating the RBA index out to ten years. When due allowance is made for the averaging process involved in estimating the cost of debt, their work favours the use of the AER's extrapolation method for doing so. Of the other methods proposed for choosing between the

RBA and BVAL indexes, and/or the AER and SAPN extrapolation methods, these are much less satisfactory because they rely upon a goodness of fit test that conflates the merits of curve fitting/extrapolation methods with the merits of different criteria for selecting bonds.

So, the AER's proposed approach satisfies the criteria and these criteria are not satisfied by any other proposed approach.

Finally, I have previously provided advice on these implementation issues to the AER and nothing in these submissions warrants any change in that advice.

1. Introduction

In its recent Rate of Return Guidelines (AER, 2013), the AER proposed switching from setting the cost of debt at the prevailing rate at the beginning of the regulatory cycle to setting it in accordance with an annually revised trailing average, to use an independent third party service provider to estimate the cost of debt, to use a debt term of ten years, and to use a benchmark credit rating of BBB+. Subsequently, the AER (2015, Attachment 3, pp. 191-216) favoured the use of a simple average of the BVAL and RBA indexes to estimate the cost of debt, extrapolated out to ten years if required in accordance with the method presented in Lally (2014, section 7), and the generation of daily values for the RBA index by interpolating over the adjoining end of month values reported by the RBA. These proposals have generated a number of contrary submissions. In accordance with the Terms of Reference (see Appendix), this paper seeks to review these submissions and to assess all proposals against a set of criteria drawn from the legislative requirements.

2. Review of Submissions

2.1 CEG: Extrapolation Methods and the Choice of Curves

CEG (2015b, section 5) compares two methods for extrapolating both the RBA and BVAL costs of debt out to ten years. The first such method (the 'AER' method) is presented in Lally (2014, section 7). Letting 10e denote the effective tenor of the bonds used to estimate the ten-year cost of debt reported by the RBA, RBA(10e) denote the cost of debt estimate for 10e years that is implicit in the RBA index, and $DRP_R(T)$ the RBA's DRP estimate for T years, the AER's extrapolated estimate for the RBA ten year cost of debt is that for 10*e* years plus the incremental base rate (swap) margin from 10*e* to 10 years plus the estimated DRP margin from 10*e* to 10 years as follows:[1]

$$R\hat{B}A(10) = RBA(10e) + Base(10) - Base(10e) + \left[\frac{DRP_R(10e) - DRP_R(7e)}{10e - 7e}\right](10 - 10e) \quad (1)$$

[1] The cost of debt reported in Table F3 of the Reserve Bank's website for ten years is in fact the base rate (swap rate) for ten years plus the DRP estimate for bonds around ten years (10e years), and the DRP on each bond used in this estimate is its yield net of the (interpolated or extrapolated) swap rate for the same term. Thus, the cost of debt reported in Table F3 is in fact the base rate for ten years plus the DRP for 10e years, and therefore is the sum of the first three terms on the RHS of equation (1).

In addition, the AER's extrapolated estimate for the BVAL ten-year cost of debt is that for 7 years plus the incremental base rate (swap) margin from 7 to 10 years plus the estimated DRP margin from 7 to 10 years (using RBA data for the last step) as follows:

$$B\hat{V}AL(10) = BVAL(7) + Base(10) - Base(7) + \left[\frac{DRP_R(10e) - DRP_R(7e)}{10e - 7e}\right](10-7) \qquad (2)$$

$$= BVAL(7) + R\hat{B}A(10) - R\hat{B}A(7)$$

The second extrapolation method is the SAPN method. Letting S_R denote the slope coefficient in a regression of RBA estimates of the DRP against term to maturity, the SAPN estimate for the extrapolated RBA ten year cost of debt is that for 10*e* years plus the incremental base rate (swap) margin from 10*e* to 10 years plus the estimated DRP margin from 10*e* to 10 years as follows:[2]

$$R\hat{B}A(10) = RBA(10e) + Base(10) - Base(10e) + (10 - 10e)S_R \qquad (3)$$

Finally, letting S_B denote the slope coefficient in a regression of the BVAL DRP against term to maturity, the SAPN estimate for the extrapolated BVAL ten-year cost of debt is the BVAL cost of debt for seven years plus the base rate (swap) margin from 7 to 10 years plus the estimated DRP margin from 7 to 10 years as follows:

$$B\hat{V}AL(10) = BVAL(7) + Base(10) - Base(7) + (10-7)S_B \qquad (4)$$

CEG tests the four estimates of the ten-year cost of debt shown in equations (1)…(4) for goodness of fit to DRP data over the period 9 February to 6 March 2015. For each of these four DRP curves implicit in equations (1)…(4), CEG averages over their daily values within the testing period to produce an average curve. CEG then selects bonds in accordance with criteria proposed by JGN (2014, pp. 24-26). For each such bond, its average DRP over the period 9 February to 6 March 2015 is determined. For each of the four curves, the goodness of fit of the curve to the bond DRP data is determined as the weighted sum of the squared differences between each bond DRP and the curve value at the same term to maturity, with the weights chosen so that the average term to maturity is ten years and the standard deviation

[2] Again, the cost of debt reported in Table F3 encompasses the first three terms on the RHS of equation (3).

is 1.5 years. In effect, the key feature of each curve that is being tested is its ability to fit the DRP data for bonds with around ten years to maturity. CEG (2015b, Table 4) reports that the rank ordering from best to worst fit is SAPN (RBA), SAPN (BVAL), AER (RBA), and AER (BVAL). Thus, the SAPN method dominates the AER's method. CEG (2015b, Table 5) also shows that, if the same test is applied to yields on bonds that are selected in accordance with the RBA criteria rather than the JGN criteria, the rank ordering is now AER (RBA), SAPN (RBA), SAPN (BVAL), and AER (BVAL). So, the best approach is now the AER's when applied to the RBA curve. CEG claims that this is to be expected because the RBA curve was constructed to fit the data. Thus, CEG claims that the important result is the first one and that it supports the SAPN extrapolation method over the AER's.

I disagree with CEG's conclusions for three reasons. Firstly, if CEG's conclusion (that the best results are obtained using the SAPN extrapolation of the RBA curve) is intended to be applied to subsequent periods, then the conclusion rests upon a relatively small sample period (one month), this period has a highly unusual feature, and therefore conclusions from it cannot be applied more generally. In particular, during this period, the RBA DRP curve slopes downward from 7e to 10e years despite sloping upwards until that point (CEG, 2015b, Figure 8); this is highly unusual (by examination of the RBA data reported by the RBA since January 2005) and may have contributed to the inferior performance of the AER's extrapolation method at this particular time. Also consistent with this point is the fact that the AER method outperforms the SAPN method applied to the RBA curve over the subsequent period 14 April to 29 May 2015 (CEG, 2015b, Table 11).

Secondly, if CEG intends that the process be repeated at subsequent points at which DRP estimates are required in order to choose the best curve fitting technique (RBA or BVAL) and the best extrapolation method (AER or SAPN) at each such point, by collecting data at each such point in accordance with the JGN criteria and testing for goodness of fit as described above, then such a process does not accord with the formulaic requirement of Rule 6.5.2 (1) of the NER and Rule 87 (12) of the NGR because some judgements are inevitable in determining issues such as whether a bond satisfies the criteria and how to convert yields on bonds issued in foreign currency into Australian currency.[3] CEG (2015b, para 232) alludes to

[3] JGN (2014, page 25) states that the conversion should be performed using a "conventional method". Clearly, this is subjective. Furthermore, as the AER (2015, page 207) notes, there may be multiple such methods and they would presumably yield different results.

this point and appears to accept it because CEG counters with the claim that its process could still be used for the first year of the exercise.

