IMPLEMENTATION ISSUES FOR THE COST OF DEBT

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EXECUTIVE SUMMARY

In its recent Rate of Return Guidelines, 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. This has led the AER to raise a number of implementation issues with me, and my conclusions are as follows.

Firstly, on the question of which independent third-party data service provider should be used to estimate the cost of debt, eleven points of distinction exist between the Bloomberg Valuation Service (BVAL) and Reserve Bank of Australia (RBA) indexes and examination of these reveals that neither index is clearly superior to the other. I therefore recommend that a combined estimator be used. Since the standard deviations of these estimators are similar and it is not possible to quantify any biases in these two indexes, I recommend that the two indexes be equally weighted. This will lower the Mean Squared Error (MSE) of the estimator relative to using only one of the indexes, and significantly so if the correlation between the indexes is low. The contrary arguments presented by NERA, CEG, ActewAGL, and Directlink in support of sole use of the RBA index do not support their preference, and the approach proposed by Jemena (involving use of the RBA index on some occasions and the BVAL on others) sacrifices the MSE gains from a combined estimator.

Secondly, in respect of the efficient financing mix for the benchmark entity, this involves bank debt, Australian currency bonds and foreign currency bonds so as to mitigate refinancing risk and to benefit from the flexibility of bank debt. The optimal weights will vary over time, in inverse relation to their costs.

Thirdly, in using a cost of debt index that is based upon bonds, as the RBA and BVAL indexes are, bank debt is excluded and this raises the question of whether bias in the allowed cost of debt might arise. However the very reason for excluding bank debt in the assessment of the allowed cost of debt (the lack of secondary market data) also precludes a formal assessment of this potential concern. Furthermore, since bank debt constitutes only about 25% of the debt of regulated firms, this low weighting mitigates any bias arising from its omission from the RBA and BVAL indexes.

Fourthly, if the AER were to use the BVAL index only or average over the RBA and BVAL indexes, the fact that the BVAL index does not include foreign bonds implies that foreign bonds will be underweighted and this raises the question of whether bias in the allowed cost of debt might arise. However, whilst there are good grounds to believe that the cost of local currency bonds does fluctuate relative to that of otherwise identical foreign currency bonds, after the currency swap required to convert foreign-currency bonds to AUD, there are no grounds to believe that there is a systematically higher rate on one or the other. Thus, the omission of foreign currency bonds from the BVAL index should not lead to systematically over or understating the cost of debt for regulated energy network businesses. In addition, even if the AER used only the RBA index, the weights on local and foreign currency bonds within that index may be significantly different to that of bonds in general and these in turn to the currently optimal weights, and this too would introduce bias but again the effect would not be systematic over time.

Fifthly, in relation to the appropriate credit rating for regulated energy network businesses, I do not think that one can differentiate between the gas and electricity businesses at the present time and I therefore favour a credit rating for the entire sector of BBB to BBB+ both at the present time and as an estimate over the next five years.

Sixthly, in respect of whether credit ratings fully reflect the cost of debt, they do not do so because (S&P) credit ratings only reflect the probability of default whilst the cost of debt also reflects the liquidity, presence of call options, presence of conversion options, and the expected loss rate for the bond in the event of default. Furthermore the bonds of regulated energy network businesses are likely to have lower average liquidity than the bonds in the BVAL and RBA sets, and are also likely to have lower than normal expected loss rates for bondholders in the event of default. The first point would lead to the BVAL or RBA indexes underestimating the cost of debt for regulated energy network businesses with the same credit ratings whilst the second point would lead to an overestimate. The net effect of these two points is not known. However, because the appropriate credit rating for regulated energy network businesses is BBB to BBB+ rather than BBB, the use of the BVAL or RBA indexes for the broad BBB group will overestimate the cost of debt for regulated energy network businesses.

Seventhly, on the question of whether differences in bond selection criteria for the BVAL and RBA indexes could have a material and systematic effect on the index results, none of the effects arising from the points of difference are clearly both significant and systematic. It is likely that the bonds in the RBA index have on average inferior liquidity than those in the BVAL index, and this will exert a systematic upward effect on the RBA index, but it is not possible to determine whether this is significant. In addition, the presence of foreign currency bonds in the RBA index may have exerted a significant impact at some points in the past. Finally, on the question of which index better reflects the cost of debt for the efficient benchmark entity, there is no clear winner. The inclusion of secured bonds in the RBA index will generate results that better reflect the benchmark entity (whether it has secured bonds or not). However, by excluding bonds with embedded options, the BVAL index better reflects the benchmark entity (which should be defined as not having any such options because the regulatory process cannot allow for them).

Eighthly, on the question of whether differences in curve fitting methodology between the BVAL and RBA indexes could have a material and systematic effect, the only clear point of distinction between the two indexes in this area is that the BVAL yields are par yields whilst the RBA yields are not. Par yields are more appropriate for the AER's purposes but the differences here are neither material nor systematic.

Finally, on the question of how to extend the BVAL and RBA indexes out to ten years, both indexes require extension out to ten years, the BVAL because the longest tenor is seven years and the RBA because the effective tenor of the bonds used for the ten-year term is generally less than ten years (and has averaged 8.7 years since its inception). The components requiring extension are the base rate and the DRP, although the RBA performs the base rate extension itself. The CGS is marginally preferred over the swap rate as the base rate although the results are almost identical in either approach. The CGS can be extended using RBA data on bonds with maturity dates shortly before and after the relevant points in time. In respect of the DRP, the required extension term for the RBA index is only 1.3 years on average (from 8.7 to 10 years), and this favours the simplest technique, which is linear extrapolation using the DRP data for the effective tenors for both the 'seven' and 'ten' year values. In respect of the BVAL, linear extrapolation is no longer clearly favoured because the extension period is now three years (from seven to ten years) rather than only 1.3 years. The available evidence suggests that the best method is use of the RBA data for the effective tenors for both the ‘seven’ and ‘ten’ year values. Since these extension procedures are feasible, and would likely lead to different margins over the course of a five-year regulatory period, there is no case for adopting a fixed margin for the five-year regulatory period.

1. Introduction

In its recent Rate of Return Guidelines (AER, 2013a), 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+. This has led the AER to raise a number of implementation issues with me, as detailed in the Appendix. This paper seeks to address these questions.

2. The Choice of Third Party Data Service Provider

2.1 The Relative Merits of the BVAL and RBA Indexes

The available third party providers for the cost of debt are the BVAL corporate debt yield curve and the RBA Australian non-financial corporation debt yield curve. Neither of these providers offers a BBB+ curve and the nearest available option is the broad BBB curve (which incorporates BBB-, BBB, and BBB+ bonds). The Regulatory Economic Unit (REU: 2014) has examined these two series, and has identified the following distinctions:

(1) The BVAL is available daily whilst the RBA is only available monthly.

(2) The BVAL is only available for terms up to seven years, and therefore would have to be extrapolated out to the desired ten years, whilst the RBA is at least notionally available for the desired ten year term.

(3) The BVAL sample of bonds is limited to those with a minimum pricing quality (liquidity measure), at least two months to maturity, and above retail size ($10m: see REU, 2014, page 20), whilst the RBA sample is limited to bond issues of at least $100mAUD and at least one year to maturity.

(4) The BVAL sample does not exclude financial corporations whilst the RBA's does.

(5) The BVAL sample is limited to unsecured bonds whilst the RBA's sample includes both secured and unsecured bonds.

(6) The BVAL sample is limited to bonds rated by either S&P or Moody's, whilst the RBA sample is limited to bonds rated by S&P or issued by a firm with an S&P rating.

(7) The BVAL sample is limited to AUD denominated bonds whilst the RBA sample also includes USD and Euro denominated bonds.

(8) The BVAL sample excludes bonds with call, put and conversion options, whilst the RBA sample does not exclude them.

(9) The BVAL methodology involves a par yield curve whilst the RBA's does not.

(10) The BVAL methodology for curve fitting is (in large part) not disclosed whilst the RBA's methodology is disclosed.

(11) The BVAL is only available back to February 2011 (continuously) whilst the RBA is available back to January 2005, and therefore there will be more problems obtaining a ten-year trailing average when using the BVAL.

In respect of point (1), NERA (2014, pp. 16-17) argues that this is not significant because the average difference between a one-year trailing average based upon daily and end of month observations (for the BFV seven-year index data from 2001 to 2014) is only 0.7 basis points (and does not exceed nine basis points), and these figures decline to 0.4 basis points and 1.4 basis points respectively for a ten-year trailing average. However, these results are not inconsistent with the BVAL having a significant advantage over the RBA during the first ten years of the new regime providing that the AER's proposed transitional process were used (involving use of the prevailing cost of debt for the first year rather than a ten-year trailing average) and the averaging period used within a year was short, but not otherwise. For example, if the averaging period used within a year was one month, then the cost of debt for the first year of the new regime would involve only one RBA observation and one month of daily BVAL observations and this choice would clearly favour the BVAL because the single RBA end of month observation might be quite untypical of the rest of the month. By contrast, if the averaging period used within a year was again one month but the ten-year transitional period had passed and therefore a ten-year trailing average was used, this would involve ten RBA observations (one per year) and ten months of daily BVAL data (one month per year), with results likely to be very similar (as with NERA's results for a one-year trailing average, involving 12 monthly RBA observations and 12 months of daily BVAL data).

In respect of point (2), the RBA is not available for ten years as the average tenor of the bonds used for that purpose (since January 2005, from when the RBA is available from) is only 8.7 years.[1] Thus, both indexes require extrapolation out to ten years and therefore the advantage of the RBA index is less than appears. In addition, NERA (2014, page 13) argues that the extrapolation required for the BVAL cannot be undertaken automatically and therefore will repeatedly require subjective and therefore contentious judgements. However,

[1] This data is from column AK of Table F3 on the RBA's website.

this claim is not correct. As will be discussed in section 7, there are a number of extrapolation methods that require no judgement in implementing them.

In respect of point (3), the RBA criteria serve as liquidity proxies but the BVAL criterion is more direct and therefore superior, i.e., some bonds that satisfy the RBA criteria may be highly illiquid and therefore would be excluded by the BVAL but not the RBA. Liquidity is important for two reasons. Firstly, illiquid bonds typically do not have recent trades and therefore the estimated yield to maturity is more likely to be in error. Secondly, when less liquid bonds do trade, the yield will be higher than otherwise to compensate for the illiquidity of the bond. Since most corporate bonds are highly illiquid, the RBA index is likely to be more representative of the typical corporate bond. However, any index that includes illiquid bonds is subject to variations over time in the yield at a specific term to maturity according to the proportion of bonds that are illiquid. The BVAL index is preferred in respect of the first point whilst the RBA is preferred in respect of the second. In statistical terms, the trade-off is between standard deviation and bias and this is embodied in the mean squared error (MSE). The preferred index would be that of lower MSE but it is not possible to quantify this, and therefore express a preference here.

In respect of point (4), the AER is concerned with regulating energy network businesses and therefore, to the extent that financial corporations have different costs of debt (at the same credit rating, term to maturity, etc), the inclusion of such firms would seem to be undesirable and therefore the RBA index would seem to be superior. It might be thought that controlling for credit rating would ensure that industry was irrelevant to the cost of debt. However, the cost of debt at a given term to maturity is affected by factors other than the credit rating (which is only an estimate of default risk, at least for S&P ratings on investment-grade bonds: see REU, 2014, page 23). These additional factors include liquidity, which lowers a bond's yield but does not affect its credit rating, and the expected recovery rate in the event of default, which lowers a bond's yield in compensation but does not affect its credit rating. If the bonds of financial corporations differ from those of other firms in these respects, then their cost of debt will differ even at the same credit rating. Both Chairmont (2012, pp. 11-17) and PwC (2013, page 9) claim this to be the case. In respect of empirical evidence, Elton et al (1996, Table I) find that financial corporations in the US have higher DRPs than other corporations at the same credit rating and term to maturity, and therefore higher costs of debt. In particular, the DRP difference is 0.15% for ten-year BBB bonds over the period 1987-

1996. In respect of Australian data, the REU (2014, Figure 4) presents BVAL yields on BBB bonds as of 6 June 2014 graphed against the residual term to maturity, which are classified into financials and nonfinancials; there is no apparent difference but the sample size (9 financial and 13 nonfinancial) is too small to draw definite conclusions. Nevertheless, even if financial corporations do have different costs of debt at the same credit level and term to maturity, the expansion in the sample size (and therefore possible reduction in standard deviation) from including them might compensate for the bias from including them. In respect of the data just noted, the inclusion of the bonds of financial firms raises the sample size by 70%, from 13 to 22. Again, the preferred index would be that of lower MSE but it is not possible to quantify this, and therefore express a preference here.

