ACCC, Regulatory Economic Unit

Return on debt estimation: a review of the alternative third party data series

Report for the AER

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Dr Yuliya Moore

Principal Economist

Regulatory Economic Unit

ACCC

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Background

This report is prepared in response to a request for Regulatory Economic Unit (REU) advice from the AER rate of return team on implementing the AER's proposed approach for estimating the return on debt. The request was issued as a follow-up to the AER rate of return guideline published on 17 December 2013.

Rate of return guideline

In the guideline the AER proposed to set the allowed return on debt using a trailing average portfolio approach (following the completion of a transitional arrangement period). In particular, the AER proposed to apply the following:[1]

- A trailing average portfolio approach with the length of the trailing average to be 10 years.

- Equal weights to be applied to each annual element of the trailing average.

- The trailing average to be automatically updated every regulatory year within the regulatory control period.

For the estimation of the prevailing return on debt, the AER proposed the following:[2]

- Use the published yields from an independent third party data service provider.

- Use a credit rating of BBB+ from Standard and Poor's or the equivalent rating from other recognised rating agencies.[3]

- Use a term to maturity of debt of 10 years.[4]

The AER did not specify in the guideline which independent third party data service provider it proposed to use. The AER had previously expressed a preference for using a method that is transparent. However, in the guideline the AER also acknowledged that other factors—such as differences in debt instruments selection criteria—would need to be considered in assessing competing data providers.[5]

WACC criteria and the benchmark efficient entity

In the rate of rate return guideline, the AER defined the benchmark efficient entity as 'a pure play, regulated energy network business operating within Australia'.[6]

Further, the AER set out criteria that it proposed to use to assess the merits of various sources of information in setting the allowed rate of return. These criteria are presented below.[7]

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[1] See: AER, *Rate of return guideline*, December 2013, p. 19.

[2] See: AER, *Rate of return guideline*, December 2013, p. 21.

[3] If the published yields do not reflect the assumed credit rating of BBB+ (or its equivalent), the AER proposed to apply the published yields that are the closest approximation of the BBB+ credit rating.

[4] Where the yield at a term to maturity of 10 years is not published by the third party service provider, the AER proposed to determine the method for extrapolation at each network service provider's determination.

[5] See: AER, *Rate of return guideline: explanatory statement*, December 2013, pp. 126–130.

[6] See: AER, *Rate of return guideline: explanatory statement*, December 2013, p. 32.

[7] See: AER, *Rate of return guideline*, December 2013, p. 6.

The AER considers decisions on the rate of return are more likely to be consistent with the allowed rate of return objective if they use estimation methods, financial models, market data and other evidence that are:

(1) where applicable, reflective of economic and finance principles and market information

    a. estimation methods and financial models are consistent with well accepted economic and finance principles and informed by sound empirical analysis and robust data

(2) fit for purpose

    a. use of estimation methods, financial models, market data and other evidence should be consistent with the original purpose for which it was compiled and have regard to the limitations of that purpose

    b. promote simple over complex approaches where appropriate

(3) implemented in accordance with good practice

    a. supported by robust, transparent and replicable analysis that is derived from available credible datasets

(4) where models of the return on equity and debt are used these are

    a. based on quantitative modelling that is sufficiently robust as to not be unduly sensitive to errors in inputs estimation

    b. based on quantitative modelling which avoids arbitrary filtering or adjustment of data, which does not have a sound rationale

(5) where market data and other information is used, this information is

    a. credible and verifiable

    b. comparable and timely

    c. clearly sourced

(6) sufficiently flexible as to allow changing market conditions and new information to be reflected in regulatory outcomes, as appropriate.

Previous regulatory decisions

At the time the AER rate of return guideline was published, two independent third parties were providing data that could be used to estimate the return on debt—the Reserve Bank of Australia (RBA) and Bloomberg. This contrasts with previous regulatory decisions, where the Bloomberg seven year fair value curve for BBB-rated bonds was the only viable third-party proxy for estimating the return on debt for the benchmark entity.

RBA series

The RBA began publishing estimates of 3, 5, 7, and 10 year credit spreads and yields for BBB–rated (and A–rated) Australian non–financial corporations in December 2013.[8] The methodology

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8   The RBA series are available from the RBA Statistical Table F3, *Aggregate measures of Australian corporate bond spreads and yields*, at http://www.rba.gov.au/statistics/tables/.

underpinning the RBA's estimates was described in its December Bulletin.[9] At present, only month–end estimates are available.

Bloomberg series

In addition to the Bloomberg fair value curve series, in November 2013 Bloomberg started publishing its Bloomberg Valuation Service (BVAL) curve series.[10] The longest published term to maturity for this series is currently seven years. The curve is meant to replace the BFV series that were retired in May 2014.

AER staff considerations

The AER is evaluating whether either of the two currently available third-party series (RBA series and Bloomberg BVAL curve) is preferable for estimating the return on debt of the benchmark efficient entity as defined in the guideline. This evaluation would need to take into account the WACC criteria set out in the guideline, as well as the transparency and robustness of the two methodologies and the availability and frequency of the estimates.

REU Report

This report aims to assist the AER's evaluation by providing a comparative analysis of the bond sample selection criteria and curve-fitting methodologies used by the RBA and Bloomberg.

The analysis takes into account the definition of the benchmark efficient entity and WACC criteria provided in the rate of return guideline. During the preparation of the report, we routinely corresponded with the RBA team (Domestic Markets Department, Securities Market Section) as well as with several Bloomberg representatives to ensure better understanding of both methodologies.[11] Some of the information we procured is confidential. The present analysis is based exclusively on non-confidential information available.

In this report we examine the two series along the following dimensions: input data and curve fitting methodology. We provide the description of specific features of the two data series in the relevant sections. Further, we provide our initial view on the relevance of the two series from the point of view of the return on debt estimation approach as specified in the rate of return guideline.

Findings

There are currently two third-party data providers producing bond yield series that could be used by the AER for its return on debt estimation: the RBA and Bloomberg. Figure below plots the available RBA yield data against the corresponding Bloomberg series (the BFV and BVAL curves). We chose the tenor of 7 years (rather than 10) to facilitate easier comparison of the series, as Bloomberg's series are not available for the 10 year tenor and would need to be extrapolated.[12] The BFV curve has been

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[9] I. Arsov, M. Brooks, M. Kosev, *New Measures of Australian Corporate Credit Spread*, Bulletin, December Quarter 2013, pp. 15-26.

[10] BS157 AUD Corporate BBB BVAL Curve.

[11] A draft of this report was gratefully reviewed by RBA staff for confidentiality checking (to check information provided to the ACCC/AER from the RBA, that the RBA considers is confidential, is not contained in the report) and for fact checking (to check the report accurately represents the RBA's debt data series). However, the analysis and views in this paper are those of the author, and do not necessarily represent the views of the ACCC, AER or RBA.

[12] The RBA series plotted are identified in the RBA statistical tables as FNFYBBB7M, that is, 7 year yields on Australian non-financial corporate BBB-rated bonds; Bloomberg series plotted have Bloomberg tickers C3567Y and BVCSAB07, that is, BFV curve and BVAL curve for Australian AUD BBB rated corporate bonds.

recently retired and is reproduced purely for illustrative purposes. The RBA data is only available for the end of each month. For comparability, for Bloomberg we have used end of month data rather than the full set of daily data available.