Thirdly, in assessing the merits of a particular extrapolation technique applied to data collected in accordance with particular criteria, one must use similar data or data collected in accordance with similar methodology. However, CEG applies the SAPN or AER extrapolation method to a DRP curve (either the RBA or BVAL) that is fitted to data on bonds selected in accordance with particular criteria (the RBA or BVAL criteria), and then compares the extrapolated curve to DRPs on bonds collected in accordance with quite different criteria (the JGN selection criteria). Thus, CEG are conflating the merits of an extrapolation method with the merits of the criteria for selecting bonds. Furthermore, the effect of using the JGN criteria to choose between the RBA and BVAL curves, and between the AER and SAPN extrapolation methods, is to essentially choose a ten-year DRP that best fits the data arising from the JGN criteria, and this in effect treats the JGN criteria as the best despite not being used by both the RBA and Bloomberg. If the JGN selection criteria are considered to be the best, one should simply fit a curve to the resulting data rather than using these criteria to select bonds, and hence DRPs, in order to choose between existing curves and possible extrapolation methods. Alternatively, if the JGN criteria are considered to be inferior, one should *not* use them to choose between existing curves and possible extrapolation methods.

By way of analogy, if polling company A selects a sample of voters in accordance with criteria X (leading to a prediction for an election of A_X) and polling company B selects a sample of voters in accordance with criteria Y (leading to an election prediction of B_Y), it would not be sensible to choose between these two polling companies by hiring a third one (C), who selects a sample of voters in accordance with criteria Z (leading to an election prediction of C_Z), and then determining which of predictions A_X and B_Y is closer to C_Z. If C is considered the best polling company, one should simply use them. If they are considered inferior to A and B, they should not be used to choose between A and B.

In respect of these differences in criteria, the JGN criteria are clearly more liberal than those of the RBA because they give rise to 157 observations in the period examined by CEG (2015b, Table 3) whilst the RBA criteria give rise to only 62 observations (CEG, 2015b, Figure 10). A comparison of the REU (2014, pp. 8-9) with JGN (2014, pp. 24-26) reveals the particular differences in criteria: relative to the RBA criteria, the JGN criteria admit bonds of any size, any residual term to maturity, the bonds of financial corporations, bonds denominated in British pounds, subordinated bonds, and bonds with floating rate coupons. Furthermore, and again by comparison of the REU (2014, pp. 8-9) and JGN (2014, pp. 24-26), relative to the BVAL criteria, the JGN criteria admit bonds of any size, any residual term to maturity, bonds issued in USD, Euros and British pounds, subordinated bonds, secured bonds, and bonds with floating rate coupons. Low value bonds are likely to experience lower liquidity, and data from such bonds is therefore of lower quality. Furthermore, as discussed in Lally (2013, section 6.5), subordinated bonds are also relatively illiquid and the general practice of assigning a credit rating to these bonds that is one class below that of senior debt of the same company suggests that these ratings for subordinated bonds are not the product of very careful consideration. Thus, data from subordinated bonds is also lower quality.[4] The effect of this point is that the extrapolation method for the RBA's or BVAL's BBB curve that yielded the best fit to a set of bonds with a substantial proportion of lower quality bonds would tend to be the method that best fitted the lower quality data, which is rejected by both the RBA and Bloomberg, and this would tell us nothing about the best extrapolation method for the RBA's or BVAL's BBB curve.

Furthermore, as also discussed in Lally (2013, section 6.5), credit ratings do not reflect the expected recovery rate on bonds in the event of default but DRPs do, subordinated bonds have unusually low recovery rates by virtue of being subordinated, and therefore subordinated bonds with a BBB credit rating could be expected to have unusually high DRPs for that rating category; consequently, their DRPs would overestimate the overall DRP of a firm with a BBB credit rating. The effect of this bias is that the extrapolation method for the RBA's or BVAL's BBB curve that yielded the best fit to a set of bonds with a substantial proportion that were subordinated would tend to be the method with the most significant upward tilt and this would tell us nothing about the best extrapolation method for the RBA's or BVAL's BBB curve. Thus, some of the additional bonds admitted by the JGN criteria are of lower quality than those meeting the RBA and BVAL criteria, and some of them are significantly different. On both counts, no useful conclusions can be drawn from CEG's

[4] As noted in Lally (2014, footnote 2), the exclusion of subordinated bonds from an index imparts a downward bias to the DRP because subordinated bonds are the high risk part of a firm's debt portfolio. Thus the inclusion of subordinated bonds from the same firm as the senior bonds that are included would deal with that bias. However, the indexes in question are for BBB bonds and therefore the inclusion of subordinated bonds would involve combining senior bonds from some firms with subordinated bonds from other firms, and this would not address the problem.

analysis (on bonds selected in accordance with the JGN criteria) about the relative merits of the SAPN and AER extrapolation methods when applied to the RBA or BVAL BBB curves.

To emphasise these points, suppose that one were interested in extrapolating the RBA's DRP curve for BBB bonds, and the results from using the AER and SAPN extrapolation methods were compared with DRPs on bonds with AAA credit ratings. Since such bonds would have lower DRPs than the RBA's BBB curve, the extrapolation method for the RBA's BBB curve that yielded the best fit to such data would be the one with the most significant downward tilt and this would tell us nothing about the best extrapolation method for the RBA's BBB curve. Alternatively, suppose the observations against which extrapolated curves were tested were purely random; the ability of one extrapolated curve to fit this data better than another extrapolated curve would not reveal anything about the relative merits of the two curves. Thus, the data that is used to conduct the test is crucial, the data arises out of particular selection criteria, and JGN's selection criteria differ quite significantly from those of the RBA or BVAL. So, the fundamental question is that of whose selection criteria is best. The AER has elected to choose between independent providers of DRP estimates, and JGN and CEG clearly do not satisfy that test. Even if they did, their expansion of the data set to include subordinated bonds and bonds of low liquidity suggests that their criteria are inferior.

CEG (2015b, page 48) defend the JGN criteria on the grounds that they maximize the data set subject to the bonds being comparable to the benchmark bond (which is BBB). However, the RBA and Bloomberg are engaged in exactly the same process and their selection criteria are much less liberal. Thus, the RBA and Bloomberg implicitly disagree with the JGN criteria. Furthermore, as noted above, the AER has elected to choose between independent providers of DRP estimates, and JGN and CEG clearly do not satisfy that test. Even if they did, their expansion of the data set to include subordinated bonds and bonds of low liquidity suggests that their criteria are inferior.

In an earlier paper CEG (2015a, sections 5.2-5.4) also apply the same type of analysis to the period 2 January to 30 January 2015. This has all the same problems as those just described. In addition CEG (2015a, section 5.5) fits a Nelson-Siegel curve to both the DRP data from bonds selected in accordance with both the JGN criteria and also the RBA criteria (presumably by first averaging over the DRP estimates for each day within the period examined for each bond). Regardless of which of these two data sets is used, the Nelson-

Siegel DRP estimates at ten years are closer to those of the BVAL and RBA curves when the latter are extrapolated out to ten years using the SAPN methodology rather than the AER's methodology. Accordingly, CEG judges the SAPN methodology to be superior. However this analysis suffers from the following drawbacks. Firstly, even when using data collected in accordance with the RBA criteria and extrapolating the RBA curve, CEG is implicitly treating the DRP estimates from the Nelson-Siegel model as the 'truth', against which results from the AER and SAPN extrapolation method are assessed. Clearly, the RBA does not share that view because they use a different methodology for curve fitting. Furthermore, unlike CEG, the RBA's preference for their curve fitting technique is that of an independent party. Secondly, when using data selected in accordance with the JGN methodology, CEG's conclusions are affected by the differences in data selection criteria (RBA versus JGN or BVAL versus JGN) and therefore do not provide any clear evidence on the merits of different extrapolation techniques. Thirdly, if CEG's conclusion (that the best results are obtained using the SAPN extrapolation of the RBA curve over the AER's method) is intended to be applied to subsequent periods, then the conclusion rests upon a relatively small sample period (one month), this sample period has a highly unusual feature, and therefore conclusions from it cannot be applied to other periods. In particular, during this period, the RBA DRP curve slopes downward from 7e to 10e years despite sloping upwards until that point (CEG, 2015a, Figure 9); this is highly unusual (by examination of the RBA data reported by them since January 2005) and may have contributed to the inferior performance of the AER's extrapolation method at this particular time.