In respect of point (5), the granting of security to some bonds comes at the expense of others and lowers the cost of debt on the secured bonds whilst raising it on the others. However the overall cost of debt on all of a firm's bonds will not be affected by such an action. Thus, it is not necessary to impose any requirement for the benchmark firm that relates to this matter and the regulator should estimate a cost of debt to be applied to all of the firm's bonds (as the AER does) rather than different rates for the two bond classes. However that uniform cost of debt must be estimated from a compatible set of bonds, i.e., if any bond from a particular firm is included in the sample, all bonds from the same firm should also be included in the sample and these bonds should be weighted in proportion to their values. Neither condition is met by the BVAL because it excludes secured bonds (the low cost ones) and this imparts an upward bias to its cost of debt estimate. Neither condition will also be met by the RBA, even though it does not exclude secured bonds, but the effect on its cost of debt could be in either direction. On this basis, the RBA is preferred. Furthermore, fixing the credit rating does not address the issue because credit ratings (or at least those of S&P for investment-grade bonds) are based on the probability of default (REU, 2014, page 23) and security does not affect this. At the present time, the issue is minor because only a small proportion of BBB bonds are secured (REU, 2014, page 22). However this might change over time.[2]

To illustrate these points, suppose that a firm has debt comprising 70% unsecured bonds with a cost of debt of 7.1% and 30% secured and otherwise identical debt with a cost of debt of

[2] The same issue arises with senior and subordinated debt, because the BVAL is limited to senior bonds whilst the RBA imposes no restriction. However, at the present time, I understand that only one bond in the RBA set is not senior (SGSP Australia Pty Ltd). So, again, the issue is currently minor but this might change over time.

6.77%. So, the firm's overall cost of debt is 7%. In regulating such a firm, it is sufficient for the regulator to allow a cost of debt of 7% on all of its bonds. However, if the bond index comprises only unsecured debt that is comparable with the firm's unsecured debt, the allowed cost of debt will be 7.1% and therefore will be too high. This is the problem with the BVAL index. Suppose instead that the bond index includes both unsecured and secured debt from firms that have the same 70/30 mix, that it value weights, and draws data from equally-weighted firms with bonds and rates as follows:

Type A:	70% unsecured (7.1%), 30% secured (6.77%)	market weights 35%, 15%
Type B:	30% unsecured (7.23%), 70% secured (6.9%)	market weights 15%, 35%

Suppose also that the particular sample used in the index is the secured bonds from type A firms (6.77% with market weight 15%) and the unsecured bonds from type B firms (7.23% with market weight 35%), because the other two bond types have been excluded for various reasons (such as illiquidity or currency). The value-weighted average of the rates on these two bonds is 7.09%:

$$R = 6.77\%(15/50) + 7.23\%(35/50) = 7.09\%$$

This is now too high relative to the correct figure of 7%. However, if the type A and B firms had market weights of 80% and 20% respectively, the result of this calculation would have been 6.94% rather than 7.09%, and therefore would now be too low rather than too high. This is the problem with the RBA index. So, the BVAL is biased up whilst the RBA could overestimate or underestimate.

In respect of point (6), the BVAL credit criteria for including bonds are the existence of a Bloomberg composite rating for the bond (an average rating across the ratings from at least two of S&P, Moody's and Fitch), or an S&P rating, or a Moody's rating; this implies inclusion of a bond if it has either an S&P or a Moody's rating. By contrast, the RBA credit criteria for including bonds are the existence of an S&P rating for the bond or a rating for the issuer. So, both indexes include bonds which have an S&P rating and each expands the sample in different ways (bonds with a Moody's rating in the case of the BVAL and bonds whose issuer has an S&P rating in the case of the RBA). However only a small number of debt issuers are rated only by Moody's (Kanangra, 2013, page 9), which suggests that the

BVAL sample expansion would be small. In addition, in respect of bonds meeting the RBA criteria, an examination of Bloomberg data for 13 June 2014 revealed 69 bonds with an S&P broad BBB rating and a further four without an S&P rating but whose issuer was rated broad BBB; this suggests that the RBA sample expansion is also very small. Consequently, no preference is expressed on this point.

In respect of point (7), Australian businesses frequently borrow in USD or Euro and the costs may differ from AUD denominated debt (for the same term and after converting the foreign-currency bonds into AUD using a currency swap).[3] Thus, an index that includes such bonds (which the RBA does) would seem to be preferable. Furthermore Arsov et al (2013, page 5) claims that the paucity of local currency bonds, especially at longer terms to maturity, makes it impractical to estimate costs of debt without using foreign-currency bonds. For example, Arsov et al (2013, page 3) report that only 20% of BBB bonds are local currency ones and that these 20% are heavily skewed towards shorter residual terms to maturity. This suggests that, of the 67 BBB bonds used by the RBA on 31 July 2014 including 10 with terms of at least eight years, only about 13 are local currency and only one of these would have a term of at least eight years.[4] However, there are a number of problems with the inclusion of these foreign currency bonds. Firstly, the QTC (2012, Attachment 1, page 25) states that secondary market activity in these bonds is low and that most of the data is only "indicative non-binding bid and offer quotes". Since the QTC raises debt finance in both domestic and foreign markets for Queensland government entities, it could reasonably be presumed to be knowledgeable about these matters.

Secondly, secondary market transactions on such bonds come from a variety of markets.[5] If they are not from the same market as the lender, the resulting estimate of the cost of debt may differ from that which would otherwise arise, and therefore may generate a biased estimate of the firm's cost of debt from that foreign source. Since the base rate component of both costs of debt will be equal after the currency swap, the source of the problem is the DRP. This

[3] Amongst non-financial corporations, the majority of currently outstanding BBB bonds are in USD whilst the proportion is even higher for residual terms to maturity in excess of seven years (Arsov et al, 2013, page 3).

[4] The data is from Table F3 on the RBA's website.

[5] This is apparent from examining the ownership composition of some of these foreign currency denominated bonds, as provided by Bloomberg.

comprises allowances for expected default losses, the illiquidity of the bonds relative to government bonds, and systematic risk. So, the DRPs on a given Australian bond arising on a secondary market transaction may differ across the nationality of the buyer because perceptions of the default risk of Australian firms may differ across markets, premiums for the relative illiquidity of the bonds may differ across markets, and the premiums for systematic risk are likely to be different. For example, if the firm borrows from an EU financial institution (in euros) at 6% (after the currency swap) and the bonds are purchased shortly afterwards by a US entity at a yield of 6.5% (after the currency swap) because the systematic risk on Australian bonds is higher for US buyers than EU buyers, then the secondary market data overestimates the firm's DRP on euro-denominated debt.

Thirdly, the use of a bond index that includes foreign currency bonds implies that they will be weighted in proportion to their inclusion in the index rather than in proportion to their usage by Australian regulated energy businesses. Amongst these firms, PwC (2013, pp. 18-19) estimates that 25% of the debt (presumably in face value terms) is foreign-currency bonds. By contrast, Arsov et al (2013, page 3) report that over 80% of the BBB bonds in the RBA index are foreign-currency ones (in face value terms). Thus, the RBA index overweights foreign-currency bonds at the present time by even more than the BVAL underweights them, and the consequence is that the RBA estimate for the cost of debt will exhibit greater bias than the BVAL if the cost of debt on local-currency bonds differs from that on foreign ones (of the same term and after the currency swaps). For example, suppose the current cost of debt on foreign-currency bonds is 8% (after the currency swap) and that on local currency bonds of the same term is 7%. Using the appropriate weights of 25% and 75% respectively, as discussed above, the overall cost of debt would be 7.25%. However, with weights of 80% and 20% respectively, the RBA would estimate the cost of debt at 7.8% whilst the BVAL would estimate it at 7%. So, the BVAL would underestimate the cost of debt by 0.25% whilst the RBA would overestimate it by 0.55%. Furthermore, given that the weighting on foreign-currency bonds in the RBA index is significantly greater than 80% around the ten-year term that is the focus here (Arsov et al, 2013, page 3), the RBA bias here would be even worse.

Fourthly, at every point in time at which the costs of debt for these two types of debt are estimated (in the course of determining a trailing average), the weighting for these types of bonds in the index will reflect earlier issuance decisions (the average term from the issuance of ten-year bonds until a randomly selected secondary market trade on that bond would be about five years), the weights fluctuate over time (see Arsov et al, 2013, Graph 3) because the differential in the costs of debt from the two sources fluctuates over time, and this has the potential to aggravate the problem described in the previous paragraph. Returning to the example in the previous paragraph, suppose in addition that the optimal weights at the time at which the calculation is being performed (time T) are 15% foreign and 85% local rather than the figures of 25% and 75% respectively (because the cost margin on foreign debt is greater at that time than the average margin over the period in which the bonds existing at time T were issued). Using these optimal weights at time T in conjunction with the contemporaneous costs of debt on the two types of bonds, of 8% and 7% respectively, the overall cost of debt at time T would be 7.15%. However, with weights of 80% and 20% respectively, the RBA would estimate the cost of debt at 7.8% whilst the BVAL would estimate it at 7%. So, the BVAL would underestimate the cost of debt by 0.15% whilst the RBA would overestimate it by 0.65%. Thus, the RBA's overestimate would be even greater than before.

These calculations assume that cost of foreign currency debt can significantly diverge from that of local currency debt (for the same term and after the currency swap). To illustrate the potential here, CEG (2012) present Bloomberg and UBS data on AUD denominated bonds (Figure 12) and both AUD and foreign-currency bonds (Figure 13), and then fits Nelson-Siegel curves to this data for BBB, BBB+ and A- bonds. In respect of Figure 12, the simple average of the three curves at the ten-year maturity is 7.38% and the corresponding result for Figure 13 is 7.93%. Furthermore, in moving from Figure 12 to Figure 13, the data set increases from 110 bonds to 297 bonds (CEG, ibid, pp. 36-37). It follows that 187 of the total set of bonds are foreign currency bonds and therefore the average ten-year yield on the foreign currency denominated bonds necessary to raise the average from 7.38% to 7.93% is 8.25%, which exceeds the local currency average by 0.87%. In addition, PwC (2013, Figure 5.9) provides estimates of the DRPs for local and foreign-currency bonds over the period from October 2010 to November 2012 and find considerable differences ranging from local bonds having a DRP that was as much as 1.00% above foreign currency bonds to 0.20% below.

In summary, regarding point (7), there are both pros and cons from the inclusion of foreign currency bonds. Arsov et al (2013, page 11) claims that the enhanced sample size from including foreign currency bonds is necessarily advantageous. However the sample size can be expanded in other ways; the BVAL does so by including the bonds of financial firms and, as discussed above, this raises the BVAL BBB sample from 13 to 22 in June 2014. Furthermore, an enhanced sample size at the expense of bias or greater variability in the underlying data is not necessarily advantageous. For example, if the sample (comprising observations X_1, X_2, ….X_N from a population with standard deviation σ) is doubled but the additional N observations (Y_1, Y_2, ….Y_N) are drawn from a population with twice the standard deviation of the first group, and the observations are independent, the standard deviation of the sample mean rises (by 12%) as follows:

$$\sigma(samplemean) = \sqrt{Var(samplemean)}$$

$$= \sqrt{Var\left(\frac{X_1 + ... + X_N + Y_1 + ... + Y_N}{2N}\right)}$$

$$= \sqrt{\frac{Var(X_1)}{4N^2} + ... + \frac{Var(X_N)}{4N^2} + \frac{Var(Y_1)}{4N^2} + ... + \frac{Var(Y_N)}{4N^2}}$$

$$= \sqrt{N\left(\frac{\sigma^2}{4N^2}\right) + N\left(\frac{4\sigma^2}{4N^2}\right)}$$

$$= 1.12\frac{\sigma}{\sqrt{N}}$$

This increase in the standard deviation of the sample mean is undesirable. Furthermore, even if the increased sample size from including foreign-currency bonds did lower the standard deviation of the mean estimate, the bias might be greater from doing so (by overweighting foreign-currency bonds) and this trade-off (reflected in MSE) might be unfavourable (higher MSE). In view of this, no preference for either the BVAL or the RBA index is expressed on this point.