Figure

RBA and Bloomberg 7 year yields, end of month data

Figure

RBA 3, 5, 7, and 10 year BBB yields

Legend: RBA BBB 3yrs — RBA BBB 5 yrs — RBA BBB 7yrs — RBA BBB 10yrs

Figure

Bloomberg 7 year series, daily

Legend: BFV BBB 7yrs — BVAL BBB 7yrs
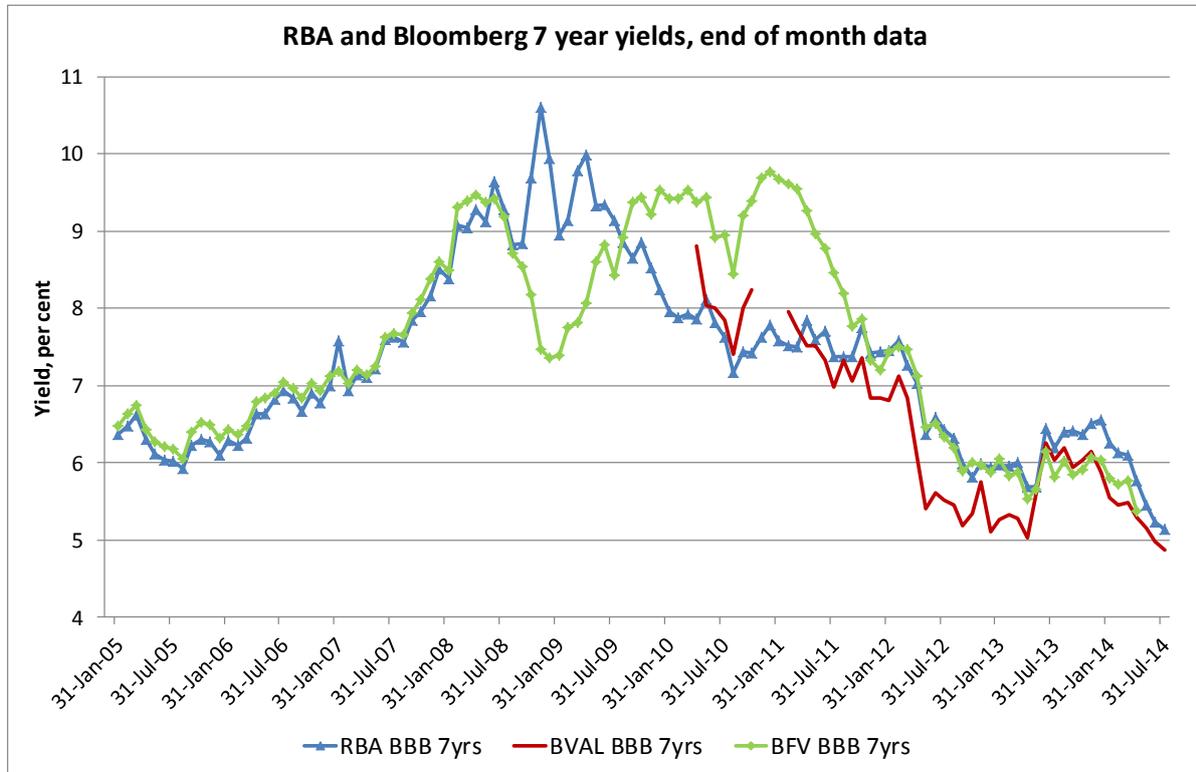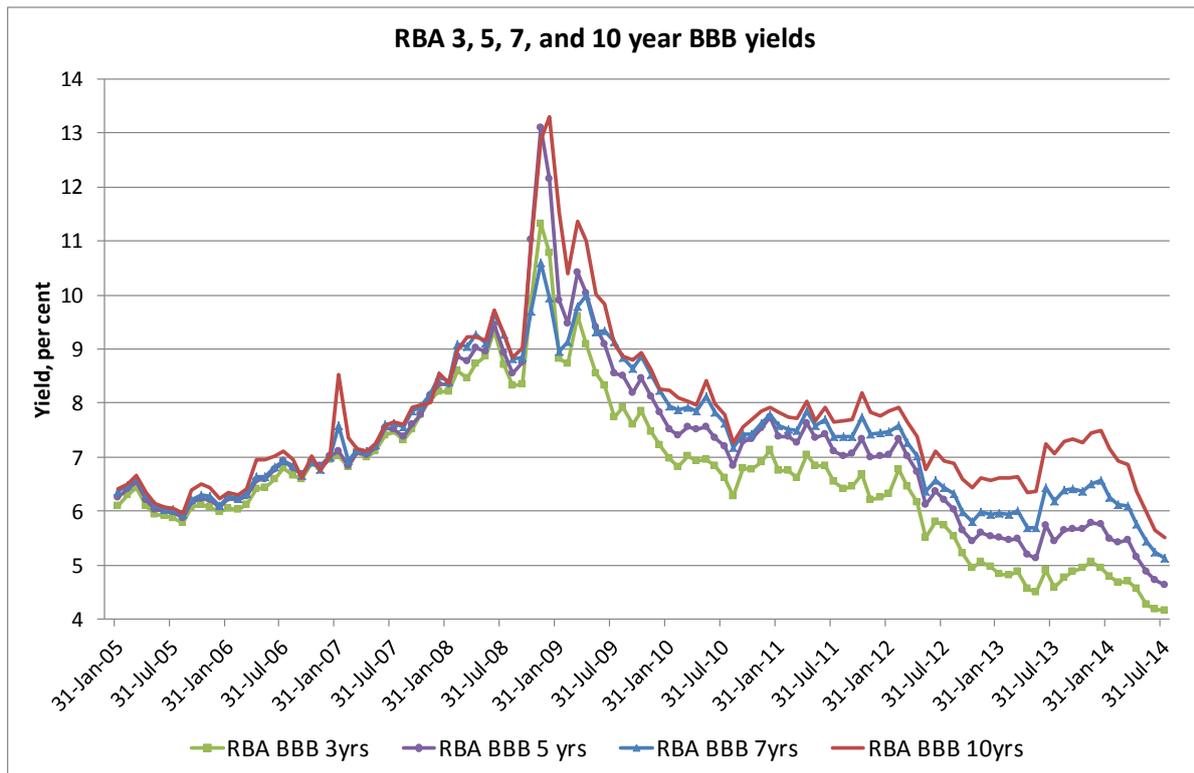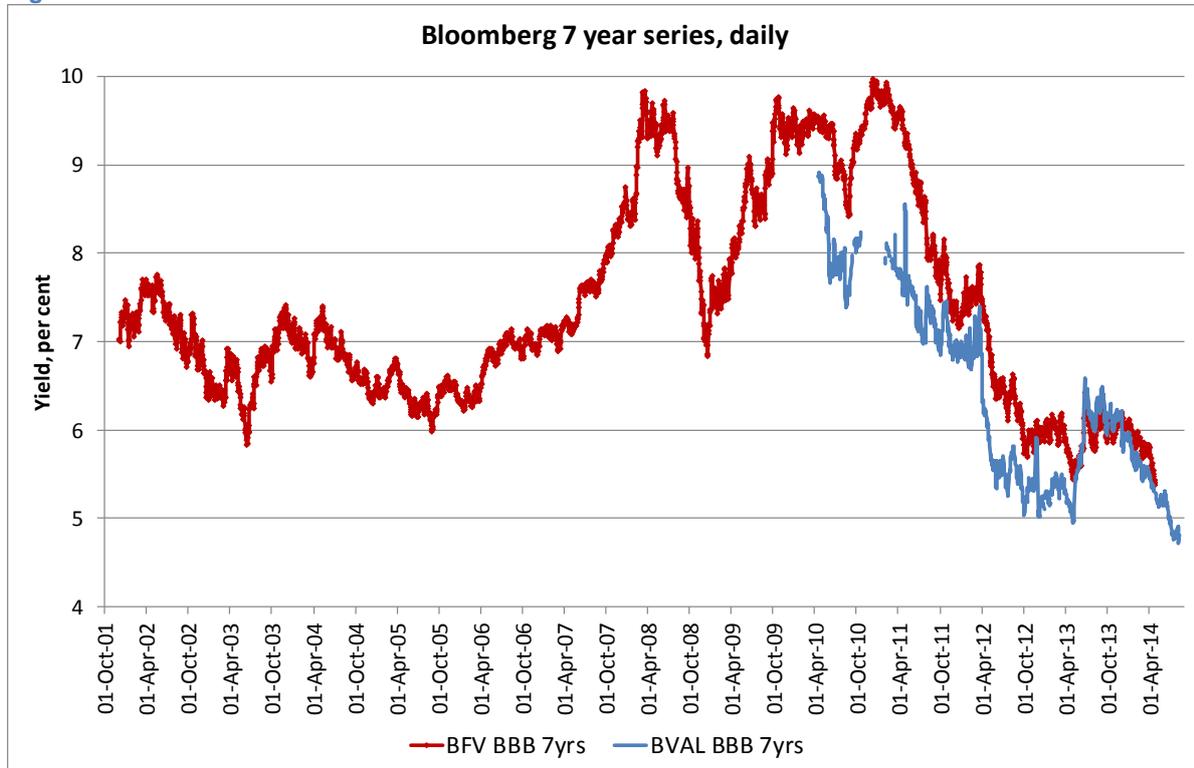
Figure and Figure , respectively, plot all available RBA yield series for Australian BBB-rated non-financial corporations and historical daily data for BFV and BVAL curves.[13]