CEG (2015a, section 5.6) also undertake a 'paired-bond' analysis on all sets of bonds matched on issuer, credit rating and coupon type, and for which data was available within the period from 2 January to 30 January 2015. Using all such bonds with the same issuer, DRPs were regressed against time to maturity. Across the eight issuers, the resulting slopes were positive in 6/8 cases (CEG, 2015a, Table 8), which is consistent with the result of the SAPN methodology (positive slope) but not the AER's methodology (negative slope). Accordingly, CEG judges the SAPN methodology to be superior to the AER's. However, of the six cases with positive slope, five of them involve matched bonds with terms to maturity of 5-7 years or a subset of this. Furthermore, the RBA DRP curve does not acquire a negative slope until a term to maturity of almost seven years. So, there is no inconsistency between the negative slope of the RBA curve and the positive slope for the matched pairs in all but one case. Furthermore, as noted in the last paragraph, the RBA DRP curve in has a highly unusual feature in January 2015, this may have contributed to the outcome, and therefore CEG's conclusion cannot be extrapolated to other periods.

2.2 CEG: *The Merits of the BVAL Ten Year Curve*

CEG (2015b, section 7) notes that Bloomberg has recently provided costs of debt for BBB bonds beyond seven years, despite lacking bond data beyond that point at the time of the regime change (14 April 2015). In response to a question from CEG as to how Bloomberg could extend its BBB curve beyond the maturity range of the data, Bloomberg responded as follows (ibid, para 269):

> "*On April 14, 2015, BVAL curve methodology has introduced enhancements to curve construction to enable curve derivation for tenors three months to 30 years. Curve derivation is now using the respective government benchmark as the underlying reference curve to enable curve construction over the full maturity spectrum, in the absence of data constituents. That's the reason why you noticed AUD Corporated BBB BVAL curve has suddenly been extended from 7 to 30 years starting from April 14, 2015.*"

CEG (2015b, Figure 18) also shows that the shape of the BVAL curve beyond seven years is almost identical to that of the CGS curve, over the period 14 April to 28 May 2015. On this basis of this Figure 18 and the quoted comments, CEG concludes that Bloomberg is extending its BBB curve beyond seven years merely by adding the CGS term spread beyond that maturity to the BVAL seven-year cost of debt. CEG (2015b, Table 11) then repeats the analysis in their section 5 to the period 14 April 2015 to 29 May 2015 and finds that the BVAL DRP curve around ten years provides an inferior fit to bond data selected in accordance with the JGN criteria than the RBA curve extrapolated to ten years using both the SAPN and the AER methods.[5] CEG concludes that the BVAL curve underestimates the ten-year DRP, that it does so because Bloomberg only adds the CGS term spread beyond seven years, and therefore that the BVAL curve should be rejected in favour of exclusive use of the RBA curve from 14 April 2015.

[5] CEG (2015, page 76) claims that the test was conducted over the period 14 April 2014 to 29 May 2015. However, this cannot be correct because Bloomberg did not extend the maturity range of the BVAL BBB curve beyond seven years until 14 April 2015. Thus, CEG's reference to 2014 must be a typo.

This line of argument suffers from the following drawbacks. Firstly, the test whose results are shown in CEG (2015, Table 11) covers a period of only six weeks, and this is far too short a period to conclude that the BVAL ten-year DRP should be rejected, i.e., the result may be a peculiarity of that short period rather than of the situation in general. Secondly, as discussed in the previous section, this type of test conflates the merits of a curve fitting/extrapolation method with the merits of the competing criteria for selecting bonds. In particular, CEG uses the JGN criteria to select the data against which the extrapolated RBA and BVAL curves are tested, the RBA uses different criteria to JGN, and Bloomberg uses different criteria again. Thus, the inferior performance of the BVAL curve relative to the extrapolated RBA curve may be due to the difference in bond selection criteria. Consequently, no conclusions can be drawn from this test about the merits of any feature of the BVAL curve, most particularly Bloomberg's method for extending it out to ten years.

Thirdly, CEG's claim that Bloomberg extends its curve beyond seven years by simply using the CGS curve is rejected by Bloomberg themselves. In particular, on 12 September 2015, Mr Varun Pawar (Head of Bloomberg Evaluated Pricing, New York) confirmed the following statement put to Bloomberg by the AER:

> "*While the government benchmark (CGS yields) influences the shape of the BVAL curve (as the "underlying reference curve"), the shape of the curve is also influenced at all points along its term structure by the underlying constituent bonds. Therefore, BVAL curve estimates will, at all points along its term structure, reflect both the underlying risk free/base rate component, and a DRP/margin component. Depending on both the underlying constituent bonds and the term structure of the government benchmark, this extrapolation may be either steep or shallow, but it will incorporate both of those inputs*."

Finally, CEG's claim that Bloomberg extends its curve beyond seven years by simply using the CGS curve is rebutted by an examination of BVAL data since Bloomberg first extended its curve beyond seven years (on 14 April 2015). In particular, I obtained the BVAL yields on seven and ten year bonds along with Bloomberg's CGS yields for seven and ten-year bonds for all days over the period from 14 April to 10 September 2015. I then determined the DRP for seven and ten year bonds relative to the CGS yield, and finally the excess of the DRP for ten over seven-year bonds. For each of the months in question, the range of daily results is shown in the second column of Table 1 below. As indicated there, all daily figures are positive and this is inconsistent with CEG's claim. Table 1 also shows the BVAL results for the last business day of each month (penultimate column) and the corresponding values for the RBA DRP relative to CGS. Across the five available observations of this kind, the BVAL end of month DRPs on ten relative to seven-year bonds are larger than those of the RBA. Again, this is inconsistent with CEG's claim. Furthermore, since CEG must have possessed the daily BVAL data for the period 14 April to 29 May 2015 in order to construct their Figure 18, and the data reveals that Bloomberg did *not* form the BVAL ten-year value by adding the CGS 7-10 spread to the BVAL seven-year value, CEG's claim that they did so is rather remarkable as is their decision to present this data in a form that supports that claim.

Table 1: DRP Margins on Ten Versus Seven Year Bonds

Month	BVAL Range	BVAL	RBA
April	.02-.04%	.03%	.10%
May	.01-.07%	.07%	.07%
June	.02-.10%	.09%	.06%
July	.04-.11%	.04%	-.05%
August	.04-.14%	.12%	-.02%
September	.12-.14%		
Average		.07%	.05%

In summary, CEG's claims concerning Bloomberg's behaviour is not correct and the test reflected in their Table 11 is deficient. Consequently, I continue to favour recourse to both the RBA and BVAL curves.