In respect of point (8), call, put, and conversion options alter the cost of debt but the exercise of the options is not and cannot be reflected in the regulatory process. Consequently, the benchmark firm should not have such options and the use of an index that includes such bonds will introduce bias unless appropriate adjustments are made for the presence of the options. For example, consider bonds with conversion options exercisable at the maturity of the bonds and which have the effect of lowering the interest rate on the bonds from 7% to 6%

(because these options are advantageous to bond holders). If the benchmark firm's bonds had these options, the regulator would allow an interest rate of 6% in setting the price or revenue cap but the conversion option would have no effect on the price or revenue cap (as conventionally determined), with the result that the price or revenue cap would be too low. Thus, the benchmark firm's debt should be defined to not have such options, and therefore should have an interest rate of 7%. Consequently, the bonds used to estimate this rate should also be free of these options or appropriate adjustments must be made to reflect their presence. If a bond does have such options, thereby reducing its interest rate from 7% to 6%, and the regulator does not make an adjustment for this, the regulator will thereby estimate the cost of debt at 6%, and apply the same rate to the benchmark firm, thereby underestimating its cost of debt by 1%. Similarly, call options raise the cost of debt because they are disadvantageous to the bond holders. So, if the regulator estimates the cost of debt of the benchmark firm from bonds with call options, and does not make an adjustment for the effect of these options, they will overestimate the cost of debt of the benchmark firm.[6]

Empirically, the impact of call options (other than make-whole call options) on the cost of debt can be substantial. For example, Oakvale Capital (2011) examined 31 such bonds, and found that the DRP impact of the call option ranged from zero to 2.0% (ibid, Appendix F and para 50) whilst CEG (2012, Figure 2, Figure 4) present results without adjustments for the call options and with them, and one of these bonds had an estimated DRP that was lower by about 1.5% (Suncorp with a 12 year term to maturity). Although the RBA does make an adjustment for the presence of options, this is likely to introduce some degree of estimation error. So, the inclusion of these bonds expands the sample size but at the expense of potentially introducing some bias. The trade-off is embodied in the MSE, and the preferred index would be that of lower MSE but it is not possible to quantify this, and therefore offer a judgement on it. At the present time, the proportion of bonds with options of any type is small (Arsov et al, 2013, Graph 5), and virtually all of these are of the make-whole call type (for which no adjustment is made). So, this is not important at the present time but this situation could change.

[6] An exception to this is "make-whole" call options, which require the firm in the event of exercising the call to make compensatory payments to the bond holders. The interest rate on these bonds should not be affected by the presence of such calls, and therefore no adjustment would be required.

In respect of point (9), regulatory situations involve a 'building block' calculation of the firm's revenue, which includes an allowed cost of debt that is derived from the yield to maturity of an existing bond or bonds, and which will give rise to interest payments in the building block calculation that involve the same rate. So, the coupon rate on the bond used to set the allowed rate must match its yield to maturity (a "par yield bond"). Since the BVAL yield is a par value yield, and the RBA yield is not, this point favours the BVAL. However, the effect here is generally quite small. For example, suppose the spot rates on BBB bonds are currently 6.41%, 6.56%, 6.7%, ….7.7% for years 1, 2…10.[7] At any given point in time, there will exist ten-year bonds with a wide range of coupon rates, with each rate reflecting the prevailing YTM at the time of the bond's issuance. Across the period for which the RBA's results are available (from January 2005), the prevailing YTM on ten-year BBB bonds has ranged from 5.33% to 13.3%. So, I consider coupon rates ranging between these two extremes. With the spot rates given above, and assuming annual coupons to simplify the example, a 5.33% coupon bond will trade at a YTM that solves the following equation:

$$\frac{.0533}{1.0641}+\frac{.0533}{(1.0656)^2}+....+\frac{1.0533}{(1.077)^{10}}=\frac{.0533}{1+y}+\frac{.0533}{(1+y)^2}+....+\frac{1.0533}{(1+y)^{10}}$$

This YTM is 7.56%. Similarly, a 13.3% coupon bond will trade at a YTM of 7.46%. Both are BBB bonds trading at the same point in time and with a residual life of ten years, and the YTMs differ simply because they were issued at different times and therefore with different coupon rates. If either bond were used to set the allowed (coupon) rate in a building block calculation, neither would have a market value matching its par value; so, the YTM on the bond will not match the YTM used by the regulator, which contradicts the regulator's intent. So, the regulator should use the YTM on a bond whose coupon rate matches its YTM (a "par yield bond").

This (hypothetical) bond is obtained by deriving the spot rates that underlie the yields to maturity on otherwise identical bonds with different terms to maturity, and then choosing a

[7] These spot rates are intended to reflect a typical situation as follows. Across the entire period for which the RBA results are available (since January 2005), the average ten-year YTM on BBB bonds was 7.7% and the average differential between the ten and three year rates was 1%. So, the ten-year spot rate was set at 7.7%, the three-year rate at 6.7% and the remaining rates follow a linear function through these two points. Naturally, yields on ten year bonds are not the same as the ten-year spot rates but they are close and the precise choice of these spot rates is not crucial to the analysis.

coupon rate on a ten-year bond so that its value using these spot rates matches its par value; this coupon rate would also be the yield to maturity on such a bond. In the example above, it would be a bond with a coupon that satisfies the following equation:

$$\frac{c}{1.0641}+\frac{c}{(1.0656)^{2}}+....+\frac{1+c}{(1.077)^{10}}=1$$

The solution is a coupon rate, and therefore also a yield to maturity, of 7.52%. Thus, if a regulator used a YTM that was not a par yield, the maximum error here would be 0.06% (7.52% v 7.46%). This difference is trivial, despite using a range in coupon rates that is unlikely to characterize the bonds underlying the ten-year BBB curve at the point in time examined.

This analysis uses a typical set of spot rates. However, the error from not using a par yield bond also depends upon the slope of the spot curve at the particular point in time that is examined. Across the period for which the RBA's results are available (from January 2005), the greatest slope occurs in January 2009, when the YTMs on three and ten-year bonds were 8.83% and 11.1% respectively. So, the ten-year spot rate is set at 11.1%, the three-year spot rate at 8.83% and the spot rates for other years 1, 2….10 are chosen to fit a linear function through these two rates. These spot rates were then applied to a 5.33% coupon bond and to a 13.3% coupon bond, yielding YTMs of 11.09% and 10.78% respectively. In addition, the YTM on a par yield bond would be 10.85%. So, the error from failing to use a par yield bond would now be as much as an overestimate of 0.24% (11.09% v 10.85%) or an underestimate of 0.07% (10.78% v 10.85%), and arise from a situation in which the slope of the spot yield curve is at its observed maximum in the last ten years and the index rate is determined solely by a bond with either the lowest or highest coupon rate observed in the last ten years. Despite these extreme conditions, the error from failing to use a par yield curve is still not very substantial. So, the BVAL advantage over the RBA in this respect is in general trivial and never very substantial.

In respect of point (10), the superior disclosure by the RBA of its curve fitting methodology favours it over the BVAL. The par yield curve issue just discussed illustrates the advantages of disclosure, i.e., it allows one to assess whether the issue is significant and if so, to then favour one of the indexes in inverse relation to the scale of the problem. Non-disclosure raises the possibility that a significant problem exists, and some weight must then be given to this possibility.

Finally, in respect of point (11), the fact that the BVAL index only goes back to 2011 whilst the RBA index goes back to 2005 is only significant if the AER uses historical data. Since it does not propose to do so, this difference between the two indexes is not significant.

In summary, eleven points of distinction have been identified between the BVAL and RBA indexes. Point (11) is irrelevant in view of the AER not requiring historical data. In respect of points (3), (4), (6), (7) and (8), it is not possible to express a preference for one of the two indexes. The BVAL is favoured in respect of points (1) and (9), but the advantage in respect of point (9) is small. The RBA is favoured in respect of points (2), (5) and (10), but the advantage in respect of point (5) is small. The most that can be said here is that neither index is clearly superior to the other.

2.2 The Merits of Combining Estimators

In general, when multiple methods of estimating a parameter are available, the use of only one approach is likely to produce a less reliable estimate of the parameter than from averaging over the results from a range of different approaches, particularly if these estimators have low correlation, similar standard deviations and similar degrees of bias. Furthermore, even if one of the estimators were significantly more biased than the others, it might still warrant significant weight. To illustrate these points, consider the following analysis. The usual criterion in selecting an estimator or combination is minimising the Mean Squared Error (MSE) of the estimate (Ferguson, 1967, page 11).[8] Letting $\hat{T}$ denote an estimator and T the true value of the parameter being estimated, the MSE of the estimator is as follows:

$$\begin{aligned} MSE &= E\left[\hat{T} - T\right]^2 \\ &= E\left[\hat{T} - E(\hat{T}) + E(\hat{T}) - T\right]^2 \\ &= E\left[\hat{T} - E(\hat{T})\right]^2 + \left[E(\hat{T}) - T\right]^2 \end{aligned} \quad (1)$$

[8] The MSE is the average over the squared differences between the estimated value and the true value.

where the first term in the last equation is the variance of the estimator and the second term is the square of the bias. Now, suppose that there are two estimators. Letting *w* denote the weight on the first estimator, this weight should be chosen to minimise the MSE of the weighted-average estimator:

$$\begin{aligned} MSE &= E\left[w\hat{T}_1 + (1-w)\hat{T}_2 - T\right]^2 \\ &= E\left[w(\hat{T}_1 - T) + (1-w)(\hat{T}_2 - T)\right]^2 \\ &= w^2 E\left[\hat{T}_1 - T\right]^2 + (1-w)^2 E\left[\hat{T}_2 - T\right]^2 + 2w(1-w)Cov(\hat{T}_1, \hat{T}_2) \\ &= w^2 MSE_1 + (1-w)^2 MSE_2 + 2w(1-w)Cov(\hat{T}_1, \hat{T}_2) \end{aligned} \qquad (2)$$

where $Cov(\hat{T}_1, \hat{T}_2)$ is the covariance between the two estimators. The MSE is minimized with the following choice of *w*:

$$w = \frac{MSE_2 - Cov(\hat{T}_1, \hat{T}_2)}{MSE_1 + MSE_2 - 2Cov(\hat{T}_1, \hat{T}_2)} \qquad (3)$$

Turning now to the two estimators under consideration in the present situation, which are the BVAL and the RBA, suppose that each of them are unbiased and each have a standard deviation of 1%. Over the period since the two indexes have each been continuously in existence (February 2011 to July 2014), the estimated correlation has been 0.94. Using equation (1), both estimators have a MSE of $.01^2$. Using equation (3), the MSE of a combined estimator is minimised with equal weight on the two estimators. Using equation (2), the resulting MSE is $.0098^2$. So, the MSE is reduced by only 3% by optimally combining the two estimators. However, consideration of the longer period for which both the BFV (another Bloomberg series) and RBA have each continuously been in existence (January 2005 to April 2014) reveals that there were periods in which they were almost identical (January 2005 to June 2008, with an estimated correlation of 0.99) and periods when they were quite different (July 2008 to January 2012, with an estimated correlation of -0.31). This suggests that the BVAL and RBA indexes might also at some future point experience much lower correlation than they have to date, and this strengthens the argument for using both series. For example, if the correlation were as low as zero, and the standard deviations were equal, the optimal weights from equation (3) would still be equal but the MSE from equation (2) would now be 50% less than that from using only one of the two estimators.