We note that even though the RBA series values go back to 2005 and the BVAL series to 2010, both series are new and became available in November 2013. Further, both series have important availability limitations given the AER's primary purpose: the RBA series are only available for one day a month and the BVAL series are not available for the 10 year tenor. That is, the AER will potentially need to develop an extrapolation and/or an interpolation approach, depending on which series it chooses. Discussion of relevant extrapolation and interpolation techniques, however, is beyond the scope of this report.

Further, for the purposes of this report we will assume that the AER's set of choices is constrained to the two series described above – or a combination of these series. That is, rather than proposing what would constitute the **best possible** approach for the AER's purposes, we provide a comparative analysis of the two **currently available** series.

We note that there is significant discrepancy between the RBA and BVAL seven-year yields, both at present and historically. However, we consider the focus of this report to be broader than analysing the source of this discrepancy. Indeed, we consider the **future** performance of the two series to be important for the AER's decision. The elements of the methodologies that have caused the curves to diverge in the past may not be the same elements that would cause the curves to diverge in the future. Therefore, our focus is on understanding what aspects of the RBA's and Bloomberg's methodologies are different and what methodology better reflects the approach detailed in the AER's rate of return guideline.

The return on debt of the benchmark efficient entity (BEE) is not directly observable and hence needs to be estimated using available financial market data. Any such estimate would be subject to limitations of both the data sample and estimation techniques used for its construction. Some limitations of the available data that might be of relevance, for example, include the following:

- Expected returns on debt instruments are usually unobservable; instead, we can observe promised returns.

- For less liquid markets the relevant primary debt market data might be scarce, and secondary market data might or might not be a close proxy for the returns investors require on newly issued debt.

- The set of issuers that are close comparators for the BEE might be limited; characteristics of the observed issuing entities in a broader sample (such as credit ratings, industry, etc.) might be different from those of the BEE.

- Characteristics of debt instruments for which data is available might be different from those likely to be issued by the BEE.

Therefore, evaluation of different estimation approaches involves making a judgement as to which characteristics of data samples and estimation techniques are more (or less) important, given the regulatory framework and the approach developed in the AER's rate of return guideline.[14]

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[13] The RBA series plotted are FNFYBBB3M, FNFYBBB5M, FNFYBBB7M, and FNFYBBB10M. Bloomberg series plotted have tickers C3567Y and BVCSAB07, that is, BFV curve and BVAL curve for Australian AUD BBB rated corporate bonds. Figures 1 – 3 use the data available as of 12 August 2014. That is, the last data point for the RBA series is 31 July 2014 and the last data point for the BVAL series is 11 August 2014. Although the BFV series is still available for Excel download, we do not plot the series past 30 April 2014, as it appears to replicate the BVAL series after that date.

We analyse the bond sample selection criteria and adjustments to the bond data, as well as the curve-fitting methodologies, based on the publicly available information and non-confidential information we obtained from the RBA and Bloomberg. For the bond sample analysis, we note that both the RBA and Bloomberg provide a detailed list of bond selection criteria. The list of bonds used to derive the curves (what Bloomberg refers to as the 'constituents') is only directly observable for the BVAL curve, and only observable on the day of estimation. The situation is different with respect to the curve-fitting methodologies: while the RBA has published a summary of its methodology, details of Bloomberg's approach have not been made available to the public.

Bond selection criteria

Overview

Table below summarises the key characteristics of the bond samples for the two data providers.

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[14] However, as we discuss below, we consider that the guideline does not provide us with enough detail to assess some characteristics of the RBA's and Bloomberg's bond data samples.

Table : Comparison of the RBA and BVAL bond samples

Bond characteristic	RBA sample	BVAL sample	Likely to result in material difference	Preferred approach for the AER
Size of issue / quality of pricing data	At least A$100 million (or equivalent)	BVAL score of 6 or higher[15] No retail size medium-term notes (MTN)[16]	Unclear	Bloomberg
Residual term to maturity	Over 1 year	At least 2 months	Unclear	Unclear
Issuing entity	Non-financial corporations only Incorporated in Australia	Both financial and non-financial corporations Australia is identified as the country of risk	Possibly. More evidence would be needed to confirm.	RBA, if evidence suggests material difference between yields on financial and non-financial bonds. Also depends on the interpretation of the country in the definition of the benchmark efficient entity.
Secured / unsecured	Both secured and unsecured senior bonds[17]	Unsecured senior bonds only	Possibly. More evidence would be needed to confirm.	Bloomberg, if evidence suggests material difference between yields on secured and unsecured bonds. Also, depends on the AER's approach to

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[15] BVAL score is a Bloomberg measure of the BVAL pricing data quality. It is discussed in detail on pages 17-18.

[16] Bloomberg Help defines MTN as follows: 'Medium-term notes are unsecured, continuously offered debt obligations with maturities ranging from nine months to 40 years. Each medium term note issue (also known as tranche) is a drawdown from a program level.' Retail size refers to the outstanding amount below 10 million dollars.

[17] A secured bond is a bond for which the issuer has set aside assets or collateral to ensure timely interest and principal payments.

			Unclear	the benchmark debt instrument(s).[18]
Credit rating	Broad BBB[19]: S&P bond rating, if available; S&P issuer rating otherwise	Broad BBB: broad BBB Bloomberg composite bond rating, if available; broad BBB or equivalent from S&P or Moody's credit rating agency otherwise	Unclear	Either approach
Currency of issue	AUD, USD, Euro	AUD	Likely	Depends on the AER's approach to the benchmark debt instrument(s).
Coupon type	Fixed rate bonds only	Fixed rate bonds only	No	Either approach
Embedded options	Both bullet bonds and bonds with embedded options[20]	Bullet bonds only	Unclear, but not very likely under the current bond sample composition.	Depends on the AER's approach to the benchmark debt instrument(s).
Other restrictions	Excludes bonds with some form of duplication and several credit wrapped securities	Outliers are detected and removed Restrictions on the number of bonds in the sample and subsamples by maturity	Unclear	Unclear, due to a more discretionary (less formulaic) nature of the restrictions.

Table illustrates that the two sets of bond selection criteria vary in a number of aspects; this can result in differences in the bond sample and, hence, can potentially affect the value of the estimated yields.

Some bond selection criteria, such as characteristics of the issuing entity and credit rating criteria, can be assessed using the relevant definitions provided in the AER's rate of return guideline. Specifically,

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[18] We discuss the concept of a benchmark debt instrument later in this section.

[19] 'Broad BBB' refers to S&P credit ratings in the following range: BBB-, BBB, BBB+.