2.3 Esquant: *Extrapolation Methods*

Esquant (2015) examines three methods to extrapolate the RBA curve to ten years: Local Linear Smoothing, SAPN and AER.[6] Esquant uses yields on bonds collected in accordance

[6] Esquant refers to the latter as the Lally method. However, consistent with the terminology in other papers, I refer to it as the AER's method.

with the RBA criteria for the month ends of November 2013 through to January 2015.[7] For each month's yield data, a Nelson-Siegel model is fitted. From this is estimated the standard deviation of the residuals (bond yield net of the curve value at the same term to maturity) and a measure of the curvature of the curve at ten years. These parameter estimates are then inserted into the formulas for the variance and bias of the estimated DRP at ten years under each of the three extrapolation methods, and hence into the formula for the RMSE under each extrapolation method.[8] The result (on average over the 15 months examined) is that the SAPN method is the best, followed by local linear and then the AER's method, with (average) RMSE values of 0.20, 0.23, and 0.25. On this basis, Esquant (2015, Table 1) favours the SAPN extrapolation method applied to the RBA index.

Esquant's analysis has the following shortcoming. Equant's RMSE formulas are for the estimated DRP at a single point in time for ten years to maturity, and therefore assume that prices are set based upon that single estimate. However, this is only the case at the commencement of the transition to the trailing average approach and only if the estimate for the DRP is based upon data for a single month end. In all other circumstances the results for multiple months per year are averaged over a period that eventually lengthens to ten years, to produce a ten-year trailing average cost of debt, and this is then used to set prices. If estimates of the DRP at different points are statistically independent, this averaging process reduces the variance term in inverse proportion to the number of observations used in the averaging period. To analyse the effect of this averaging, I estimate the bias and variance terms within the RMSE for each extrapolation model, averaged over the 15 months examined by Esquant. For example, for the AER's model, the RMSE for a particular month is:

$$RMSE(AER) = \sqrt{B_{AER}^2 G_{10}^2 + V_{AER} S_e^2}$$

[7] Esquant uses data over a period of 15 months and also uses data collected in accordance with the RBA criteria in order to test extrapolation methods applied to the RBA curve. This contrasts with CEG, who use data over a much shorter period and fail to match the data collection criteria as discussed earlier. On both points, Esquant's analysis is superior.

[8] The RMSE (root mean squared error) is the square root of the MSE (mean square error), and the latter is the expectation over the squared differences between the outcomes of an estimation process and the corresponding true values. So, the MSE is the sum of the squared bias in the estimation method and the variance of the estimation method. Both bias and variance are undesirable and therefore the best estimation method has the lowest RMSE. The RMSE or equivalently the MSE is the standard criterion for assessing competing estimation methods.

where B_{AER} is a bias multiplier that is unique to the AER's extrapolation model, V_{AER} is a variance multiplier that is unique to the AER's extrapolation model, G_{10} is a measure of the curvature of the Nelson-Siegel curve at ten years to maturity (the second derivative), and S_e is the standard deviation of the residuals around the Nelson-Siegel curve. Each of these four parameters varies by month. So, I average over the monthly estimates of them, to yield values of -2.10, -.011, .244, and .499 respectively (from Esquant, 2015, Table 4 and Table 9). Substitution into the last equation then yields the RMSE for the estimated DRP at ten years to maturity, using the AER's extrapolation method, of 0.248 as follows:

$$RMSE(AER) = \sqrt{((-2.10)^2(-.011)^2 + (.244)(.499)^2} = \sqrt{.023^2 + .061} = .248$$

Application of the same process to the Local Linear and SAPN methods yields RMSE values:

$$RMSE(LL) = \sqrt{((-2.24)^2(-.011)^2 + (.214)(.499)^2} = \sqrt{.025^2 + .053} = .232$$

and

$$RMSE(SAPN) = \sqrt{((-4.45)^2(-.011)^2 + (.152)(.499)^2} = \sqrt{.049^2 + .038} = .201$$

These RMSE values are almost identical to the average values reported in Esquant (2015, Table 9). As stated by Esquant, the lowest RMSE is that of the SAPN method. I now consider the consequences of averaging over ten observations (these could be all in the first year, or two per year for five years, etc), which implies dividing the variance terms in each of the last three equations by 10. The results are shown in the central column of Table 2. The best method is now Local Linear Smoothing. Finally, I consider the consequence of averaging over 120 observations (one per month for ten years), and the results are shown in the last column of Table 2. The best extrapolation method is now the AER's. Thus, once the averaging process used to estimate the cost of debt is recognized and applied to the maximum possible extent, the ranking of methods reverses, with the AER's method moving from last to first place and the SAPN method experiencing the opposite. This occurs because the AER's method has the lowest bias and the highest variance.[9] So, the reduction in variance arising from more observations in the averaging process is most favourable to the AER's method.

[9] Interestingly, Esquant (2015, Table 1) claims that Local Linear Smoothing has the lowest bias, but this is inconsistent with the average bias coefficients in their Table 9.

Table 2: RMSE for Various Extrapolation Methods

	Number of Observations		
	1	10	120
AER	.248	.081	.032
Local Linear Smoothing	.232	.077	.032
SAPN	.210	.079	.052

Examining the results in Table 2, the AER's method will be mildly inferior to the SAPN method in the first year but will dominate it well before the end of the ten-year transitional period, and therefore should be preferred now if one method is to be consistently used over the entire transition period. In addition, the AER's method is marginally inferior to Local Linear Smoothing in the first year, equally good by the end of the transitional period, and simpler to both implement and understand. So, it should also be preferred to Local Linear Smoothing. Furthermore, since the averaging process is repeated each year, one might also consider the RMSE from the average such outcome over several years. If so, this would tilt the decision even more in favour of the AER's extrapolation method.

Esquant (2015, page 7) clearly understands that the effect of averaging over data is to favour the AER's method. However, they never quantify this effect. Esquant (2015, page 5) also understands that there will be a transition towards a ten-year trailing average. However, they do not seem to have fully connected these two points, and therefore favour the SAPN method because it has the lowest RMSE when one observation on the ten-year cost of debt is made.

Notwithstanding these points, the differences between these RMSE results in absolute terms (for a given number of observations) are small. In particular, even with one observation, the maximum RMSE difference is between the SAPN and AER methods and this is only 4 basis points. Furthermore, these results are contingent upon the use of the Nelson-Siegel approach to model the yield curve, and therefore the RMSE results might be different if a different modelling approach had been used.

2.4 Esquant: Interpolation Methods

Esquant (2014, section 5) reviews the AER's process to obtain daily data for the RBA index, which involves interpolating over beginning and end month values to obtain 'observations' for a particular day within that month. Esquant examines 162 months of daily Bloomberg BBB FV data. Defining C_t as the average of the beginning and end month values for month t and AV_t as the average over all daily observations for month t, Esquant defines the relative error for month t as follows:

$$RE_t = \frac{C_t - AV_t}{AV_t}$$

Esquant determines the distribution of such errors over the 162 months, and notes that 30% of these relative errors exceed 5%. Since the distribution shown in Esquant (2014, Figure 14) is approximately normal, and 32% of normally distributed errors exceed one standard deviation, this implies that the standard deviation of the relative errors is approximately 5%. If prices are set using the RBA's values at the beginning and end of one month, rather than the average of the daily observations during that month, the DRP error arising from the lack of daily observations accords with Esquant's analysis. However, this is never the case. At the very least, the AER proposes to average over the BVAL and RBA values for a period of one month. Since the BVAL data is daily, there is no such error arising from this data and this reduces the standard deviation of the error by 50% as follows:

$$\sigma(.5RBA + .5BVAL) = \sqrt{Var(.5RBA + .5BVAL)} = .5\sigma(RBA) = .5(.05) = .025$$