Suppose now that one of the estimators were considered to be biased. Naturally, one could not specify the degree of bias to a high degree of precision. Nevertheless, one could consider the implications of a range of possible values for that bias. For example, suppose the bias in that estimator was considered to be as much as its standard deviation. At this upper limit, and continuing to assume a correlation of zero, the optimal weight on the biased estimator would now be 0.33 following equation (3), and the MSE would then be 34% less than that from sole use of the unbiased estimator. As the bias goes to zero, the MSE of the combined estimator falls to 50% of that from sole use of the unbiased estimator. So, even with significant bias in one estimator, it may still warrant significant weight in a weighted-average estimator and the combined estimator would have an MSE that was significantly less than the better of the two individual estimators.

Equation (3) does not imply that the weights on the two estimators would be equal; such a result would only arise if both estimators were unbiased and had equal standard deviations. Naturally, there is no reliable basis for estimating the bias and, if there were, one would simply adjust the estimator accordingly and therefore the bias would be removed. However, the time-series of observations for the BVAL and the RBA allow us to at least estimate the standard deviation for each estimator. Over the period since both series have continuously operated, the standard deviations of the time-series observations for the seven-year term are 0.89 for the BVAL and 0.76 for the RBA. For each series, some of this time-series variation is variation over time in the 'true' cost of debt and is therefore irrelevant to the standard deviation of the estimator (the standard deviation of the distribution from which today's estimate is drawn). However, whatever this time-series variation in the true cost of debt is, it will be common to both series. Thus, since the BVAL has higher time-series variation than the RBA, the estimated standard deviation of the BVAL estimator will be greater than that of the RBA estimator. However, the difference here is not substantial. Consequently, one should act as if the standard deviations of the two estimators are equal. So, following equation (3) with the common standard deviation σ and no bias, the optimal weight on each estimator is 50% regardless of the correlation coefficient ρ:

$$w = \frac{\sigma^2 - \sigma^2\rho}{\sigma^2 + \sigma^2 - 2\sigma^2\rho} = \frac{\sigma^2(1-\rho)}{2\sigma^2(1-\rho)} = 0.5$$

In summary, since neither the BVAL nor the RBA index is clearly superior to the other, I recommend that a combined estimator be used. Furthermore, since the standard deviations of the two estimators are similar and it is not possible to quantify biases, I recommend that the two indexes be equally weighted. This will lower the MSE of the estimator relative to using only one of the indexes, and significantly so if the correlation between the two indexes is low.

2.3 Contrary Views

NERA (2014, section 4.3) raises points (1), (2), (7), and (10), and concludes in favour of the RBA index. However, the failure to discuss the other points of distinction between the two series, as detailed in the previous section, undercuts the merit of NERA's conclusion.

NERA (2014, page 13) also argues in respect of point (2) that the extrapolation required for the BVAL cannot be undertaken automatically and therefore will repeatedly require subjective and contentious judgements. However, this claim is not correct. As will be discussed in section 7, there are a number of extrapolation methods that require no judgement in implementing them. So, whilst point (2) favours the RBA index, the advantage is not as great as claimed by NERA.

NERA (2014, page 14) also argues that the RBA estimates are "reliable" because there are no grounds to suspect bias in its results, and this in turn follows from its 'Code of Conduct'. However, even without bias, estimates will be unreliable if they are drawn from a distribution with a high standard deviation. Furthermore, the RBA index values for ten-year bonds are biased at the very least because the weightings given to bonds used for this purpose do not have a weighted-average tenor equal to ten years and this point is even acknowledged by the RBA (Arsov et al, 2013, page 10). In fact, across the entire period for which the RBA series is presented (from January 2005), the average tenor of the bonds used to form the index value for ten years is 8.7 years and has been as low as 6.11 years (in August 2005).[9] Furthermore, as discussed earlier, the RBA index values are likely to be biased because they significantly overweight foreign currency bonds, especially for ten years.

[9] This data is from column AK of Table F3 on the RBA's website.

NERA (2014, page 18) also argues that the RBA series appeared to perform better than the BFV series during the GFC. However, whatever the merits of this claim, the alleged failings of the BFV are irrelevant to the current choice, which involves the BVAL and RBA rather than the BFV and the RBA. It might be argued that, since the BVAL is highly correlated with the BFV in the common period of existence (0.92), the BVAL would inherit the deficiencies in the BFV. However, the RBA is similarly highly correlated with the BFV (0.90) and therefore it could not be argued that the BFV would inherit the deficiencies in the BVAL whilst the RBA was free of them.

CEG (2014, section 3.1) favours the RBA index purely on the basis that it provided more plausible results than the BVAL and BFV over the period since the GFC commenced. However CEG's failure to discuss any of the points raised in the previous section undercuts the merit in this conclusion. Furthermore, since the choice facing the AER is between the RBA and the BVAL, the historical performance of the BFV is irrelevant. CEG offer only two comments that are relevant to a comparison of the RBA and the BVAL indexes. Firstly, CEG (2014, para 143) argues that the BVAL curve is more erratic, with large single day changes in yields. However, the RBA is only reported for the last day of each month rather than daily and therefore no such comparison of the day-to-day volatility of the two indexes is possible. Secondly, CEG (2014, para 144) argues that the BVAL DRP fell from a peak of 3.44% in December 2011 to 2.98% in June/July 2012 whilst there was considerable turmoil in financial markets, and therefore that the behavior of the BVAL was implausible. However the only points in time at which a comparison can be performed are on the last day of each month, and therefore the comparison should involve 31 December 2011 and 31 July 2012. Furthermore, there is no BVAL ten-year curve and the comparison should then be with the seven-year curves.[10] Consistent with CEG's Figure 9, the DRPs are determined relative to the CGS and, consistent with using seven-year values for the RBA and the BVAL, the CGS is for a seven-year bond. The results are shown in Table 1 below. Both the RBA DRP and the BVAL DRP fall over this period (by 0.37% and 0.69% respectively), whilst CEG thinks they should have risen. The only reasonable conclusion to draw from this is that CEG's views do not accord with the market.

[10] CEG extrapolate the seven-year BVAL out to ten years and therefore any deficiencies in the resulting ten-year series might be due to CEG's extrapolation rather than the BVAL series.

Table 1: DRPs in the First Half of 2012

Date	RBA	BVAL	CGS	RBA-DRP	BVAL-DRP
31 December 2011	7.44	6.84	3.44	4.00	3.40
31 July 2012	6.43	5.51	2.80	3.63	2.71

ActewAGL (2014, section 10.6.5) favours the RBA index over the BVAL index on the grounds that the RBA methodology is more transparent, that a ten-year cost of debt is provided, that it is available over a much larger fraction of the required historical period of ten years, that it has behaved more as one would expect over the last ten years, and notwithstanding its availability at only monthly rather than daily intervals (which would have no material effect upon a ten-year trailing average). In respect of the last point, and as noted earlier, this is only clearly true once the ten-year transitional period has passed. In respect of the claims concerning how it has behaved over the last ten years, ActewAGL repeats the points made by CEG (2014, section 3.1) and these have been addressed in the previous paragraph. In respect of the historical availability issue, and as noted earlier, this is irrelevant in view of the AER's decision to avoid the use of historical data. In respect of the other two points, these are both valid but they represent only two of the eleven points of difference examined in section 2.1 above. ActewAGL's failure to consider the other seven points undercuts the merit of their conclusion.

Directlink (2014, Attachment 6.1) favours the RBA index over the BVAL index because the former incorporates foreign-currency bonds and these are part of the financing of the benchmark efficient entity. However, there are a number of disadvantages from doing do as discussed in section 2.1. Furthermore, this point of distinction between the two indexes is only one of the eleven points raised in section 2.1 and Directlink's failure to consider the other ten points undercuts the merit of their conclusion.[11]

Jemena (2014, section 5.3.2) argues that the AER should choose between the available indexes according to which offers a better fit to the available data (defined in accordance with

[11] Directlink refers to some of these additional points but only in the course of citing the AER and Arsov et al (2013). They express no view on these points.

criteria proposed by Jemena). However, such an approach sacrifices the MSE gains from a combined estimator.

In summary, the arguments presented by NERA, CEG, ActewAGL, and Directlink do not support their preference for the RBA index, and the approach proposed by Jemena sacrifices the MSE gains from a combined estimator.

3. The Efficient Financing Mix

Australian corporates draw debt financing from three primary sources: local bank borrowing, local bond issues, and foreign bond issues. Amongst Australian regulated energy businesses, PwC (2013, pp. 18-19) estimates the 2012 proportions at approximately 25%, 50% and 25% respectively. The explanations for this mix are threefold. Firstly, borrowing from a variety of sources gives the firm protection against the possibility of funding from one source not being available at the desired time. Naturally, if a firm were dependent upon only one source and that source ceased to provide it, the firm would seek out an alternative source but the lack of a history of borrowing from the new source would be an impediment. Secondly, the level of bank borrowing is much more easily adjusted in the face of short-term fluctuations in the firm's demand for debt, and therefore some level of it is desirable even if other features of it are disadvantageous (such as the shorter term for which it is available). Thirdly, at present only foreign bonds can provide very long-term debt finance, which minimizes refinancing risk, and therefore might be desired even if other features of such debt were undesirable.[12]

Over time, the relative rates charged by these three sources (for the same term and after converting foreign-currency bonds into AUD using a currency swap) will vary and therefore will affect the optimal weights in the inverse direction. For example, if the cost of debt were 7% from all three sources, the optimal weights might be 20% bank debt, 50% local bonds, and 30% foreign bonds. If the cost of foreign debt rose to 8%, the optimal weights might then be 20%, 60%, and 20% respectively. Different firms might have different views on the optimal mix, which trades off cost against flexibility (in the case of bank debt), the term for which the debt is available, and the protection that comes from multiple sources.

[12] PwC (2013, pp. 17-18) estimates that the Australian market provides bonds with maturities up to 15 years whilst the US market does so up to 30 years.

In using a cost of debt index that is based upon bonds, as the RBA and BVAL indexes are, bank debt is excluded and this raises the question of whether bias in the allowed cost of debt might arise. For example, if bank debt were less expensive for the same term, the allowed cost of debt would be overstated as a result of excluding it. However the very reason for excluding bank debt in the assessment of the allowed cost of debt (the lack of secondary market data) also precludes a formal assessment of this potential concern. Furthermore, since bank debt constitutes only about 25% of the debt of regulated firms, this low weighting mitigates any bias arising from its omission from the RBA and BVAL indexes.

In addition, if the AER were to use the BVAL index only or average over the RBA and BVAL indexes, the fact that the BVAL index does not include foreign currency bonds implies that foreign currency bonds will be underweighted and this raises the question of whether bias in the allowed cost of debt might arise. For example, if foreign currency debt is currently more expensive, the allowed cost of debt from the BVAL will be too low. However, in respect of primary market data, I understand from discussions with corporate treasury staff that the rate differential between local bonds and otherwise identical foreign denominated bonds fluctuates considerably over time, with the differential typically up to 1% (after the currency swap). The source of this is in the DRP. Since it comprises allowances for expected default losses, the illiquidity of the bonds relative to government bonds, and systematic risk[13], the DRPs paid by a given Australian borrower at a given time for debt with the same term and other conditions may differ between local and foreign currency borrowing because local and foreign lender perceptions of the default risk of Australian firms may be different, premiums for the relative illiquidity of the bonds may differ across markets, and the premiums for systematic risk are likely to be different.[14] The first two of these factors will change over time. Thus, even if foreign debt were currently materially more expensive than

[13] Elton et al (2001) conclude that most of the DRP is compensation for systematic risk whilst Dick-Nielsen et al (2012, Table 5) conclude that about 25% of the DRP on A to BBB bonds was due to illiquidity in the period 2007-2009.

[14] In respect of systematic risk, financial institutions in (say) the US who lend to Australian rather than US companies are akin to US investors who buy Australian rather than US equities. In both cases, with imperfect integration of markets, the imperfect correlation between the Australian and US markets implies that the Australian investments exert a lower impact than further US investments upon the risk of the assets currently held by these US investors. For example, if the correlation is zero, the systematic risk incurred by a US lender to an Australian company will be zero whereas that incurred by the same lender to a US company will be positive. Furthermore, in respect of lending, one would expect the benefits to be shared with the borrowers in the form of a lower DRP than they would pay on local borrowing so as to encourage borrowers to seek foreign loans. These effects may or may not persist after the issue date because the interest rate data is then from the secondary market and secondary market buyers may or may not be from the same market.

otherwise identical local debt, the average differential over time would be less significant (or even zero) and therefore the bias problem less significant (or even eliminated).