[20] Bullet bonds are redeemable only at maturities. An embedded option is a component of a financial bond or other security, and usually allows either the bondholder or the issuer the right to take some action against the other party on specified dates at specified prices.

the benchmark efficient entity is defined in the guideline as 'a pure play, regulated energy network business operating within Australia'. The guideline also provides considerations for the benchmark credit rating. At the same time, we consider that the guideline does not provide enough detail to inform our assessment of other bond selection criteria, for example, those related to the currency of bond issuance and embedded options.

Issuing entity characteristics

With respect to the issuing entity, the bond selection criteria differ in two aspects: (1) treatment of financial bonds, and (2) definition of a bond's country.

While the RBA sample does not include bonds from the financial sector, the BVAL sample includes both financial and non-financial corporate bonds. As such, non-financial corporations might generally be expected to be closer comparators to the benchmark efficient entity than financial corporations. An empirical study based on the US bond data (for 1987-1996) observes that financial bonds have higher yields than non-financial bonds in the same rating category.[21] It is not clear, however, whether this result applies in the context of the Australian market. While some Australian market participants suggest that yields of financial and non-financial bonds trade differently, we consider that more evidence would be needed to conclude that the yields on the non-financial bonds in the BVAL sample materially and consistently differ from those on the financial bonds.

We consider that WACC criteria (1) and (2) might be of particular relevance for the AER assessment. Specifically, the AER would need to be satisfied that the exclusion (or inclusion) of financial bonds from the sample is consistent with well accepted economic and finance principles, informed by sound empirical analysis and fit for purpose.

Further, while both data providers refer to Australian corporate bonds, their definitions of a bond's country vary. The RBA uses bonds of businesses incorporated in Australia and Bloomberg uses bonds for which Australia is identified as the country of risk. While for a large proportion of bonds such a distinction does not make a difference, there can still be important divergences between the resulting bond samples. We suggest that the AER would need to assess whether the definition of the benchmark efficient entity is more consistent with a business being incorporated in Australia or a business for which Bloomberg identifies Australia as a country of risk – or both.

Credit rating

The two data service providers also use different credit rating criteria. Even though both bond samples reflect a broad BBB credit rating, the BVAL sample uses the Bloomberg composite rating as the primary indicator and would also generally include bonds not rated by S&P but rated by Moody's. On the other hand, the RBA's selection is based exclusively on the rating produced by S&P. The AER would need to assess whether the RBA's approach would better reflect the credit rating definition provided in the guideline, given the formulation 'a credit rating of BBB+ from Standard and Poor's or the equivalent rating from other recognised agencies'. We do not, however, consider that one approach would be clearly preferable to another.

Size of issue, quality of pricing data, and residual term to maturity

Both data service providers impose sets of restrictions meaning to eliminate bonds with poor quality of pricing data. In particular, both of them impose restrictions on the residual term to maturity. Further, the RBA imposes a restriction on minimal issue size; while Bloomberg excludes retail size

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[21]   Edwin Elton, Martin J. Gruber, Deepak Agrawal, and Christopher Mann, *Explaining the rate spread on corporate bonds*, February 2001, Journal of Finance, Vol. LVI, No. 1, p.253.

medium term notes (MTN) and also imposes a restriction on bonds' BVAL score (a Bloomberg measure of the BVAL pricing data quality).

In our opinion, the restriction on the BVAL score deals with the problem of pricing data quality more effectively and directly than the restrictions imposed by the RBA.[22] It is also more consistent with the AER WACC criteria (2) and (5), that is, it is better fit for purpose, and the market data used is comparable and timely. However, the overall effect of both sets of restrictions on the resulting estimate would depend on the proportion of the bonds with low BVAL scores in the RBA sample at any particular time.

Benchmark debt instrument(s)

We consider that the AER guideline does not provide enough detail to assess the differences in the following three selection criteria:

- Secured and unsecured bonds

- Bullet bonds and bonds with embedded options

- The currency of issuance

In particular, the guideline specifies that a credit rating of BBB+ and a term to maturity of 10 years would be used to estimate the return on debt, using the published yields from an independent third party data service provider. However, credit ratings are primarily an indicator of a bond's probability of default, whereas a bond's return also reflects other information, for example, market expectations regarding recovery of loss in case of default. Other features of bonds, such as coupon type and size, embedded options, and currency of issue might also affect their yields. Therefore, unless it can be demonstrated that the effect of those other features is negligible, to estimate the BEE's return on debt we would prefer to have more information about its debt issuance than its credit rating and term. For example, if investors require a premium on callable bonds compared to otherwise identical bullet bonds, then we would need to know if the BEE is assumed to issue bullet bonds, callable bonds, or a combination of those. That is, we would need to know what 'benchmark debt instruments' the BEE is assumed to issue.

As such, two alternative approaches are possible:

1. Under the first approach it is assumed that the BEE only issues one type of debt instrument, for example, AUD senior unsecured fixed rate bond with no embedded options. We refer to the first approach as a 'simple portfolio'. This is similar to the AER's definition of the benchmark bond in previous decisions before the publication of the rate of return guideline.[23]

2. Under the second approach it is assumed that the BEE finances its debt via a portfolio of different debt instruments, for example, bank debt, domestic bonds, and foreign currency

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[22] More detailed reasoning is provided on pages 17-18.

[23] For example, in the Aurora draft decision, in addition to taking into account the benchmark credit rating and benchmark term the AER estimated the debt risk premium based on a sample of bonds that, among other conditions, were 'Australian domestic corporate issuance', 'fixed interest rate—or floating interest rate where this can be reliably converted into a fixed interest rate equivalent' and 'standard bonds (that is, not callable or subordinated debt)', or 'non-standard bond type where this can be reliably converted into a standard bond equivalent'. AER, *Draft distribution determination—Aurora Energy Pty Ltd—2012-13 to 2016-17*, November 2011, p.216. The Aurora draft decision was the most recent AER decision that contained substantive analysis on the return on debt, prior to the rate of return guideline. For the Aurora final decision, and subsequent AER decisions, the AER adopted the Bloomberg fair value curve following the outcome of several Australian Competition Tribunal decisions on the debt risk premium.

bonds. In this case features for each of the debt instrument in such a portfolio would need to be specified. In addition, assumptions would need to be made about the relative weights of the debt instruments in such a portfolio. We refer to this approach as a 'complex portfolio'.

To avoid some possible confusion, we note that in both cases the entire 'portfolio' is issued at a specific point of time (regulatory year). That is, the return on such a portfolio would correspond to a **single (annual) component** of the AER's trailing average.

Under both approaches, in order to make a conclusion about the appropriateness of using specific bond selection criteria, we would need to know the characteristics of the benchmark debt instrument(s). Since providing the definition of the benchmark debt instrument is beyond the scope of this report, we discuss how and whether particular features of the bonds included in the RBA and BVAL curve samples are likely to result in different aggregate yields.

Secured/unsecured bonds and bonds with embedded options

With respect to the treatment of secured bonds and bonds with embedded options, we suggest that **at present** the difference between the two series might be moderate due to the following considerations:

- Currently the majority of BBB rated Australian senior bonds are unsecured.[24]

- The current population of bonds with embedded options in the RBA sample is dominated by those with a 'make whole' call feature. US empirical evidence appears to suggest that incremental yields due to the 'make whole' call feature are low, especially in more recent time periods.

At the same time, however, the following considerations suggest that the difference in the treatment of secured bonds and bonds with embedded features by the RBA and Bloomberg should not be ignored:

- It is conceivable that the composition of the RBA bond sample with respect to secured bonds and bonds with embedded feature might change in the future.

- We consider that at present there is insufficient evidence as to the differences in bond yields between secured and unsecured Australian BBB rated bonds.