Furthermore, even for the first year of the transitional period, up to 12 months of data may be used to determine the cost of debt for that year, and this further reduces the standard deviation of the estimation error below 5%. Furthermore, after a ten-year transitional period, the cost of debt will be a ten-year trailing average, and this further reduces the standard deviation of the estimation errors. If only one month's data per year is used in a ten-year trailing average, and also (reasonably) that the annual estimation errors are uncorrelated, the standard deviation of the estimation error will then be .008 as follows:

$$\begin{aligned}\sigma(.05RBA_1 + .05BVAL_1 + ... + .05RBA_{10} + .05BVAL_{10}) &= \sigma(.05RBA_1 + ...05RBA_{10})\\ &= \sqrt{10}(.05)\sigma(RBA)\\ &= \sqrt{10}(.05)(.05)\end{aligned}$$

$$= .008$$

Thus the estimation errors are far smaller than claimed by Esquant. Furthermore, regardless of size, their existence was acknowledged in Lally (2014, section 2.1) and included amongst the points favouring the BVAL over the RBA index.

2.5 QTC

The QTC (2014) compares the AER's method for extrapolating the RBA curve out to ten years with the SAPN extrapolation method shown in equation (3).[10] Using data from January 2005 to July 2014, the QTC finds that the SAPN slope estimates are less variable over time than that of the AER's method (the standard deviation is about 70% less) and therefore concludes that they are superior estimates.

I do not think that this is a sensible test for two reasons. Firstly, the QTC's approach implies that the best estimator would be one with no variation in outcomes over time. Clearly, this would not be desirable because the parameter that is being estimated does vary over time, and therefore a perfect estimator would also have to vary over time. The important aspect of variation is the standard deviation of the estimation errors rather than variation over time.

Secondly, in assessing an estimator, the standard deviation of the estimation errors is important but so too is bias and the QTC analysis has nothing to offer on this matter. The presence and direction of bias depends upon the nature of the true relationship between the DRP and term to maturity. If this is linear, there is no bias in extrapolation, using more than the two points that the AER does in its extrapolation method (the DRPs at nominal tenors of seven and ten years) would yield a lower standard error on the estimate, and therefore support the SAPN approach over the AER's. By contrast, if the true relationship between the DRP and term to maturity were concave downwards, both approaches would have upward bias in their estimates and it would be worse for the SAPN approach because it used data over a wider range up to ten years. A priori, the last case should hold otherwise the DRP would go to infinity as the term to maturity goes to infinity (and this has not occurred with infinite life bonds). Furthermore, Esquant's (2015, Table 9) analysis is consistent with this downward

[10] The QTC does not refer to this approach as the SAPN approach, but it is the same method and I therefore refer to it as such.

concavity in that the second derivative of the Nelson-Siegel curve at ten years is negative for every month examined.

The QTC's work reveals that the greatest difference in the extrapolation margins between the AER and SAPN methods would have occurred in late 2008 and early 2009, when the AER's extrapolation margin was 1.40% and the SAPN margin was only 0.25% (QTC, 2014, Figure 4 and Figure 5). An examination of the RBA data for 3, 5, 7 and 10 years at that time provides the explanation. For example, in December 2008, the DRP values for these target terms were 6.91%, 7.90%, 5.64%, and 8.97% respectively. Clearly, the figure for seven years is wrong and has induced significant overestimation in the extrapolation margin using the AER's method. By contrast, the extrapolation margin arising from the SAPN method is much less because it is largely shielded from the error in the seven-year data. So, the error was substantial and arose from the AER's method. However, the approach by Esquant (2015) as described in the previous section is far superior, in that it uses the generally accepted criterion of minimum RMSE, and RMSE incorporates both bias and standard deviation in estimation errors. Furthermore, the extreme circumstances in late 2008 and early 2009 as described above contribute to the lower standard deviation on the residuals in the SAPN method relative to the AER's method. However, the SAPN method has greater bias, and the net effect (embodied in the RMSE) favours the AER's method once the averaging process used to determine the trailing average cost of debt is recognized.

2.6 Ausnet

Ausnet (2015, pp. 343-344) favours the SAPN extrapolation methodology in general on the basis of CEG's (2015a, sections 5.2-5.4) analysis of data in January 2015. However, as discussed in section 2.1, CEG's analysis conflates the merits of curve fitting/extrapolation methods with the merits of competing criteria for selecting bonds, and its conclusions (even if valid for the period examined) should not be extrapolated to other periods because the period examined is too short.

2.7 Citipower

Citipower (2015, pp. 234-235) favours repetition of the CEG (2015a, sections 5.2-5.4) analysis on all periods in which DRPs are required, especially when the results of the two extrapolation methods (AER and SAPN) are materially different. However, as discussed in section 2.1, CEG's analysis conflates the merits of curve fitting/extrapolation methods with the merits of competing criteria for selecting bonds, and application of the same approach to future periods would also violate the requirement in Rule 6.5.2 (1) of the NER and Rule 87 (12) of the NGR for the annually updated cost of debt to be determined in a formulaic fashion.

2.8 Jemena Electricity Networks

JEN (2015, pp. 96-101) argues that, in choosing between competing providers of DRP data and extrapolation methods for their curves (where necessary), it is important to perform a contemporaneous comparison of such curves with traded bond data, and cites the ACT (2010, 2011) in support of this. Accordingly, JEN favours determining the results from the RBA and BVAL curves at ten years under each of the AER and SAPN extrapolation methods, at each point at which a DRP is required. If the four results do not differ materially (as defined in a particular way), they should be averaged. If not, all independent entities providing yield data on BBB Australian corporate bonds during the relevant period should be identified, bonds should be selected in accordance with particular criteria, their yields determined and then the independent data source (subject to using either the AER or SAPN extrapolation methods out to ten years, if required) providing the best fit to the yield data around ten years to maturity is selected.

This approach has the following drawbacks. Firstly, there may be circumstances in which reasonable people disagree over the set of independent providers for the yields on BBB Australian corporate bonds, in which case JEN's proposal does not have the required formulaic feature of Rule 6.5.2 (1) of the NER and Rule 87 (12) of the NGR, which requires the automatic operation of a formula in annually resetting the cost of debt within the regulatory control period. Secondly, the ACT's (2010, para 77; 2011, para 53) advice to perform a contemporaneous comparison of curves with traded bond data predates Rule 6.5.2 (1) of the NER and Rule 87 (12) of the NGR, which came into effect in November 2012, and is therefore irrelevant if it does conflict with the requirement for the automatic operation of a formula (which it does). Thirdly, and most importantly, JEN's testing process is essentially the same as that proposed by CEG (2015b) and therefore suffers from the crucial drawback discussed earlier; the bond selection criteria of JEN, RBA and BVAL are all different, this will influence the results, and therefore the proposed testing process conflates the merits of a curve fitting/extrapolation method with the merits of the competing criteria for selecting bonds. A proper test of competing curve fitting/extrapolation methods requires holding constant the bond selection criteria. This has been done by Esquant (2015), who select an extrapolation method for the RBA curve by using bond yield data from bonds selected in accordance with the RBA criteria. Furthermore, when due allowance is made for the averaging process used to determine the cost of debt, Esquant's results favour the AER's extrapolation method over the SAPN method.