In addition, even if the AER used only the RBA index, the weighting on foreign bonds in that index will not reflect the current optimal weights but the optimal weights at the earlier times that these existing bonds were issued and the extent to which the sample of bonds appearing in the RBA index reflects the entire population of existing bonds. Consequently, even if the AER used only the RBA index, there may still be bias in estimating the current cost of debt. For example, the current optimal weights may be 25% foreign currency bonds and 75% local currency bonds but the proportions of existing bonds that are of these two types may be 40% and 60% respectively (because the cost of foreign currency debt relative to that of local currency is higher today than at the times that these existing bonds were issued), and the subset appearing in the RBA index may be 50% each. Nevertheless, for the reasons given in the previous paragraph, the average bias tends to zero over time.

In summary, the efficient financing mix for Australian corporates involves bank debt, Australian currency bonds and foreign currency bonds so as to mitigate refinancing risk and benefit from the flexibility of bank debt. The optimal weights will vary over time, in inverse relation to their costs. In using a cost of debt index that is based upon bonds, as the RBA and BVAL indexes are, bank debt is excluded and this raises the question of whether bias in the allowed cost of debt might arise. However the very reason for excluding bank debt in the assessment of the allowed cost of debt (the lack of secondary market data) also precludes a formal assessment of this potential concern. Furthermore, since bank debt constitutes only about 25% of the debt of regulated firms, this low weighting mitigates any bias arising from its omission from the RBA and BVAL indexes. In addition, if the AER were to use the BVAL index only or average over the RBA and BVAL indexes, the fact that the BVAL index does not include foreign bonds implies that foreign bonds will be underweighted and this raises the question of whether bias in the allowed cost of debt might arise. However, whilst there are good grounds to believe that the cost of local currency bonds does vary from that of otherwise identical foreign currency bonds, after the currency swap to convert the foreign-currency bonds to AUD, there are no grounds to believe that there is a systematically higher rate on one or the other. Thus, the omission of foreign currency bonds from the BVAL index should not lead to it systematically over or understating the cost of debt of the efficient benchmark entity. In addition, even if the AER used only the RBA index, the weights on local and foreign currency bonds within that index may be significantly different to that of bonds in general and these in turn to the currently optimal weights, and this too would introduce bias but again the effect would not be systematic over time.

4. Credit Ratings

4.1 The Appropriate Credit Rating for the Benchmark Entity

The AER favours a credit rating of BBB+ for pure-play regulated energy networks (gas and electricity transmission and distribution) operating within Australia over the period 2002-2013, consistent with the median of the ratings assigned to the 13 comparator firms selected by the AER (2013, pp. 153-154). However, the AER does not supply the underlying ratings for the individual firms used as comparators, or the medians for the individual years (apart from 2013, for which the median is claimed to be BBB).

CEG (2014, Appendix B) do report the ratings for the individual firms and, using the same weighting scheme used by the AER to average across different credit ratings, derive the median rating for each of the years 2002-1013. They find that the median rating falls from BBB+ to BBB in 2009 (presumably in response to the GFC) and has remained there since. Consequently they favour a median credit rating at the present time of BBB. By contrast, the AER (2013, page 154) argues that the number of firms in this industry is limited, averaging over a historical period improves the reliability of the estimate, and at least five years would be appropriate (in fact, data from 2002-2013 are used) consistent with their approach to estimating the equity beta. However the optimal historical period over which to draw upon data to estimate an industry-level parameter will depend upon the standard deviation of the annual estimation errors at the level of the individual firm. In respect of beta, estimates for an individual firm using one year of data have very high standard errors, and even betas for large portfolios of comparable firms estimated with the use of five years of data still have significant standard errors; this supports the use of more than five years of data in estimating industry betas. However, inspection of CEG (2014, Table 13) reveals that the ratings at the individual firm level are very stable over time and the principal changes (in 2007/2008 for three firms and in 2013 for SP Ausnet Group and SPIAA) have highly plausible explanations (the GFC for the first three cases and the loss of majority ownership by Singapore Power in the last two cases). This suggests that the ratings are estimated much more accurately than equity betas, and therefore that the optimal period of historical data to use is much less than for equity betas, i.e., the use of ratings data from only the recent past shields the estimate from past conditions that no longer prevail (avoidance of bias) whilst the lost benefits of averaging over a longer period (washing out estimation errors) are minimal.[15] However, the accuracy of ratings does not imply that they are error-free, because they will reflect some firm-specific features that are irrelevant to the benchmark firm. If a sufficiently large number of firms were available, averaging over the very recent ratings of these firms will largely wash-out such effects. However the number of firms is very limited and therefore also averaging results over a significant historical period may significantly contribute to mitigating these firm-specific events (providing that they do not afflict the firms over a long period). Thus, there are pros and cons from significant averaging over time. Taking account of all this, my judgement is that the optimal historical period to use is less than five years. Using the data presented in CEG (2014, Table 13), this points to an industry credit rating of BBB consistent with CEG's conclusion.

CEG (2014, Appendix B) also argue that three of the 13 firms used by the AER are part of the same corporate group (Citipower, Powercor, and ETSA), that they should be treated as a single observation, and that doing so would produce a median BBB rating in many of the pre-GFC years as well as subsequently. This argument for using only one observation across these three firms is reasonable. However, the same argument would apply to DUET, Energy Partnership (wholly owned by DUET) and DBNGP (80% owned by DUET). If both contractions in the set of observations were undertaken, then CEG's Table 14 would be as shown in Table 2 below (up to and including 2013). As is apparent, these two steps do not materially change the picture; the median rating shown in the last row of Table 2 fell from 3 (BBB+) to 2 (BBB) in 2009 and has remained there up to and including 2013.

A more important issue is that five firms have experienced rating changes since CEG's data was presented, all but one of which involves an upgrade. This gives rise to the results in the last column of Table 2, and the median is now BBB+. Given my earlier view that one does not need to engage in much historical averaging, this points to an industry credit rating of BBB to BBB+ at the present time.

[15] It is possible that rating agencies delay changing ratings until the case for doing so is very strong, and therefore the stability in ratings over time is a spurious indicator of accuracy in estimation. However the ratings changes in 2007 and 2008 shown in CEG (2014, Table 14) were presumably in response to the GFC and this suggests that rating agencies do not delay changes for several years.

Table 2: Credit Rating Values for Regulated Energy NSPs

	2003	04	05	06	07	08	09	10	11	12	13	14
APT							2	2	2	2	2	2
ATCO									2	2	2	4
DUET Group	1	1	1	1	1	1	1	1	1	1	1	1
Electranet	3	3	3	3	3	3	2	2	2	2	2	2
Envestra	2	2	2	1	1	1	1	1	1	1	2	3
SP Ausnet	5	5	5	5	5	4	4	4	4	4	3	4
SPIAA						4	4	4	4	4	2	3
Citipower Grp	4	4	4	4	4	4	4	4	4	4	4	4
United	2											
Median	2.5	3	3	3	3	3.5	2	2	2	2	2	3

A further issue arises from the AER's definition of the benchmark entity as a 'pure-play'. This raises the related question of whether firms with parents who have a higher credit rating have experienced a rating boost from that association, and therefore should be deleted on the grounds that their credit rating has been affected by the unrelated activities of their parent. If this were done, it would lead to the deletion of ATCO Australia (owned by ATCO Group, with an A rating), Electranet (41% owned by State Grid Corp of China (with an AA- rating), Envestra (owned by CKI Group, with an A rating), SP Ausnet Group (majority owned by SPI, with an A+ rating), SPI Australia (owned by SPI, with an A+ rating), and Citipower (majority owned by CKI, with an A rating). Doing so would leave only two firms (APT and DUET), and these are predominantly involved in only gas. Even leaving aside the lack of significant electricity operations by these firms, two firms are insufficient to enable one to form a conclusion about the credit rating of Australian energy network businesses in general.

A further issue concerns the period for which the credit rating applies to. Since it is intended to apply to the entire regulatory cycle of five years, then it is not sufficient to judge the appropriate credit rating at the beginning of the cycle; it is instead necessary to form a judgement about the average value over the next five years. To do so, the current value must be coupled with an assessment about its future direction. Taking account of the time series of median ratings shown in the last row of Table 2, the current rating of BBB to BBB+ could reasonably be viewed as a good predictor for the next five years.

Table 3: Median Credit Ratings for Gas and Electricity Businesses

	2007	2008	2009	2010	2011	2012	2013	2014
Electricity (2)	3.5	3.5	3	3	3	3	3	3
Gas (4)	1	1	1	1	1.5	1.5	2	2.5
Gas (2)					1.5	1.5	2	3.5

A further issue concerns whether to apply the same rating to all businesses within the regulated energy network sector. Jemena (2014, section 3) argues that gas distribution businesses are subject to greater risks than other energy network businesses. They classify businesses into electricity, gas, and mixed and claim that the median rating for the electricity businesses is A- whilst the others are BBB. However their analysis does not pool companies that are part of the same corporate group. Doing so from 2009 onwards leaves only Citipower Group and Electranet amongst electricity businesses, and only ATCO, APT, DUET Group, and Envestra amongst the gas businesses. Furthermore, both APT and DUET whilst predominantly involved in gas have some electricity assets and therefore might be excluded from the gas set, leaving only two electricity businesses and two gas ones. Drawing upon the data in Table 2, the median results for each of these two sets from 2007 onwards is as shown in Table 3.[16] Taking account of the fact that there are only two electricity firms, and 2-4 gas firms, I cannot confidently conclude that there is any difference between the two subsets at the present time. Accordingly, my assessment of the credit rating is limited to the entire energy network sector. As indicated above, this is BBB to BBB+ both at the present time and as an estimate for the next five years.

In summary, I do not think that one can differentiate between the gas and electricity businesses at the present time and I therefore favour a credit rating for the entire sector of BBB to BBB+ both at the present time and as an estimate over the next five years.

[16] The results for the two gas firms are shown only from 2011, because there was only data for one firm prior to that point.

4.2 The Relationship Between Costs of Debt and Credit Ratings

The AER seeks to estimate the cost of debt for the benchmark entity by first specifying a credit rating. Implicit in doing so is a belief that there is a close correspondence between costs of debt and credit ratings. However there are considerable variations in the DRPs (or equivalently the costs of debt) for bonds of the same credit rating (and term to maturity). For example, CEG (2012, Figure 1) shows a spread in the Bloomberg DRPs on two-year BBB+ bonds from 1.6% to 3.4%. In addition, CEG (2012, Figure 2) shows a spread in the Bloomberg DRPs on six-year BBB bonds from 2.8% to 5.2%.[17] Nor is this variation limited to Bloomberg data. For example, CEG (ibid, Figure 2) shows a spread in the UBS DRPs on one-year A- bonds from 1% to 4%, on six-year A- bonds from 2% to 4%, and on fifteen-year A- bonds from 3.3% to 5.8%. Even more spectacularly, CEG (Figure 11) shows a spread in the DRPs on pooled UBS and Bloomberg data on ten-year BBB bonds issued by Australian firms from 7% to 14.5%. Chairmont Consulting (2012, Graph 1) provides another dramatic example of this kind, in the form of yields on 18.11.2011 for a range of AAA rated public-sector entities that issued debt in the Australian market; the yields range from 3% to 7% at a five year term to maturity. Thus, in using any curve that is fitted to data of a particular credit rating and at a particular term to maturity, one is averaging over huge variation in DRPs.