- It might not always be appropriate to use the Bloomberg embedded functionality to evaluate option adjusted spreads for bonds with embedded options other than those with make whole call features.

We suggest that, similarly to the considerations regarding the industry of the bond issuer, it would be desirable to obtain further evidence to assess whether the inclusion of secured bonds in the bond sample is warranted from the AER's perspective. If the AER forms a view on its approach to the benchmark debt instrument(s), this decision would further inform the assessment. Further, if the AER chooses to use the RBA estimates, it would be prudent to monitor the RBA bond sample composition on an ongoing basis.

We consider that WACC criteria (1) and (2) might be of particular relevance for this assessment. Specifically, the AER would need to be satisfied that the exclusion (or inclusion) of secured bonds and bonds with embedded features is informed by sound empirical analysis and is fit for purpose.

Currency of issue

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[24] That is, bonds rated BBB-, BBB, BBB+ by S&P or with equivalent ratings from other credit rating agencies.

With respect to the currency of bond issuance, we suggest that the appropriateness (for the AER's purposes) of including foreign currency bonds in the sample depends on:

▪ the difference between the credit spreads on the AUD bonds and hedged credit spreads on similar foreign currency bonds in the sample, and

▪ the AER's assumptions about the benchmark debt instrument(s).

Assume first that a version of 'swap' covered interest parity holds for the AUD, USD and Euro-denominated bonds issued by Australian companies. This would imply that the difference between the AUD bond credit spreads and the hedged foreign currency spreads on comparable bonds is small (i.e., can be attributed simply to transaction costs). If that is the case, then it would be appropriate to treat the hedged credit spreads on the USD and Euro-denominated bonds as similar to the credit spreads on the AUD-denominated bonds.[25] In this case the considerations of whether the AER's benchmark debt instruments only include AUD-denominated bonds or also comparable USD and Euro-denominated bonds would be of less importance.

However, the approach would differ if this kind of swap covered interest parity is not observed – or is not always observed. In that case, if the AER were to use only AUD bonds as the benchmark debt instruments, then the RBA's approach would not be well suited for the AER's purposes. Further, if the AER were to use both AUD and foreign currency bonds as benchmark debt instruments, then it would need to assess whether the mix of bonds in the RBA's and Bloomberg's bond samples is a good proxy for the mix of bonds making up the benchmark debt instrument(s). Since Bloomberg's sample includes AUD bonds only, it is unlikely to present a good proxy for such a 'complex portfolio' of benchmark debt instruments. On the other hand, the RBA's sample is not guaranteed to present a good proxy either. This is because the RBA's bond sample contains bonds issued in the past as well as new bonds. Hence, the sample proportions of bonds with different maturities and in different currencies might not be reflective of the optimal proportions of a benchmark business issuing its debt today (or in the near future).

We consider WACC criteria (1) and (2) to be most relevant for the AER's decision. Specifically, the AER would need to assess whether or not the inclusion of foreign currency bonds in the estimation sample is consistent with the relevant finance principles and informed by sound empirical analysis. Further, the AER's decision on what represents the benchmark debt instrument(s) would inform which of the two approaches (BVAL and RBA) best fits the AER's purpose.

Curve fitting

Different levels of information are available with respect to the estimation (or, as we refer to them, 'curve-fitting') methodologies of the two data providers. The details behind Bloomberg's BVAL use of econometric techniques are not currently available in the public domain. The only non-confidential information available to us with respect to Bloomberg's curve-fitting approach is that the estimated BVAL curves are par yield curves and that 'the Bloomberg curve is fitted to observations by using an adaptive mix of zeroth and first order non-parametric regression and subsequently smoothed by using rational Bezier polynomials'.[26] In contrast the RBA methodology is discussed at length in the RBA Bulletin December 2013 edition. For this reason, our analysis below mostly refers to the RBA methodology.

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[25] For example, as in the RBA's methodology.

[26] The former information is available, for example, from the AUD Corporate BBB BVAL Curve page on Bloomberg terminal. The latter information is available from the description of the 'Bloomberg curve fitter' in Bloomberg CRV tool. Correspondence with Bloomberg representatives (24 June and 14 August 2014) confirms that this description also applies to BVAL sector level curves (such as AUD Corporate BBB BVAL Curve).

We make the following observations.

Firstly, the RBA methodology is based on computing the weighted average of the bonds' credit spreads, that is, the differences between the bonds' yields to maturity and the corresponding swap rates. Such an approach does not result in an estimate of a par yield curve, a zero coupon yield curve, or an instantaneous forward yield curve, which are the standard ways to represent the term structure of interest rates. The BVAL curve, in comparison, is a par yield curve.

Secondly, the RBA's econometric technique is a non-parametric econometric method using an analogue of the Nadaraya-Watson kernel estimator. This estimation approach may result in a biased estimate for the bond tenors close to ten years, in particular, due to 'the dearth of issuance of bonds with tenors of 10 years or more' and, in general, due to the asymmetry of the bond sample distribution across terms to maturity.[27] The behaviour of the estimate close to the ten year tenor is particularly relevant to the AER, because its benchmark term to maturity is ten years.

Thirdly, based on the very limited information available on the BVAL curve fitting methodology, Bloomberg appears to be using a somewhat similar approach to that of the RBA, although there would also be differences – for example, Bloomberg's approach is estimating a par yield curve, local linear regression appears to be used, and there is a separate smoothing step. However, a more detailed comparison – and in particular that related to a potential bias and goodness of fit – is not possible due to the limited amount of information available on the BVAL curve-fitting approach.

Finally, we consider that the RBA's article does not provide sufficient detail as to its method of converting the foreign currency credit spreads into their AUD equivalent for us to replicate the conversion.

To summarise, in evaluating the appropriateness of the RBA's and Bloomberg's approaches for the AER's purposes, we suggest that AER needs to take into consideration WACC criteria (1), (2), and (3). That is, it needs to form an opinion of whether the RBA methodology and, respectively, BVAL methodology are fit for the purpose of providing an estimate of the return on debt of the benchmark debt instrument and whether, as such, they are consistent with well accepted economic and finance principles. Further, with respect to the RBA's conversion of foreign currency credit spreads – as well as with respect to Bloomberg's overall curve-fitting approach, the AER needs to consider whether it is satisfied that the analysis is supported by robust, transparent and replicable analysis.

Summary

The purpose of this report is to review the RBA's and Bloomberg's approaches and to suggest factors that might be important for the AER's decision. As such, we consider that at this point it would not be appropriate for us to make a recommendation of the preferred approach for the following reasons:

- Some features of the two approaches might not be fit for the AER's purpose or might not be consistent with well accepted economic and finance principles.

- The available evidence with respect to some features of the bond samples might not be sufficient to make a judgement whether one approach would be clearly preferable to another.

- Our view on whether some features are fit for the AER's purpose depends on what approach the AER uses with regards to the benchmark debt instrument(s).

- Very little non-confidential detail is available on Bloomberg's curve-fitting methodology to enable a comparison with the RBA's curve-fitting methodology.

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[27] I. Arsov, M. Brooks, M. Kosev, *New Measures of Australian Corporate Credit Spread*, Bulletin, December Quarter 2013, p. 23.

Comparative analysis of the input data

The process of estimating a yield curve for a set of financial instruments can, in general, be split into two stages: (1) selection and preliminary 'standardisation' of the data inputs, and (2) econometric estimation. This section elaborates on the first stage of the process and presents a comparison of the input data sets used by the RBA and Bloomberg, as well as preliminary adjustments applied to these data sets. The next section deals with the estimation methods employed by the two data providers.

Input data and sample selection criteria

At present, both RBA and Bloomberg rely on the same primary data source - BVAL bond pricing data produced by Bloomberg. As BVAL pricing data only became available in 2009, the RBA had to rely on other data sources to back-cast their yield estimates. In particular, the RBA's historical estimates make use of two other pricing sources: Bloomberg generic prices (BGN) and the UBS data in case neither BVAL nor BGN are available.