2.9 United Energy

UED (2015, pp. 24-30) favours a similar process to that of JEN, in choosing between independent providers of DRP curves according to their goodness-of-fit to data collected in accordance with particular criteria, but subject to dispensing with the preliminary test of materiality in differences and also augmenting the set of independent providers by the results from Nelson-Siegel and par yield curves (applied to bond yields on bonds selected in accordance with criteria determined by Esquant (2013)). In addition, UED (2015, page 29) also states that, "notwithstanding the goodness-of-fit tests…precedence will be given to the results from the Nelson-Siegel yield curves and from par yield curves…".

This approach has the following drawbacks. Firstly, the requirement to annually determine the set of independent data providers violates the requirement in Rule 6.5.2 (1) of the NER and Rule 87 (12) of the NGR for the annual updating of the cost of debt to be formulaic. Secondly, the process involved in testing for goodness of fit also violates the formulaic requirement in the NER and NGR. Thirdly, the requirement to give precedence to the results from the Nelson-Siegel yield curves and from par yield curves requires judgement over when these results would supplant all others, and therefore also violates the formulaic requirement of the NER and NGR. Fourthly, as discussed in section 2.1, the goodness of fit test conflates the merits of curve fitting/extrapolation techniques with the merits of competing criteria for selecting bonds. Fifthly, the Nelson-Siegel and par value curves are fitted to data selected in accordance with criteria chosen by Esquant (2013), who in turn have acted as advisors to UED and other regulated businesses. UED is clearly alive to the possibility that Esquant's work might not be viewed as that of an independent provider and states that this work "..should be regarded as an independent and credible data source..". However, in my view, an entity hired by a regulated business is not an independent provider and UED cannot turn black into white merely by saying that it should be regarded as white. Thus, Esquant's work is not that of an independent provider, and therefore fails a test that is imposed by UED. Furthermore, even if one accepts that UED sincerely believes Esquant to be an independent provider, the fact that UED's view differs from mine highlights the fact that the process of selecting all independent data providers requires judgement, and therefore is inconsistent with the formulaic requirement in Rule 6.5.2 (1) and Rule 87 (12) of the NGR.

2.10 Ergon Energy

Ergon Energy (2015, page 26) supports the SAPN extrapolation method over the AER's, on the basis of the analysis in the QTC (2014). As discussed in section 2.5, the QTC analysis is inferior to that of Esquant (2015), and the latter work favours the AER's extrapolation method over SAPN's when the averaging process used in determining the cost of debt is recognized.

2.11 SA Power Networks

SAPN (2015, pp. 389-391) favours a simple average of the extrapolated RBA curve and the extrapolated BVAL seven year curve rather than the extrapolated RBA curve and the BVAL ten-year curve, on the same grounds argued by CEG (2015b, section 7). However, as discussed in section 2.2, CEG's arguments for rejecting the BVAL curve are unwarranted. SAPN also favours the SAPN extrapolation method applied to the RBA and seven-year BVAL curves, for all periods, on the basis of the analysis by CEG (2015b, section 5) over the period 9 February 2015 to 6 March 2015. However, as discussed in section 2.1, CEG's analysis conflates the merits of curve fitting/extrapolation methods with the merits of competing criteria for selecting bonds, and its conclusions (even if valid for the period examined) should not be extrapolated to other periods because the period examined is too short.

2.12 ActewAGL

ActewAGL (2015, section 7) favours essentially the same process as JEN, as described in section 2.8. The drawbacks in JEN's analysis have been outlined in that section, and equally apply here. Interestingly, ActewAGL quotes the AER's (2015, pp. 204-207) concerns about JEN's proposal, and then repeats its claim that its proposed process is objective without addressing any of the AER's specific concerns on that matter. ActewAGL also characterizes its proposed approach as choosing a provider and method that "best fits the underlying market data". However, the "underlying market data" do not come labelled as such. They arise from the selection criteria that are adopted, and there are many choices. Each data provider has different criteria, and therefore different definitions of the "underlying market data". If the data implied by the RBA criteria is X, and that implied by the BVAL criteria is Y, there is no merit in ActewAGL defining the underlying market data to be Z, and testing the RBA and BVAL curves against Z; finding the RBA curve to be the better fit, for example, could arise merely because the RBA selection criteria were closer to that of Z than the BVAL's criteria, and this does not imply that the RBA's criteria are better than BVAL's.

2.13 Australian Gas Networks

AGN (2015, section 10.5) favours repetition of the CEG (2015a, sections 5.2-5.4) analysis for each period in which the DRP is estimated. However, as discussed in section 2.1, CEG's analysis conflates the merits of curve fitting/extrapolation methods with the merits of competing criteria for selecting bonds, and application of the same approach to future periods would also violate the requirement in Rule 6.5.2 (1) of the NER and Rule 87 (12) of the NGR for the annually updated cost of debt to be determined in a formulaic fashion.

2.14 Amadeus

Amadeus (2015, pp. 142-143) favours the RBA over the BVAL index because its methodology is transparent, the sample size is larger due to the inclusion of foreign currency bonds, and it provides estimates for longer terms to maturity. However, these comments represent a small subset of the entire set of differences between the two indexes and a comprehensive assessment of all points of difference does not suggest that either index is superior (Lally, 2014, section 2.1).

3. Assessment of Proposed Approaches Against Relevant Criteria

The AER has identified a number of criteria drawn from the legislative requirements, against which methods for estimating the cost of debt should be assessed. These are as follows:

(1) The method will or is likely to promote efficient investment in, and efficient operation and use of, electricity and gas services for the long term interests of consumers.
(2) The method is likely to provide service providers with a reasonable opportunity to recover at least the efficient costs the operator incurs in providing regulated network services.
(3) The method is likely to provide a return commensurate with the regulatory and commercial risks involved in providing regulated network services.

(4) The method produces a return on debt 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 regulated network services. The AER defines a benchmark efficient entity as a pure play, regulated energy network business operating within Australia. The AER also considers a benchmark efficient entity would have a BBB+ credit rating and a 10 year debt term.

(5) The method is capable of producing annual changes in revenue through the automatic application of a formula specified in the regulatory determination. That is, whether the approach can be fully specified upfront in the regulatory determination such that no judgement or discretion is required to annually update the return on debt each year, and therefore there are no elements of the approach which are open for debate or dispute in applying the pre-specified approach.

The last criterion requires a formulaic approach and is therefore clearly satisfied by the AER's approach. This criterion also precludes many of the alternative approaches proposed. In particular, it precludes the approaches favoured by Citipower, JEN, United Energy, ActewAGL, and AGN. Each of these latter approaches involve selecting bonds in accordance with particular criteria, and estimating their yields, at various future points in order to assess the best curve fitting/extrapolation method at each particular point in time, and both steps involve the exercise of judgement.

The first four criteria listed above are essentially equivalent, and are most fully expressed in the fourth criterion. In the face of uncertainty about the true cost of debt of the benchmark entity, one should seek the best available estimate, and best is generally understood to mean minimum RMSE (Ferguson, 1967, page 11). As argued in Lally (2014, section 2.2), this is best achieved by equally weighting the RBA and BVAL costs of debt. Esquant (2015) uses the same RMSE criterion in assessing competing methods for extrapolating the RBA index out to ten years. When the averaging process used in determining the cost of debt is recognized, their work supports the use of the AER's extrapolation method for doing so. Of the other methods proposed for choosing between the RBA and BVAL indexes, and/or the AER and SAPN extrapolation methods, those of CEG, Ausnet, Citipower, JEN, UED, SAPN, ActewAGL, and AGN are much less satisfactory because they rely upon a goodness of fit test that conflates the merits of competing curve fitting/extrapolation methods with the merits of different criteria for selecting bonds. Finally, the QTC's proposal (which is also favoured by

Ergon Energy) is inferior to Esquant's MSE test because there is no allowance for bias and the estimate for the standard deviation of the estimation errors is deficient.