Many of the sources of this variation are quite well understood; current DRPs depend not simply on credit rating (which is an estimate of default risk based upon past information, at least in the case of S&P) and term to maturity but a host of other factors that affect the DRP but not the current credit rating.[18] One of these is liquidity, which lowers a bond's yield but does not affect its credit rating. Another is callability, which raises a bond's yield to compensate the bondholder for the bond issuer's right to call the bond but may not affect its credit rating. Another is a conversion option, which lowers a bond's yield to compensate the issuer for the bond holder's right to convert the bond but may not affect its credit rating. Another is the expected loss rate in the event of default, which lowers a bond's yield in

[17] The terms to maturity of these bonds range from 5.5 to 7.5 years with the DRP monotonically decreasing whilst the BFVC is upward sloping. Consequently, if the terms to maturity had matched more closely, the DRP range would have been even greater.

[18] S&P credit ratings are measures of default risk and do not also take account of the expected loss to bondholders in the event of default except for bonds below BBB (REU, 2014, page 23). By contrast, Moody's allow for both considerations in their credit ratings (Moody's, 2014, page 4). Since the RBA uses only S&P ratings, and BVAL uses an average over the ratings of any two of S&P/Moody's/Fitch, or S&P, or Moody's, most of the credit ratings used here will be those of S&P. So, the analysis here is premised on this.

compensation but does not affect its S&P credit rating. Another is mere differences in opinion between the market and the rating agencies about the risk of default, and this can extend to entire industries. Lastly, markets react more quickly to new developments than rating agencies and therefore bonds may have unusually high or low DRPs relative to other bonds of the same rating until the rating is changed. Chairmont Consulting (2012, Graph 2) again provides a particularly pointed example of this point, involving GE Capital whose DRP rose from 0.8% to 5.0% over the two year period preceding a rating downgrade in March 2009.

The implications of all this for the AER's process is clear. Amongst the energy network businesses that the AER regulates, if the liquidity of their bonds, incidence of call options, incidence of conversion options, or expected loss rates in the event of default are not typical of bonds within the BVAL and RBA samples with the same credit ratings, their cost of debt will diverge from that of these comparator bonds with the same credit rating. Consequently, an allowed cost of debt for these energy network businesses that is based upon the average cost of debt of a comparator group of bonds will be biased. Two points warrant mention. Firstly, bonds within the RBA and (especially) BVAL sample sets have higher than normal liquidity (because liquidity is one of the selection criteria in both indexes), and therefore lower than normal DRPs, and this would exert a downward bias in estimating the cost of debt for the energy network businesses. Secondly, and in relation to expected loss rates in default, defaults can occur for a variety of reasons including collapse of demand for the product or service supplied by the entire industry, or collapse in the demand for the product or service supplied by the particular firm due to the higher output quality or the lower costs of its competitors. In such cases, the business will have no value as a going concern and the loss rate to debt holders will depend upon the liquidation value of the individual assets, which could be very low. These scenarios are much less relevant to firms with regulated energy network businesses; in the event of them defaulting on their debt obligations, the regulated businesses are still likely to be viable and their value as a going concern undiminished. Consequently, the firm's bond holders would be likely to experience lower than normal expected loss rates in the event of a default. Consistent with this, PwC (2013, pp. 11-12) find that the yields on the ten-year BBB bonds of US utilities are 0.34% less on average than for BBB bonds in general over the period since 1991.

To explore this issue further, let p denote the probability of a firm defaulting over the next (and final) year of its life, L the loss rate for bondholders in the event of default, d the expected rate of return, and k the promised yield to maturity. The value now of a bond per \$1 of promised payoff is then as follows:

$$B = \frac{\$1}{1+k} = \frac{p(1-L)+(1-p)}{1+d}$$

Solving this yields

$$k = \frac{1+d}{1-Lp}$$

Thus, the loss rate in the event of a default is as important as the default probability in determining the promised yield on a bond, i.e., doubling the loss rate would have the same effect as doubling the default probability. Thus, any feature of a firm that significantly affects the loss rate suffered by its bond holders in the event of a default would significantly affect that part of its cost of debt that is compensation for expected default losses.

In summary, credit ratings do not fully reflect the cost of debt because they do not reflect the liquidity, presence of call options, presence of conversion options, and (in respect of S&P) expected loss rates for bonds. Furthermore, the bonds of regulated energy network businesses would have lower average liquidity than the bonds in the BVAL and RBA sets, and are also likely to have lower than normal expected loss rates for bondholders in the event of default. The first point would lead to the BVAL or RBA indexes underestimating the cost of debt for regulated energy network businesses with the same credit ratings whilst the second point would lead to an overestimate. The net effect of these two points is not known.

4.3 Application of the RBA/BVAL BBB Indexes to Regulated NSPs

Section 4.1 argues that the appropriate credit rating for regulated energy network businesses is BBB to BBB+, both at the present time and over the next five years. In addition, section 4.2 argues the bonds of regulated energy network businesses would have lower average liquidity than the bonds in the BVAL and RBA sets, and are also likely to have lower than normal expected loss rates for bondholders in the event of default. The first point would lead to the BVAL or RBA indexes underestimating the cost of debt for regulated energy network businesses with the same credit ratings whilst the second point would lead to an overestimate.

The net effect of these two points is not known, and therefore one would have to act as if this net effect is zero. So, because the appropriate credit rating for regulated energy network businesses is BBB to BBB+ rather than BBB, the use of the BVAL or RBA indexes for the broad BBB group is likely to overestimate the cost of debt for regulated energy network businesses.

5. Bond Selection Criteria

The BVAL and RBA indexes use different criteria for selecting bonds. As discussed in section 2, these are as follows:

(1) The BVAL sample of bonds is limited to those with a minimum pricing quality (liquidity measure), at least two months to maturity, and bond issues of at least \$10m whilst the RBA sample is limited to bond issues of at least \$100m and at least one year to maturity.

(2) The BVAL sample does not exclude financial corporations whilst the RBA's does.

(3) The BVAL sample is limited to unsecured bonds whilst the RBA's sample includes both secured and unsecured bonds.

(4) The BVAL sample includes bonds rated by either S&P or Moody's, whilst the RBA sample is limited only to bonds rated by S&P or issued by a firm with an S&P rating.

(5) The BVAL sample is limited to AUD denominated bonds whilst the RBA sample also includes USD and Euro denominated bonds.

(6) The BVAL sample excludes bonds with call, put and conversion options, whilst the RBA sample does not exclude them.

The difference in criteria raises the question of whether this would lead to a significant and systematically different result. In respect of point (1), and as discussed in section 2.1, the liquidity of bonds in the BVAL set is likely to be higher than in the RBA set and this has two effects. Firstly, illiquid bonds typically do not have recent trades and therefore the estimated yield to maturity is more likely to be in error; this could be in either direction and is therefore not systematic. Secondly, when more illiquid bonds do trade, the yield will be higher than otherwise to reflect the illiquidity of the bond, and this will exert a systematic upward effect on the RBA index but it is not possible to determine the scale of this effect. Since most corporate bonds are highly illiquid, the RBA index is likely to be more representative of the typical corporate bond. The BVAL index is preferred in respect of the first point whilst the

RBA is preferred in respect of the second. In statistical terms, the trade-off is between standard deviation and bias. The preferred index would be that of lower MSE (Mean Squared Error) but it is not possible to express a preference on this.

In respect of point (2), there are no a priori grounds to expect a difference in yields between financial and non-financial corporations (for a given credit rating and term to maturity) and, as discussed in section 2.1, the Australian empirical evidence is unclear. Furthermore, even if financial corporations do have different costs of debt at the same credit level and term to maturity, the resulting expansion in the sample size (and therefore possible reduction in standard deviation) from including them might compensate for the bias from including them. Again, the preferred index would be that of lower MSE but it is not possible to express a preference on this.

In respect of point (3), and again as discussed in section 2.1, the omission of secured bonds from the BVAL sample will systematically raise its index value but the point is not significant at the present time due to the paucity of these bonds. In respect of point (4), and as discussed in section 2.1, the effect is unlikely to be significant and even less likely to be systematic. In respect of point (5), I do not have current data on the differential between local and foreign currency bonds. However, there are no a priori grounds to expect that any differential would be systematic. Consistent with this, the empirical evidence discussed in section 2.1 suggests that the differential has fluctuated over time (from positive to negative). Finally, in respect of point (6), and as discussed in section 2.1, the omission of callable bonds lowers the index value whilst the omission of convertible bonds would raise it but only if no adjustments are made. Any adjustments that are made are likely to be imperfect to some degree but this only adds noise rather than a systematic effect. Since the proportion of bonds in the RBA index with embedded options (other than make-whole call options, for which there is minimal effect) is very small at the present time, the effect on the index would be minimal even without adjustments and even more so if there were adjustments.

In summary, none of these effects are clearly both significant and systematic. It is likely that the bonds in the RBA index have on average inferior liquidity than those in the BVAL index, and this will exert a systematic upward effect on the RBA index, but it is not possible to determine whether this is significant. In addition, the presence of foreign currency bonds in the RBA index may have exerted a significant impact at some points in the past. Over the period since both indexes have been continuously available (since February 2011), the BVAL index initially exceeded the RBA index by 0.44% but the situation quickly reversed and the RBA index has exceeded the BVAL since then by between 0.07% and 0.97% with an average of 0.50%.[19] The most likely cause of this substantial fluctuation is the inclusion of foreign-currency bonds in the RBA index. Finally, on the question of which index better reflects the cost of debt for the efficient benchmark entity, there is no clear winner. The inclusion of secured bonds in the RBA index will generate results that better reflect the benchmark entity (whether it has secured bonds or not). However, by excluding bonds with embedded options, the BVAL index better reflects the benchmark entity (which should be defined as not having any such options because the regulatory process cannot allow for them, as discussed in section 2.1).

6. Curve Fitting Methodology

Arsov et al (2013) provides considerable detail on the curve fitting methodology adopted by the RBA. By contrast, Bloomberg is much less forthcoming and the only clear point of distinction is that the BVAL yields are par yields whilst the RBA yields are not (REU, 2014, pp. 13-14). This issue has been examined in section 2.1 and it is argued there that par yield results are more appropriate for the AER's purposes (i.e., the BVAL is superior), that the error from failing to use par yields would not exceed 0.06% when the slope of the spot yield curve is typical, and that the error would not exceed 0.24% when the slope of the spot yield curve was at its greatest. These upper limits would only arise if the RBA index estimated the yield at a particular tenor using bonds with extreme coupon rates, and therefore are unlikely to arise. In addition, the error from failing to use a par yield could be in either direction (too low or too high). Thus, the differences between the BVAL and RBA indexes in this respect are neither material nor systematic. Finally, since the BVAL index has exceeded the RBA index by as much as 0.44%, and the RBA index has exceeded the BVAL by as much as 0.97%, the par yield issue could have contributed at most only a small part to these differences.

[19] These calculations presume that the RBA and BVAL rates have been consistently annualized in the presence of semi-annual or quarterly coupons. If there is an inconsistency, and it is not clear to me whether this is the case, it would affect the results but not materially. For example, if the BVAL rates have been corrected in this way but the RBA rates have not been, then the RBA rates should be raised by about 0.10% (3% semi-annually converts to 6% annually using simple interest and 6.09% using compounding) and therefore the average difference would fall from 0.50% to 0.40%.

In summary, and in respect of curve fitting methodology, the only clear point of distinction between the BVAL and RBA indexes is that the BVAL yields are par yields whilst the RBA yields are not. Par yields are more appropriate for the AER's purposes but the differences are neither material nor systematic.

7. Curve Extrapolation

Both the RBA and BVAL indexes require extension out to ten years, the latter because the longest tenor is only seven years[20] and the former because the effective tenor for the DRP component of the ten-year term is generally less than ten years (and has averaged 8.7 years since its inception). I therefore examine techniques for extending the index values out to ten years subject to these techniques involving the automatic application of a formula.

I start with the RBA. Although the index is a cost of debt, it can be decomposed into a base rate (CGS or swap rate) and a DRP relative to the base rate, and doing so allows different extension techniques to be applied to the two components. In respect of the DRP, the required extension term is only 1.3 years (on average), and this favours a simple extension technique (because the downside to simplicity, which is error, is likely to be small). The natural candidate is therefore linear extrapolation using the effective tenors for both the 'seven' and 'ten' year values. Letting 10*e* denote the effective tenor corresponding to 10 years, the estimate for the RBA ten year cost of debt is that for 10*e* years plus the base rate margin from 10*e* to 10 years plus the DRP margin from 10*e* to 10 years as follows:[21][22]

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[20] The BVAL was available for terms up to seven years at the time the new regime came into effect (mid 2014). Since then, the seven year term has been terminated due to lack of data and the longest term is currently five years. However, the principles involved in extending the BVAL out to ten years are the same in both cases.