Bloomberg provides the following description of its BVAL pricing service:[28]

> Bloomberg's BVAL Evaluated Pricing Service provides transparent and highly defensible prices for fixed income securities across the liquidity spectrum. The foundation of BVAL's methodology is its access to a wealth of market observations from thousands of contributed sources. This mass of market data is the main driver of our innovative and quantitative approach that first prices actively traded financial instruments and then derives a price on comparable financial instruments that trade less frequently. This methodology aligns with Bloomberg's tried-and-tested capabilities as the financial industry's leading analytics platform and source of fixed income information. In addition to sophisticated algorithms that generate prices, the BVAL methodology assigns a BVAL Score based on the quantity and quality of market data used.

Further, the following observations by a Bloomberg representative we have contacted suggests that BVAL pricing service is relied upon by many market participants and, further, highlights Bloomberg's resources designated to support the service:[29]

> - BVAL curves are a key component of our BVAL service for fixed income securities. BVAL is our independent valuation service that provides transparent and defensible valuation for roughly 2.5 million securities up to 7 times per day.
>
> - To date, we have 300K+ desktop users accessing BVAL through their Bloomberg professional. As part of our customer base we also have large Sell-Side and Buy-Side institutions as well as Government Agencies and Accounting firms subscribing to BVAL at the firm level (enterprise solution)
>
> - Our BVAL support team comprises 70+ evaluators and 50+ R&D staff with 24h coverage

We consider that the BVAL pricing source is likely to satisfy the AER WACC criterion (5), that is, the information used is credible and verifiable, comparable and timely, and clearly sourced.

While both Bloomberg and the RBA use the same underlying Bloomberg data source for each bond, their bond samples differ in a number of aspects, and we suggest that this might explain a large proportion of the current difference in their resulting yield estimates. Below, we summarise the bond selection criteria used by the two data providers. We discuss them in more detail in following subsections of the report.

The RBA's methodology is published in a 2013 RBA Bulletin article.[30] The following selection criteria for the bond sample are identified in the article:

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[28] Bloomberg product sheet, BVAL sector curves & issuer curves, p.1.

[29] E-mail correspondence with Bloomberg, 30 May 2014.

- The sample includes fixed-rate bonds identified by Bloomberg that were outstanding after 1990 and were issued by non-financial entities incorporated in Australia

- Both bullet bonds and bonds with embedded options are included (callable, convertible and puttable) [31]

- Only bonds with residual maturities over a year are included

- The sample is restricted to bonds with prices, reported face values and available credit ratings

- Only bonds with broad BBB credit rating are included in the estimation of the BBB yield curve. Individual bond ratings issued by Standard & Poor's (S&P) are used where available, and S&P's issuer rating is used otherwise

- The sample is restricted to bonds raising the equivalent of at least A$100 million

- The sample is restricted to bonds denominated in Australian dollars, USD or euros

- Where a USD-denominated bond line has both 144A and Regulation S series, the latter is omitted to avoid duplication [32]

- A further seven securities were excluded due to other forms of duplication (the securities are not identified in the article)

- Further eight securities were excluded that had been downgraded multiple notches by credit rating agencies during, or shortly after, the onset of the GFC (the securities are not identified in the article)

- Finally, the RBA states that 'a small number of negative bond spread observations were excluded from the sample' [33]

We consider that while the criteria above provide a degree of clarity on the sample composition at any specific point of time, they do not identify the sample precisely (due to the conditions in the last three bullet points).

Bloomberg uses the following selection criteria in relation to its BVAL sectoral curves: [34]

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[30] I. Arsov, M. Brooks, M. Kosev, *New Measures of Australian Corporate Credit Spread*, Bulletin, December Quarter 2013, pp. 15-26.

[31] Bullet bonds are redeemable only at maturities. An embedded option is a component of a financial bond or other security, and usually allows either the bondholder or the issuer the right to take some action against the other party on specified dates at specified prices. For example, callable bonds can be redeemed prior to their maturity at the discretion of the bond issuer while puttable bonds give the holder a right to demand early repayment. A convertible bond can be converted into a predetermined amount of the company's equity at certain times during its life, usually at the discretion of the bond holder.

[32] As explained in the RBA Bulletin article (I. Arsov, M. Brooks, M. Kosev, *New Measures of Australian Corporate Credit Spread, Bulletin*, December Quarter 2013, p. 17), 'issuers raising bond funding in US dollars can issue two types of securities for the same bond line that are intended for different investors and classified as either 144A or Regulation S (Reg S). Securities issued under the US Securities and Exchange Commission's Rule 144A are privately placed into the US market and are sold to Qualified Institutional Buyers. Reg S securities are issued in the Eurobond market for international investors and are exempt from registration under the US Securities Act 1993. Each security type is typically assigned its own International Securities Identification Number.'

[33] I. Arsov, M. Brooks, M. Kosev, *New Measures of Australian Corporate Credit Spread*, Bulletin, December Quarter 2013, p.18.

- AUD bonds are included, if credit ratings and prices are available[35]

- Senior unsecured bonds issued by both financial and non-financial Australian corporations are included ('country of risk' field is used to determine the country of the bond[36])

- Bond Structures:[37]

  o Retail MTN — Exclude bonds with an embedded survivor put option OR are of retail size.[38]

  o Embedded structures — Exclude bonds with call/put options, Convertibles and Sinking Funds.

  o Coupon types — Exclude Inflation Linked, Floating Rate and Structured Notes.

- Minimum Bond Maturity — only bonds with a minimum of 2 months to maturity are used in curve construction

- Bond Count Requirements — curves are constructed when there are:

  o At least 15 bonds across the term structure

  o At least 5 bonds with maturities between 5 and 10 years

  o At least 5 bonds with maturities beyond 10 years[39]

- Only bond with broad BBB credit rating are included. If available, Bloomberg composite rating is used, if not, either S&P or Moody's credit ratings are used, whichever is available[40]

- Outlier Detection — bonds that breach certain yield-to-maturity thresholds are excluded from curve construction

- BVAL Score — only bonds with a BVAL score of 6 or higher are used in curve construction[41]

Table 1 in the previous section summarises the key characteristics of the bond samples used by the RBA and Bloomberg. Below we discuss the selection criteria in more detail.

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[34] Bloomberg product sheet, *BVAL sector curves & issuer curves*, p.2; Bloomberg terminal description screen for BS157 AUD Corporate BBB BVAL Curve [accesses 4 June 2014].

[35] The latter condition is implied rather than explicitly stated, as otherwise the corresponding bond data could not be used in the curve construction.

[36] E-mail correspondence with Bloomberg, 30 May 2014.

[37] The implication of this criterion is that only fixed rate bullet bonds are included in the construction.

[38] Survivor put option (also known as a 'survivor's option' or a 'death put') is an optional redemption feature on a debt instrument allowing the beneficiary of the estate of the deceased to put (sell) the bond (back to the issuer) in the event of the beneficiary's death or legal incapacitation. Retail medium-term notes (MTNs) are discussed on page 17. Refer to footnote for the definition of an MTN.

[39] It appears that this criterion is currently relaxed and would be needed for the 10 year yield to be estimated.

[40] E-mail correspondence with Bloomberg, 4 February 2014.

[41] The definition of BVAL score and relevant intuition are discussed in next subsection.

BVAL score and issue size restrictions

The estimated yield curve is to a large extent affected by the quality of the input data used in the estimation. For example, if bonds in the sample are traded very infrequently, their pricing data might be 'stale' and not reflective of the current market conditions. In addition, Chairmont Consulting emphasises the importance of comparing 'like with like' when estimating the return on a benchmark bond:[42]

> Consistent with the principles of benchmarking, an appropriate proxy needs to have a similar degree of liquidity to the bond being benchmarked, all other things being equal.