In summary, these five criteria listed above are satisfied by the AER's proposed approach and are not satisfied by any other proposed approach.

4. Conclusions

The AER has recently proposed estimating the cost of debt using a simple average of the BVAL and RBA indexes, extrapolated to ten years if required in accordance with a particular method, and the generation of daily values for the RBA index by interpolating over the adjoining end of month values reported by the RBA. These proposals have generated a number of contrary submissions. This paper has reviewed these submissions and assessed all of the proposals against a set of criteria drawn from the legislative requirements. The conclusions are as follows.

Firstly, of these contrary submissions, I agree only with some aspects of the submissions by Esquant. In particular, I agree that the AER's use of interpolation to produce daily estimates of the cost of debt for the RBA index will produce errors, but this point is already reflected in both my own and the AER's assessment of the pros and cons of the RBA index. Furthermore, the errors identified by Esquant are much less than claimed by them once it is recognized that the cost of debt is estimated through an averaging process. I also agree with Esquant's use of the RMSE criterion for assessing the relative merits of the AER and SAPN extrapolation methods to extend the RBA index out to ten years. However, once again, the errors are much less than claimed by Esquant once it is recognized that the cost of debt is determined through an averaging process. Furthermore, the effect of recognizing that averaging process is to promote the AER's extrapolation method from last to first place.

Secondly, the goodness of fit test proposed by CEG and others (which involves selecting bonds in accordance with particular criteria) in order to choose between the RBA and BVAL curves, and also between competing extrapolation methods, conflates the merits of those extrapolation methods with the merits of competing criteria for selecting bonds. It also effectively treats the JGN criteria as the best despite not being used by both the RBA and Bloomberg. Furthermore, if the results of CEG's test are applied to future periods, the period of data examined is too short to warrant such application. Alternatively, if CEG's test is repeated at subsequent points in order to identify the best curve fitting/extrapolation technique at each such point, this would involve various judgements and therefore contravene the requirement in Rule 6.5.2 (1) of the NER and Rule 87 (12) of the NGR for the process of annually updating the cost of debt to be formulaic.

Thirdly, CEG's claim that Bloomberg has recently extended its cost of debt curve beyond seven years by simply adding the CGS term spread is both refuted by Bloomberg and rebutted by an examination of BVAL data since Bloomberg extended its curve beyond seven years. In fact, over this period, the BVAL DRP for ten-year bonds exceeds that for seven year bonds on every single day and also does so by more on average than does the RBA index.

Fourthly, the analysis undertaken by the QTC in order to choose between the AER and SAPN methods of extrapolating the RBA curve out to ten years bears some connection to the RMSE analysis in Esquant, but without any estimate of bias and an unsatisfactory method for estimating the standard deviation of the estimation errors. Esquant's analysis is therefore superior.

Fifthly, of the criteria for assessing methods for estimating the cost of debt that arise from the legislative requirements, the requirement in Rule 6.5.2 (1) of the NER and Rule 87 (12) of the NGR for a formulaic approach is clearly satisfied by the AER's approach. This criterion also precludes approaches that involve selecting bonds in accordance with particular criteria, and estimating their yields, at various future points in order to assess the best curve fitting/extrapolation method at each particular point in time, because both such steps involve the exercise of judgement.

Sixthly, the remaining criteria arising from the legislative requirements are essentially equivalent and require the cost of debt 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 the face of uncertainty about the true cost of debt of the benchmark entity, one should seek the best available estimate, and best is generally understood to mean minimum RMSE. This is best achieved by equally weighting the RBA and BVAL costs of debt. Esquant uses the same RMSE criterion in assessing competing methods for extrapolating the RBA index out to ten years. When due allowance is made for the averaging process involved in estimating the cost of debt, their work favours the use of the AER's extrapolation method for doing so. Of the other methods proposed for choosing between the RBA and BVAL indexes, and/or the AER and SAPN extrapolation methods, these are much less satisfactory because they rely upon a goodness of fit test that conflates the merits of curve fitting/extrapolation methods with the merits of different criteria for selecting bonds.

So, the AER's proposed approach satisfies the criteria and these criteria are not satisfied by any other proposed approach.

Finally, I have previously provided advice on these implementation issues to the AER and nothing in these submissions warrants any change in that advice.

REFERENCES

ACT, 2010. *Application by ActewAGL Distribution [2010] ACompT 4* (http://www.judgments.fedcourt.gov.au/judgments/Judgments/tribunals/acompt/2010/2010acompt0004).

____ 2011. *Application by Jemena Gas Networks (NSW) Ltd (No 5) [2011]* (http://www.judgments.fedcourt.gov.au/judgments/Judgments/tribunals/acompt/2011/2011acompt0010).

ActewAGL, 2015. *Initial Proposal-Appendix 8.01-Detailed Return on Debt Proposal* (www.ear.gov.au).

AER, 2013. *Better Regulation*: *Explanatory Statement Rate of Return Guideline* (www.aer.gov.au).

____ 2015. *Final Decision Jemena Gas Networks (NSW) Ltd Access Arrangement 2015-20 Attachment 3* (www.aer.gov.au).

AGN, 2015. *Attachment 10.1 Rate of Return 2016/17 to 2020/21 Access Arrangement Information* (www.aer.gov.au).

Amadeus, 2015. *Initial Proposal – Access Arrangement Revision Submission* (www.aer.gov.au).

Ausnet, 2015. *Ausnet Electricity Services Pty Ltd*: *Electricity Distribution Price Review 2016-20* (www.aer.gov.au).

CEG, 2015a. *Critique of the AER's Draft Decision on the Cost of Debt*, report prepared for Ausnet (www.aer.gov.au).

____ 2015b. *The Hybrid Method for the Transition to the Trailing Average Rate of Return on Debt*: *Assessment and Calculations for AGN*, report prepared for AGN (www.aer.gov.au).

Citipower, 2015. *Regulatory Proposal 2016-2020* (www.aer.gov.au).

Ergon Energy, 2015. *Submission to the AER on its Preliminary Determination-Rate of Return*: *Cost of Debt* (www.aer.gov.au).

Esquant, 2013. *The Development of Yield Curves, Zero Coupon Yields, and Par Value Yields for Corporate Bonds*, report prepared for United Energy and Multinet Gas (www.aer.gov.au).

_______ 2014. *A Review of Measures of Australian Corporate Credit Spreads Published by the Reserve Bank of Australia*, report prepared for United Energy and Multinet Gas (www.aer.gov.au).

_______ 2015. *Evaluation of Methods for Extrapolating Australian Corporate Credit Spreads Published by the Reserve Bank of Australia*, report prepared for United Energy and Multinet Gas (www.aer.gov.au).

Ferguson, T., 1967, *Mathematical Statistics*: *A Decision Theoretic Approach*, Academic Press, Orlando.

JEN (Vic) Ltd, 2015. *2016-2020 Electricity Distribution Price Review Regulatory Proposal Attachment 9-2 Rate of Return Proposal* (www.aer.gov.au).

JGN, 2014. *2015-20 Access Arrangement Information Appendix 9.10*: *Return on Debt Proposal*, submission to the AER (www.aer.gov.au).

Lally, M., 2013. *Estimating the Cost of Debt of the Benchmark Efficient Regulated Energy Network Business*, report prepared for the AER (www.aer.gov.au).

_______ 2014. *Implementation Issues for the Cost of Debt*, report prepared for the AER (www.aer.gov.au).

Regulatory Economic Unit, 2014. *Return on Debt Estimation*: *A Review of the Alternative Third Party Data Series*, report prepared for the AER (www.aer.gov.au).