[21] The cost of debt reported in Table F3 for ten years is in fact the base rate (swap rate) for ten years plus the DRP estimate for bonds around ten 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, effectively, the cost of debt reported in Table F3 is the estimated yield for 10*e* years net of the estimated swap rate for 10*e* years, plus the swap rate for 10 years, and therefore encompasses the first three terms on the RHS of equation (4). The yield for 10*e* years can be deduced from the rate reported in Table F3 and the contemporaneous swap rates for 10*e* and 10 years.

[22] To illustrate the possibility that extrapolation errors can grow dramatically with the extrapolation term, suppose that the DRP as a function of term to maturity is D = -0.0139T^2 + 0.333T, which implies DRPs at 5, 7, 8.7, and 10 years of 1.32%, 1.65%, 1.85%, and 1.94% respectively. Using the observed DRPs at 7 and 8.7 years, of 1.65% and 1.85% respectively, the estimated increment in the DRP from 8.7 to 10 years in accordance with equation (4) is 0.15% whilst the true increment is 0.09%. So, the extrapolation overestimates the DRP at ten years by 0.06%. By contrast, if the observed DRPs at 5 and 7 seven years had been used to estimate the DRP from 7 to 10 years, the extrapolation would overestimate the DRP at ten years by 0.20%. So, the error would be magnified three times by extrapolating over three years rather than only 1.3 years.

$$\hat{RBA}(10) = RBA(10e) + Base(10) - Base(10e) + \left[\frac{DRP(10e) - DRP(7e)}{10e - 7e}\right](10 - 10e) \quad (4)$$

In respect of the base rate, which could be the swap rate or the CGS rate, the swap rate is only available for a limited number of terms (including five, seven and ten years), and the average tenors for the seven and ten year bonds (as reported in Table F3) is 6.7 and 8.7 years respectively. Consequently, when using the swap rates, interpolation (over 1.3 yrs, being 10 yrs less 8.7 yrs) is required to obtain the swap rate for *Base*(10e), which is both the third term on the RHS of equation (4) and is implicit in *DRP*(10e).[23] By contrast, in the relevant future period of six to ten years, the CGS maturity dates are only one year apart, and therefore the desired maturity date on a bond would only differ from the nearest available one by three months on average. So, the problem is less severe when using the CGS as the base rate, and I therefore favour it. However, the difference in outcomes is trivial.

For example, for 31 July 2014, the RBA's Table F3 gives 7e = 6.84 years, 10e = 8.64 years, and costs of debt on the seven and ten year bonds of 5.13% and 5.51% respectively. In addition, the five, seven, and ten year swap rates from Bloomberg on the same date are 3.28%, 3.569%, and 3.878% respectively, and interpolation gives rates for 6.84 years and 8.64 years of 3.546% and 3.738% respectively. This implies that

$$RBA(7e) = 5.13\% - Swap(7) + Swap(6.84) = 5.11\% - 3.569\% + 3.546\% = 5.11\%$$
$$RBA(10e) = 5.51\% - Swap(10) + Swap(8.64) = 5.51\% - 3.878\% + 3.738\% = 5.37\%$$

In addition, interpolating using the RBA's Table F16 gives *CGS*(7e) = 3.23%, *CGS*(10e) = 3.41%, and *CGS*(10) = 3.53%.[24] Therefore, *DRP*(7e) = 1.88% and *DRP*(10e) = 1.96%. Substitution into equation (4) then yields:

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[23] Both interpolations have already been performed by Bloomberg, and are reflected in the reported cost of debt and the reported DRP relative to the swap rate respectively, as shown in the RBA's Table F3.

[24] The interpolation involves the bond with a greatest residual term to maturity below the target term and the bond with the lowest residual term to maturity above the target term. For example, a ten-year term to maturity from 31 July 2014 is 31 July 2024, and the bonds used in the interpolation have maturity dates of 21 April 2024 and 21 April 2025. So, the interpolation here is only over three months (from April 2024 to July 2024).

$$\hat{RBA}(10) = 5.37\% + 3.53\% - 3.41\% + \left[\frac{1.96\% - 1.88\%}{8.64 - 6.84}\right](10 - 8.64) = 5.58\%$$

So, starting with 5.37% for the cost of debt for an effective tenor of 8.64 yrs, the CGS margin for 10 over 8.64 year bonds adds 0.12%, and the DRP margin for 10 over 8.64 year bonds adds a further 0.06% with the DRP margin requiring extrapolation over 1.36 years whilst the CGS margin involves (more accurate) interpolation over no more than three months (because observed yields exist closer to the target dates). By contrast, CEG (2014, section 3.5) extrapolates the entire cost of debt from 8.64 to 10 years and therefore fails to take account of the ability to estimate the base component more accurately through interpolation.

Alternatively, using the swap rate as the base rate, the RBA's reported yield on ten year debt in Table F3 of 5.51% constitutes the first three terms on the RHS of equation (4), whilst Table F3 also provides *DRP*(7e) = 1.56% and *DRP*(10e) = 1.64%. Substitution of these values into equation (3) then generates an estimate for the ten-year cost of debt of 5.57%, and this differs from the result above of 5.58% from using the CGS as the base rate by only 0.01%.

In respect of the BVAL, the base rate can be dealt with using observed rates or interpolation as before. In respect of the DRP, linear extrapolation is no longer clearly favoured because the extension period is now three years (from seven to ten years) rather than only 1.3 years. It is therefore necessary to consider the merits of various extension techniques. Incenta (2014) has considered various techniques for estimating the increment in the DRP from seven to ten years, and concludes that the best technique involves use of the QTC quarterly survey data (ibid, section 1.1.2). The principal basis for this conclusion is that the best estimate of the true DRP increment is that arising from the AER's 'Paired Bonds' approach, and the estimates generated using the QTC data produce a lower RMSE than any other estimation technique examined (comprising linear extrapolation applied to the BFV, use of the RBA index, and the use of two Bloomberg US indexes). However, since the root mean squared error (RMSE) results are dependent upon the particular input data used and the true increment in the DRP is not observable (it is merely proxied by the AER's 'Paired Bonds' technique), there is little to choose between the use of the QTC approach with an RMSE of 7.7 basis points and the use of the RBA index with a RMSE of 11.7 basis points (ibid, Table 1). Furthermore, the RBA approach is much simpler to implement, requiring only observations on the RBA index (which are publicly available) whilst the QTC approach would require periodic rerunning of a regression model to utilize the additional QTC survey data that becomes available as time passes. Furthermore, any regression model requires judgement over whether to delete some outliers and therefore does not in this respect satisfy the AER's requirement for the extrapolation process to involve the "automatic application of a formula" (see Terms of Reference, point 6). Furthermore, the tests are biased against the RBA because Incenta assumes that the seven and ten-year DRPs reported by the RBA are in fact for those periods and this is not the case as discussed above; had the reported RBA values been adjusted as described above, the performance of the RBA index may have been superior.[25] The tests are further biased against the RBA index because the proxy for the true increment in the DRP is the paired bonds technique and these are only local currency bonds whilst the RBA includes foreign-currency bonds.

Finally, the alleged superiority of the QTC approach over the RBA approach (in RMSE terms) lies in the lower standard deviation outweighing the higher bias (Incenta, 2014, Table 1). However, this analysis presumes that the exercise in question involves a single estimate of the DRP differential (for seven to ten years) and this is only the case if the estimate is being made for the first year and only one RBA observation per year is used. Otherwise, multiple RBA estimates are used and, once the transitional period of ten years has passed, there will be at least one RBA observation per year used to form a ten-year trailing average. So, the better test is not the RMSE from one estimate but the RMSE from the trailing average estimate. The greater number of individual estimates will not affect the bias in the estimate, but it will reduce the standard deviation and this will favour the RBA approach over the QTC approach. For example, suppose the trailing average requires ten (equally-weighted) DRP estimates and these are statistically independent. Letting *SD* denote the standard deviation associated with one estimate, the standard deviation of the trailing-average estimator will then be

$$SD(TA) = \frac{SD}{\sqrt{10}}$$

[25] Incenta uses RBA values for 6.8 and 8.7 years (on average) to estimate the DRP increment from 7 to 10 years. This may lead to bias in the RBA estimates, and therefore adversely reflect on Incenta's assessment of the RBA index. However, if Incenta had corrected the RBA estimates to generate estimates for 7 and 10 years, this potential bias would have been eliminated and therefore the performance of the RBA index may have been better.

Using the *SD* and bias results shown in Incenta (2014, Table 1) for their preferred 2012-2013 analysis, the RMSE results for the RBA and QTC approaches are now as follows:

$$RMSE(RBA) = \sqrt{(1.3)^2 + \frac{(11.7)^2}{10}} = 3.9$$

$$RMSE(QTC) = \sqrt{(4.8)^2 + \frac{(6.0)^2}{10}} = 5.2$$

So, in RMSE terms, the RBA approach now has the lower RMSE and is therefore superior. These calculations assume that the estimates are statistically independent whereas positive correlation is likely, and therefore the benefit from the multiple observations shown above is reduced. However, at the very least, this analysis undercuts Incenta's claim that the QTC approach has the lower RMSE.

In view of these points, the RBA approach is favoured for estimating the DRP increment for the BVAL from seven to ten years. Following equation (4), the estimate for the BVAL ten-year cost of debt is as follows:

$$B\hat{V}AL(10) = BVAL(7) + Base(10) - Base(7) + \left[\frac{DRP(10e) - DRP(7e)}{10e - 7e}\right](10-7) \quad (5)$$

As with equation (4), the preferred base rate is the CGS rate but again the difference in outcomes is minor. For example, consider 31 July 2014 on which *BVAL*(7) = 4.86%.[26] In addition, the RBA's Table F3 gives 10e = 8.64 yrs and 7e = 6.84 yrs. In addition, interpolating using the RBA's Table F16 gives *CGS*(7) = 3.25% and *CGS*(10) = 3.53%. In addition, *DRP*(7e) = 1.88% and *DRP*(10e) = 1.96% as shown above. Substitution into equation (5) then yields:

$$B\hat{V}AL(10) = 4.86\% + 3.53\% - 3.25\% + \left[\frac{1.64\% - 1.56\%}{8.64 - 6.84}\right](10-7) = 5.27\%$$

[26] This figure may be for an effective term of less than seven years, as with the RBA value for seven years. However, in the absence of any information from Bloomberg on this matter, I assume the figure is also for an effective term of seven years. The average discrepancy in the RBA data averages only 0.3 years and therefore, if the same is true for the Bloomberg data, the issue is minor.

So, starting with 4.86% for the BVAL index for a seven-year term, the CGS margin for ten over seven year bonds adds 0.28%, and the DRP margin for ten over seven year bonds adds a further 0.13%, with the DRP margin requiring extrapolation whilst the CGS margin involves (more accurate) interpolation.

Alternatively, using the swap rate as the base rate, the Bloomberg rates for seven and ten years on 31 July 2014 are 3.57% and 3.88% respectively whilst the RBA's Table F3 provides DRP(7e) = 1.56% and DRP(10e) = 1.64%. Substitution of these values into equation (5) then generates an estimate for the ten-year cost of debt of 5.30%, and this differs from the result above of 5.27% from using the CGS as the base rate by only 0.03%.