For this reason, some measures of bond liquidity or the quality of the pricing data are often taken into account when estimating yield curves. For example, the European Central Bank (ECB) uses the following set of (typical) liquidity criteria to restrict a bond sample used to construct its yield curves for government bonds: total turnover (total volume of daily trades), average trade size, bid-ask spread. Further, only bonds with a minimum trading volume of €1 million per day are used.[43]

The ECB further suggests that:[44]

> Bonds with maturities below three months are less traded and thus typically have more volatile prices/yields than other bonds.

The RBA and Bloomberg also impose restrictions on the bond sample to address this issue of the pricing data quality.

In particular, Bloomberg BVAL curve bond sample only includes bonds with the BVAL score of 6 or higher. BVAL score is a metric developed by Bloomberg as a part of its BVAL pricing service:[45]

> **The BVAL Score**
>
> An important and complementary component of the Bloomberg Valuation Service is the BVAL Score. This innovative, proprietary metric is designed to provide subscribers with a consistent and quantifiable means of assessing the market data supporting each BVAL price. The BVAL Score scale ranges from 1 to 10, reflecting the relative quantity and strength of the market data used to generate the BVAL Price. The quantity and quality of the market data are measured using BVAL's proprietary "Effective Number" and "Standard Deviation" calculations.
>
> **Effective Number** — reflects the number of quality observations used in deriving the BVAL Score. The "quality" of each observation is measured using various attributes, including timeliness, lot size and quote type (e.g., trades versus broker levels). The Effective Number is the weighted sum of the quality score for the individual quotes used in the BVAL price.
>
> **Standard Deviation** — is a metric that captures the consistency of market input observations, indicating the degree of corroboration or dispersion among the supporting market data.

Intuitively, the BVAL score is designed to serve as a measure of the BVAL pricing data quality. That is, the higher BVAL score is, the higher is the quality of the corresponding pricing data. All other things being equal, one would expect more liquid bonds to have a higher BVAL score.

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[42] Chairmont Consulting, *Debt risk premium expert report*, February 2012, pp. 12-13.

[43] ECB, *The new euro area yield curves*, Monthly bulletin, February 2008, p.101.

[44] ECB, *The new euro are yield curves*, Monthly bulletin, February 2008, p.101.

[45] Bloomberg product sheet, *BVAL sector curves & issuer curves*, p.2.

In addition, Bloomberg excludes bonds with less than two months left to maturity. It also excludes retail size MTNs:[46]

> The "Retail MTN" criteria is based on outstanding amount. Anything under 10 million will be considered as retail MTN. We exclude them as they are usually more illiquid and not considered institutional size (which are more representative of the market). Retail size MTNs also have volatile contributions, easily causing outliers.

The RBA does not specify any restrictions on the BVAL score.[47] Instead, the RBA restricts the bond sample based on face value. The RBA also excludes bonds with residual maturity of one year or less. To the extent that pricing data for bonds with smaller face value and those close to their maturity date are of lower quality, this restriction can effectively serve the same purpose as the restriction on the BVAL score.

In our opinion, the restriction on the BVAL score deals with the problem of pricing data quality more effectively and directly. That is, it is conceivable that bonds with large issue size (and over one year residual maturity) might be traded infrequently and it is therefore conceivable that their pricing data might not be reflective of the current market conditions. As such, the restriction on the BVAL score is more consistent with the AER WACC criteria (2) and (5), that is, it is better fit for purpose, and the market data used is comparable and timely. However, the overall effect of the restrictions discussed above on the resulting estimate would depend on the proportion of the bonds with low BVAL scores in the RBA sample at any particular time.[48]

Issuing entity: use of financial and non-financial corporate bonds

The next restriction on the bond sample deals with the question of whether the industry of the issuing entity has a significant effect on how bonds are priced.

The RBA's sample does not include financial bonds. That is, those issued in the following sectors, as identified by Bloomberg: banking, commercial finance, consumer finance, financial services, life insurance, property and casualty insurance, real estate, government agencies, government development banks, government regional or local, sovereigns, supranationals and winding-up agencies.

On the other hand, Bloomberg AUD Corporate BBB BVAL curve bond sample includes both financial and non-financial bonds. In fact, as of 6 June, 2014, the sector composition of the AUD Corporate BBB BVAL curve bond sample included the total of 22 bonds, out of which 9 were identified as real estate and one as commercial finance sector bonds.

A simple visual inspection (Figure) of the current (6 June 2014) BVAL series bond sample does not appear to suggest a significant difference in the yields to maturity of financial and non-financial BBB rated Australian bonds in the current sample. However, such analysis does not take into account potential differences in original time of issue, maturity at issue, and coupon rates.

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[46] E-mail correspondence with Bloomberg, 9 June 2014.

[47] BVAL scores for individual bonds cannot be automatically downloaded into an Excel spread sheet. In addition, historical information on BVAL scores is not readily available. Thus, the RBA might not be using this criterion for practical reasons.

[48] As explained in the footnote above, tracing BVAL scores for a set of bond is a relatively resource-intensive exercise. As such, it is outside the scope of this report.

BVAL bond sample, yield to maturity
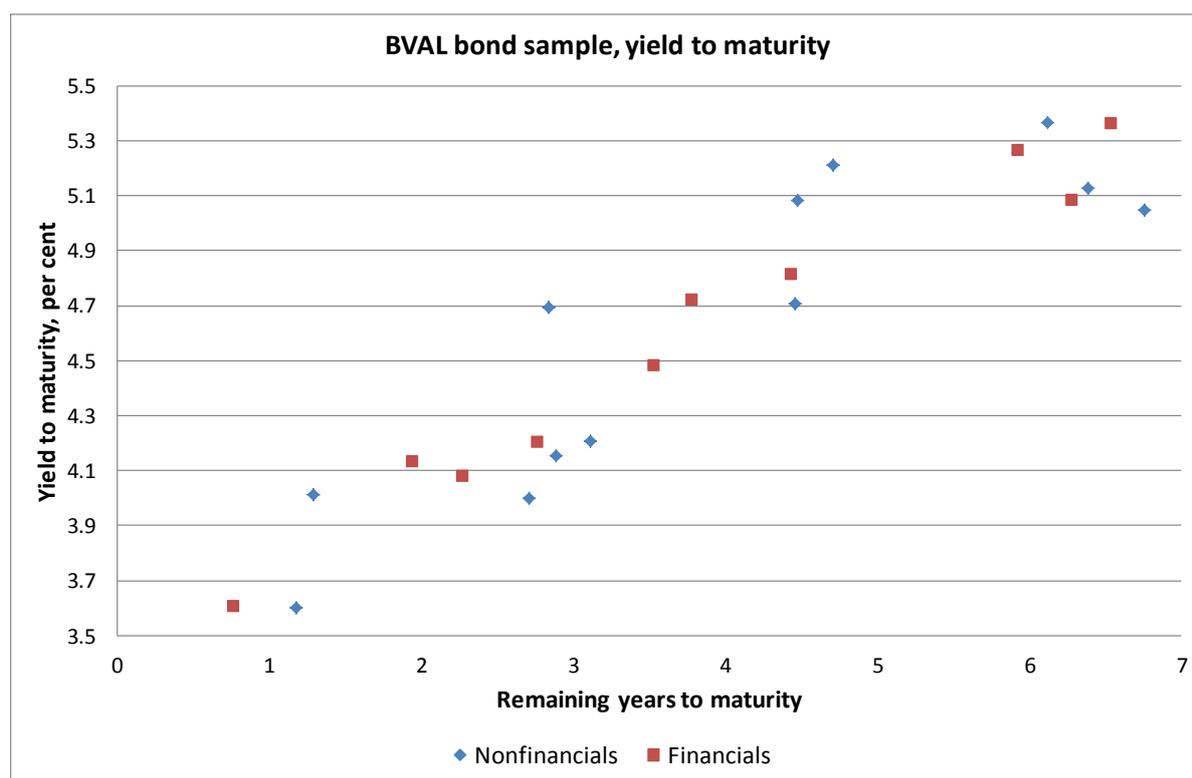
Source: Bloomberg, BS157 AUD Corporate BBB BVAL Curve constituents for 6 June 2014.