SAPN, 2015. *SA Power Networks Revised Regulatory Proposal* (www.aer.gov.au).

UED, 2015. *Rate of Return on Debt*: *Proposal for the 2016 to 2020 Regulatory Period* (www.aer.gov.au).

APPENDIX: Terms of Reference

Services Required

Based on a review of the material listed in the attachment to this request for quote, provide a supplementary report updating the advice provided in November 2013.[11] The report is to:

1. Critically review the AER's position and reasons for:

    a. adopting a simple average of the RBA and BVAL curves
    b. extrapolating and interpolating the RBA curve to produce daily 10 year estimates
    c. adopting the newly published BVAL 10 year curve, instead of extrapolating the BVAL 7 year curve to 10 years

2. Critically review the various alternative methods proposed by service providers in current regulatory determinations on the choice of data series and extrapolation and interpolation adjustments.

3. Explain whether and why your advice and conclusions on the choice of third party data series and extrapolation adjustments are either changed or unchanged from the November 2014 report.

4. Consider the comments in recent submissions from consumer groups and previous decisions of the Australian Competition Tribunal in answering the questions.

5. In answering each of the above questions, compare and contrast the AER's method with the various methods proposed by service providers with current regulatory determinations, and advise on:

    a. Whether the method will or is likely to promote efficient investment in, and efficient operation and use of, electricity and gas services for the long term interest of consumers

    b. Whether the method is likely to provide service providers with a reasonable opportunity to recover at least the efficient costs the operator incurs in providing regulated network services

    c. Whether the method is likely to provide a return commensurate with the regulatory and commercial risks involved in providing regulated network services

    d. Whether the approach produces a return on debt commensurate with the efficient financing costs of a benchmark efficient entity with a similar degree of risk at that which applies to the service provider in respect of the provision of regulated network services. The AER defines a benchmark efficient entity as a pure play, regulated

[11] Lally, *Implementation issues for the cost of debt*, 20 November 2014.

energy network business operating within Australia. The AER also considers a benchmark efficient entity would have a BBB+ credit rating and a 10 year debt term.

e. Whether the approach is capable of producing annual changes in revenue through the automatic application of a formula specified in the regulatory determination. That is, whether the approach can be fully specified upfront in the regulatory determination such that no judgement or discretion is required to annually update the return on debt each year, and therefore there are no elements of the approach which are open for debate or dispute in applying the pre-specified approach.

Attachment—Background documents

Rate of return guideline

Key AER rate of return guideline documents including consultant reports commissioned by the AER are listed in the following table.

Author and document link	Document
AER (2013a)	AER, *Better regulation—Explanatory statement to the draft rate of return guideline*, August 2013, pp.98–115.
AER (2013b)	AER, *Better regulation—Final rate of return guideline*, December 2013, pp.18–22.
AER (2013c)	AER, *Better regulation—Explanatory statement to the final rate of return guideline*, December 2013, pp.126–157.
Lally (2013)	Lally. *Estimating the cost of debt of the benchmark efficient regulated energy network business*, 13 August 2013
Chairmont (2012)	Chairmont, *Debt risk premium expert report*, 9 February 2012.

Recent AER regulatory determinations

Key recent AER regulatory determination documents including consultant reports commissioned by the AER are listed in the following table.

Author and	Document

document link	
(AER 2014)	AER, *Draft decision—JGN access arrangement 2015–20*, November 2014, pp.128–159, 301–308
(AER 2015)	AER, *Final decision—JGN access arrangement 2015–20*, June 2015, pp.191–227.
Lally (2014)	Lally, *Implementation issues for the cost of debt*, 20 November 2014.
REU (2014)	ACCC Regulatory Economic Unit, *Return on debt estimation: A review of alternative third party data series*, August 2014.
Chairmont (2015)	Chairmont, *Cost of debt: Transitional analysis*, April 2015, pp.66–68.

Current regulatory proposals

Key service provider proposal documents are listed in the following table.

Author and document link	Document
Electricity distribution—Victoria	
AusNet	AusNet, *Initial proposal*, April 2015, pp.343–345.
CitiPower	CitiPower, *Initial proposal*, April 2015, pp.234–235. [Note: Powercor's proposal is identical to CitiPower's proposal with respect to return on debt]
JEN	JEN, *Initial proposal—Attachment 9.2—Rate of return proposal*, April 2015, pp.96–101.
UED [Attached]	UED, *Initial proposal—Rate of return on debt attachment*, April 2015, pp.24–30.

Electricity distribution—SA and Queensland	
Ergon	Ergon Energy, *Revised proposal—Appendix C—Rate of return*, July 2015, p.143.
Ergon	Ergon Energy, *Submission to the AER—Rate of return: Cost of debt*, July 2015, p.26.
SAPN	SA Power Networks, *Revised proposal*, July 2015, pp.389–393.
Gas—ACT, SA and NT	
ActewAGL	ActewAGL, *Initial proposal—Appendix 8.01—Detailed return on debt proposal*, June 2015, section 7 [no page numbers].
AGN	Australian Gas Networks, *Initial proposal—Attachment 10.1—Rate of return*, July 2015, pp.51–53, 58.
Amadeus	Amadeus, *Initial proposal—Access arrangement information*, August 2015, pp.28–33.
Amadeus	Amadeus, *Initial proposal—Access arrangement revision submission*, August 2015, pp. 137–147

Key consultant reports submitted or referenced by service providers in support of their proposals are listed in the following table.

Author and document link	**Document**	**Submitted or referenced by**
CEG	CEG, *WACC estimates—A report for NSW DNSPs*, May 2014, pp.39–49.	ActewAGL
CEG	CEG, *Critique of the AER's JGN draft decision on the cost of debt*, April 2015.	ActewAGL AusNet JEN
CEG	CEG, *Memorandum: Extrapolation of the Bloomberg curve to 10 years*, 19 June 2015.	ActewAGL SAPN

CEG	CEG, *The hybrid method for the transition to the trailing average rate of return on debt—Assessment and calculations for AGN*, June 2015	AGN
Esquant	Esquant, *The development of yield curves, zero coupon yields, and par value yields for corporate bonds*, 17 October 2013.	UED
Esquant	Esquant, *A review of measures of Australian corporate credit spreads published by the RBA*, 19 May 2014.	AusNet JEN
Esquant	Esquant, *Evaluation of methods for extrapolating Australian corporate credit spreads published by the RBA*, 27 March 2015	UED
QTC	QTC, *Extrapolating the RBA BBB curve to a 10 year curve*, September 2014.	Energex

Key consumer submissions submitted in current regulatory processes

Author and document link	**Document**
CCP	Consumer Challenge Panel, *sub panel 2—Advice on Energex and Ergon regulatory proposals*, January 2015, pp.9–10
CCP	Consumer Challenge Panel, *Sub panel 3—Response to proposals from Victorian electricity distribution network service providers for a revenue reset for the 2016–2020 regulatory period*, 5 August 2015, pp.63–75, and attachment 1

Previous Tribunal decisions

Key documents from previous Tribunal reviews of the return on debt.

Author and document link	**Document**	**Notes**
Australian Competition Tribunal	Australian Competition Tribunal, *Application by ActewAGL Distribution [2010] ACompT 4.*	Previous Tribunal decision that considered the

		debt risk premium.
Australian Competition Tribunal	Australian Competition Tribunal, *Application by Jemena Gas Networks (NSW) Ltd (No 5) [2011] ACompT 10.*	Previous Tribunal decision that considered the debt risk premium.