These extrapolated results for the RBA and BVAL, as determined by equations (4) and (5), should then be averaged in accordance with section 2.2. In respect of 31 July 2014, averaging over 5.58% for the extrapolated RBA and 5.27% for the extrapolated BVAL yields 5.42%.[27]

In summary, both the RBA and BVAL indexes require extension out to ten years, the latter because the longest tenor is seven years and the former because the effective tenor of the bonds used for the ten-year term is generally less than ten years (and has averaged 8.7 years since its inception). The components requiring extension are the base rate and the DRP, although the RBA performs the base rate extension itself. The CGS is marginally preferred over the swap rate as the base rate although the results are almost identical in either approach. The CGS can be extended using RBA data on bonds with maturity dates shortly before and after the relevant points in time. In respect of the DRP, the required extension term for the RBA index is only 1.3 years on average (from 8.7 to 10 years), and this favours the simplest technique, which is linear extrapolation using the DRP data for the effective tenors for both the 'seven' and 'ten' year values. In respect of the BVAL, linear extrapolation is no longer clearly favoured because the extension period is now three years (from seven to ten years) rather than only 1.3 years. The available evidence suggests that the best method is use of the RBA data for the effective tenors for both the 'seven' and 'ten' year values. Since these extension procedures are feasible, and would likely lead to different margins over the course

[27] All of these calculations presume that the RBA and BVAL rates have been properly annualized in the presence of semi-annual or quarterly coupons. If this is not the case, it should be done first. For example, with semi-annual coupons and a semi-annual rate of 3%, the annual equivalent of this is 6.09%.

of a five-year regulatory period, there is no case for adopting a fixed margin for the five-year regulatory period.

8. Conclusions

In response to the questions posed by the AER, my conclusions are as follows. Firstly, on the question of which independent third-party data service provider should be used to estimate the cost of debt, eleven points of distinction exist between the BVAL and RBA indexes and examination of these reveals that neither index is clearly superior to the other. I therefore recommend that a combined estimator be used. Since the standard deviations of these estimators are similar and it is not possible to quantify any biases in these two indexes, I recommend that the two indexes be equally weighted. This will lower the MSE of the estimator relative to using only one of the indexes, and significantly so if the correlation between the indexes is low. The contrary arguments presented by NERA, CEG, ActewAGL, and Directlink in support of sole use of the RBA index do not support their preference, and the approach proposed by Jemena (involving use of the RBA index on some occasions and the BVAL on others) sacrifices the MSE gains from a combined estimator.

Secondly, in respect of the efficient financing mix for the benchmark entity, this involves bank debt, Australian currency bonds and foreign currency bonds so as to mitigate refinancing risk and to benefit from the flexibility of bank debt. The optimal weights will vary over time, in inverse relation to their costs.

Thirdly, in using a cost of debt index that is based upon bonds, as the RBA and BVAL indexes are, bank debt is excluded and this raises the question of whether bias in the allowed cost of debt might arise. However the very reason for excluding bank debt in the assessment of the allowed cost of debt (the lack of secondary market data) also precludes a formal assessment of this potential concern. Furthermore, since bank debt constitutes only about 25% of the debt of regulated firms, this low weighting mitigates any bias arising from its omission from the RBA and BVAL indexes.

Fourthly, if the AER were to use the BVAL index only or average over the RBA and BVAL indexes, the fact that the BVAL index does not include foreign bonds implies that foreign bonds will be underweighted and this raises the question of whether bias in the allowed cost of debt might arise. However, whilst there are good grounds to believe that the cost of local currency bonds does fluctuate relative to that of otherwise identical foreign currency bonds, after the currency swap required to convert foreign-currency bonds to AUD, there are no grounds to believe that there is a systematically higher rate on one or the other. Thus, the omission of foreign currency bonds from the BVAL index should not lead to systematically over or understating the cost of debt for regulated energy network businesses. In addition, even if the AER used only the RBA index, the weights on local and foreign currency bonds within that index may be significantly different to that of bonds in general and these in turn to the currently optimal weights, and this too would introduce bias but again the effect would not be systematic over time.

Fifthly, in relation to the appropriate credit rating for regulated energy network businesses, I do not think that one can differentiate between the gas and electricity businesses at the present time and I therefore favour a credit rating for the entire sector of BBB to BBB+ both at the present time and as an estimate over the next five years.

Sixthly, in respect of whether credit ratings fully reflect the cost of debt, they do not do so because (S&P) credit ratings only reflect the probability of default whilst the cost of debt also reflects the liquidity, presence of call options, presence of conversion options, and the expected loss rate for the bond in the event of default. Furthermore the bonds of regulated energy network businesses would have lower average liquidity than the bonds in the BVAL and RBA sets, and are also likely to have lower than normal expected loss rates for bondholders in the event of default. The first point would lead to the BVAL or RBA indexes underestimating the cost of debt for regulated energy network businesses with the same credit ratings whilst the second point would lead to an overestimate. The net effect of these two points is not known. However, because the appropriate credit rating for regulated energy network businesses is BBB to BBB+ rather than BBB, the use of the BVAL or RBA indexes for the broad BBB group will overestimate the cost of debt for regulated energy network businesses.

Seventhly, on the question of whether differences in bond selection criteria for the BVAL and RBA indexes could have a material and systematic effect on the index results, none of the effects arising from the points of difference are clearly both significant and systematic. It is likely that the bonds in the RBA index have on average inferior liquidity than those in the

BVAL index, and this will exert a systematic upward effect on the RBA index, but it is not possible to determine whether this is significant. In addition, the presence of foreign currency bonds in the RBA index may have exerted a significant impact at some points in the past. Finally, on the question of which index better reflects the cost of debt for the efficient benchmark entity, there is no clear winner. The inclusion of secured bonds in the RBA index will generate results that better reflect the benchmark entity (whether it has secured bonds or not). However, by excluding bonds with embedded options, the BVAL index better reflects the benchmark entity (which should be defined as not having any such options because the regulatory process cannot allow for them).

Eighthly, on the question of whether differences in curve fitting methodology between the BVAL and RBA indexes could have a material and systematic effect, the only clear point of distinction between the two indexes in this area is that the BVAL yields are par yields whilst the RBA yields are not. Par yields are more appropriate for the AER's purposes but the differences here are neither material nor systematic.

Finally, on the question of how to extend the BVAL and RBA indexes out to ten years, both indexes require extension out to ten years, the BVAL because the longest tenor is seven years and the RBA because the effective tenor of the bonds used for the ten-year term is generally less than ten years (and has averaged 8.7 years since its inception). The components requiring extension are the base rate and the DRP, although the RBA performs the base rate extension itself. The CGS is marginally preferred over the swap rate as the base rate although the results are almost identical in either approach. The CGS can be extended using RBA data on bonds with maturity dates shortly before and after the relevant points in time. In respect of the DRP, the required extension term for the RBA index is only 1.3 years on average (from 8.7 to 10 years), and this favours the simplest technique, which is linear extrapolation using the DRP data for the effective tenors for both the 'seven' and 'ten' year values. In respect of the BVAL, linear extrapolation is no longer clearly favoured because the extension period is now three years (from seven to ten years) rather than only 1.3 years. The available evidence suggests that the best method is use of the RBA data for the effective tenors for both the 'seven' and 'ten' year values. Since these extension procedures are feasible, and would likely lead to different margins over the course of a five-year regulatory period, there is no case for adopting a fixed margin for the five-year regulatory period.

APPENDIX: Terms of Reference

Your advice should refer to the relevant sections of the key documents, as well as any other relevant material. In the context of the AER's rate of return framework, advice is sought on the following matters:

Choice of third party data service provider

1. Recommend a debt data series published by an independent third party data service provider, for the AER's purposes, between the following options:
    a. Adopting the Bloomberg Valuation Service (BVAL) BBB-rated corporate debt yield curve (the Bloomberg data series)
    b. Adopting the RBA BBB-rated Australian non-financial corporation debt yield curve (the RBA data series)
    c. Adopting a simple average of the Bloomberg and RBA data series
    d. Adopting a complex average of the Bloomberg and RBA data series, or
    e. Adopting an alternative debt data series published by an independent third party data service provider, or combination of series, the consultant considers relevant.

    If:

    - Recommending sole use of either data series, explain why this is preferable to a simple or complex average of both series
    - Recommending a simple average of both data series, explain why this is preferable to either adopting the sole use of either series or a complex average
    - Recommending a complex average, explain how the weights for each data series would be determined, determine those weights, and explain why this complex average is preferable to either adopting the sole use of either series, a simple average, or other potential complex averages.

    In answering the above question, take into account your answers to the following questions and any other considerations the consultant considers relevant.

Use of bond data

2. In relation to the use of bond yield data (only) for determining the return on debt of a benchmark efficient entity:
    a. Advise on the efficient financing instrument or mix of financing instruments that would be used by a benchmark efficient entity which is a regulated energy network business operating within Australia (e.g. between bank debt, Australian issued bonds, foreign issued bonds, variants of these instruments and other potential financial instruments)
    b. Would the efficient choice of this instrument or efficient mix of instruments change over time? If so, what factors influence this choice?
    c. In considering the options in question (1) which are restricted to bond yield data series, based on your answer to questions (2a) and (2b), would a return on debt that is based only on a bond data series be likely to systematically undercompensate,

overcompensate or fairly compensate the efficient financing costs of a benchmark efficient entity?

d. Does your answer to (2c) differ depending on whether the Bloomberg data series, RBA data series, or some average of the two, is adopted?

Credit ratings

3. In relation to the use of credit ratings (and tenors) for determining the return on debt:
    a. Advise on whether a BBB+ credit rating is an appropriate benchmark for the benchmark efficient entity, including whether this rating is appropriate for both regulated electricity networks and regulated gas pipelines
    b. What risks are priced into the return on debt and how well do credit ratings (and tenors) fully reflect this risk of debt for the benchmark efficient entity?
    c. In considering the options in question (1) which are restricted to debt data series that are principally defined based on credit rating and term, based on your answer to questions (3a) and (3b), would a return on debt that is based on a debt data series principally defined based on a broad BBB rated credit rating (and long debt tenor) be likely to systematically undercompensate, overcompensate or fairly compensate the efficient financing costs of a benchmark efficient entity?
    d. Does your answer to (3c) differ depending on whether the Bloomberg data series, RBA data series, or some average of the two, is adopted?

Bond selection criteria and data filtering

4. Bloomberg and the RBA adopt bond selection criteria and data filtering processes which have similarities and differences. In relation to these similarities and differences:
    a. Advise on whether the different criteria and processes are likely to lead to a materially and systematically different outcome?
    b. If your answer to question (4a) is yes:
        i. Do these differences explain the different observed outcomes of the Bloomberg and RBA data series
        ii. Which better reflect the return on debt of the benchmark efficient entity?

In answering question (4), the consultant is to review, among other elements:

- The differences in the risk characteristics of bonds issued by financial corporations vs. non-financial corporations
- The differences in the risk characteristics of Australian issued bonds vs. foreign issued bonds
- The differences in the risk characteristics of secured vs. unsecured bonds
- The differences in the risk characteristics of subordinated vs. senior bonds
- The differences in the risk characteristics of bonds with embedded options vs. bonds with no non-standard features

Curve fitting methodology

5. Bloomberg and the RBA adopt different curve fitting methodologies. In relation to these similarities and differences:
    a. Advise on whether the different methodologies are likely to lead to a materially and systematically different outcome?
    b. If your answer to question (5a) is yes:
        i. Does this difference explain the different observed outcomes of the Bloomberg and RBA data series
        ii. Which better reflect the return on debt of the benchmark efficient entity?

In answering question (5), the consultant is to review, among other elements:

- The difference in the properties of a par yield curve vs. a curve resulting from the averaging of credit spreads

Curve extrapolation

6. In the guideline, the AER proposed a benchmark debt term of 10 years. However, the Bloomberg data series is currently available only up until the 7 year mark. Further, CEG, Esquant and REU have identified problems with the RBA data series at the 10 year mark due to the choice of averaging methodology and the asymmetric distribution of long dated bonds.

   Further, under the rules, the annual updating of the return on debt must occur through an 'automatic application of a formula' that is specified in the regulatory determination.

   In this context

    a. Is it reasonable to adopt the RBA 7 year data series and/or Bloomberg 7 year data series and add a 'fixed margin' to extrapolate either/both series out to 10 years, where the margin would be fixed for the five years of the regulatory period?
    b. If yes:
        i. Advise on a methodology to determine that fixed margin, and
        ii. Estimate that fixed margin
    c. If no:
        i. Advise on an alternative methodology to extrapolate the Bloomberg and/or RBA data series in order to estimate a 10 year return on debt

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