In our opinion, the issue of whether or not it is appropriate to treat BBB rated Australian financial bonds differently from non-financial bonds might still be open to debate.

In its 2012 report Chairmont Consulting suggested that:[49]

> Appropriate benchmarking must take into consideration that similar or same industry specific risks may impact similarly on the trading spread determination for debt in similar or same industries. Therefore, proxies should come from the same or similar industry as the entity issuing the debt being benchmarked.

Chairmont Consulting further suggested that:[50]

> Economic cycles are part of the capitalistic model. In downturn periods, default levels increase and it is the financial services sector, primarily banks that carry many of the losses that result. Traders consider this factor as well as other industry specific risks when they price bank and insurance company issued debt. It highlights why financial institution debt is not an appropriate proxy for infrastructure as the industry risks are different. Consequently, credit spreads of banks compensate for and are affected by different factors than credit spreads of entities from other industries that have their own specific risks.

And finally:[51]

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[49] Chairmont Consulting, *Debt risk premium expert report*, February 2012, p.11.

[50] Chairmont Consulting, *Debt risk premium expert report*, February 2012, p.13.

[51] Chairmont Consulting, *Debt risk premium expert report*, February 2012, p.17.

The industry of the debt issuer is of paramount importance in benchmarking and banking is not similar enough industry to infrastructure to qualify bank debt as an appropriate proxy for this process…

In its recent report to the QCA, PwC states:[52]

We conclude that industry membership is generally not important for estimating the debt risk premium, but single out the finance industry as an exception. Market participants consider that the yields of the bonds of banks and finance companies trade materially differently from operating non-financial businesses.

PwC further refers to the following evidence:[53]

In relation to this matter we interviewed Mr. Michael Bush, Head of Fixed Interest Securities at National Australia Bank, who confirmed that the industry practice is to remove the bonds of financial institutions when estimating FVCs for corporate bonds. Formal empirical analysis confirms this.

PwC refers to an empirical study using the US bond data (for 1987-1996), that observes that:[54]

…in general, the corporate spread for a rating category is higher for financials than it is for industrials.

While this observation was made for the US sample of 1987-1996, we are not aware of an empirical study that would make a similar observation using current Australian bond data – specifically those in the broad BBB credit rating range. One reason for this might be the scarcity of available bond data. With respect to Chairmont's observations, we note that in its analysis Chairmont mostly focuses on the banking industry, and there are currently no BBB rated bonds in the BVAL sample issued by banks. We consider that more evidence would be needed to conclude that the yields on the non-financial bonds in the BVAL sample materially and consistently differ from those on the financial bonds.

Ultimately, the AER would need to make a judgement on whether financial bonds are relevant comparators for the benchmark debt instrument. We consider that WACC criteria (1) and (2) might be of particular relevance for this assessment. Specifically, the AER would need to be satisfied that the exclusion of financial bonds is informed by sound empirical analysis and is fit for purpose. The AER's original purpose is informed by the definition of the benchmark efficient entity and its judgement of what represents a relevant set of comparators for the benchmark debt instrument. This judgement, in turn, is informed by available evidence (or lack thereof).

Secured and unsecured bonds

The RBA and BVAL samples further diverge in their treatment of secured bonds. AUD BBB Corp BVAL sample only includes senior unsecured bonds, while the RBA does not specify an equivalent restriction on bond security. Currently the vast majority of Australian BBB-rated corporate bond are unsecured bonds. However, there are currently (June 2014) more than 10 BBB-rated Australian bonds, mostly in transportation and logistics sector (e.g., airports), which are secured. It is also conceivable that this composition could change in response to more constrained market conditions.

In its 2012 report Chairmont Consulting noted that while 'there are two components market practitioners consider when forming expectations about total credit risk', specifically, probability of

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[52] PwC, *A cost of debt estimation methodology for businesses regulated by the Queensland Competition Authority*, June 2013, p.9.

[53] PwC, *A cost of debt estimation methodology for businesses regulated by the Queensland Competition Authority*, June 2013, p.9.

[54] Edwin Elton, Martin J. Gruber, Deepak Agrawal, and Christopher Mann, *Explaining the rate spread on corporate bonds*, February 2001, Journal of Finance, Vol. LVI, No. 1, p.253.

default and the loss given default, 'the ratings that [credit] Agencies publish are an indicator of the Probability of Default only'.[55] Further:[56]

> All other things equal (like ratings), potential holders of debt will always require greater compensation for being lower down the capital structure… The marketplace is not and should not be indifferent to a security position ranking in the capital structure.

Diagram I in the Chairmont's report (reproduced in Figure below) puts senior secured debt higher (i.e., as less risky) in the capital structure than senior (unsecured) debt.[57]

Figure
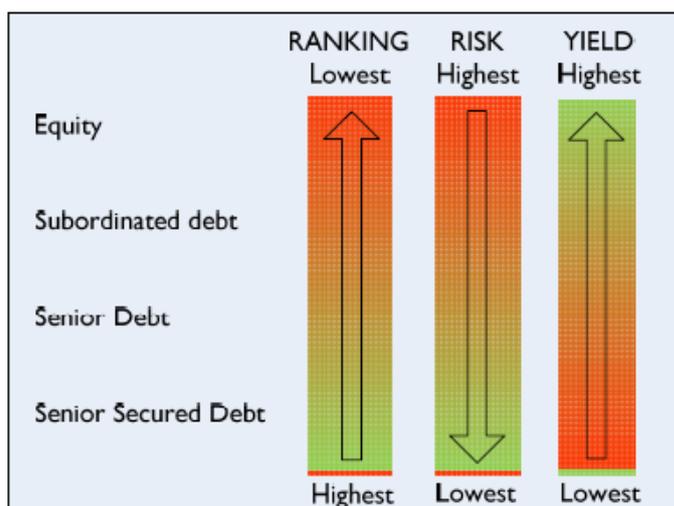
Diagram I: Ranking & Risk/Return Continuum

Our recent correspondence with S&P confirms that S&P evaluates primarily probability of default while assigning a credit rating to a bond issue, whereas the security of a bond is related predominantly to the recovery of loss given default:[58]

> From our view point security is a recovery issue and independent of default probability. We give credit to this in sub investment grade but not investment grade.

We suggest that, similarly to the considerations regarding the industry of the bond issuer, more evidence would be needed to assess whether the inclusion of secured bonds in the bond sample is warranted. Further, the AER would need to assess whether it is more appropriate to consider the benchmark debt instrument to be secured or unsecured. As in the previous section, we consider that WACC criteria (1) and (2) might be of particular relevance for this assessment. Specifically, the AER would need to be satisfied that the exclusion (or inclusion) of secured bonds is reflective of economic and finance principles, is informed by sound empirical analysis, and is fit for purpose.

Use of foreign currency bonds data

The single selection criterion that is currently likely to most affect the bond sample size and composition of the two series is that related to the currency of bonds. Specifically, while the BVAL

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[55] Chairmont Consulting, *Debt risk premium expert report*, February 2012, p.10.

[56] Chairmont Consulting, *Debt risk premium expert report*, February 2012, p.12.

[57] Just referred to as 'Senior Debt' in the diagram.

[58] E-mail correspondence with S&P, June 3, 2014.

curve only makes use of AUD-denominated bonds, the RBA bond sample includes bonds denominated in AUD, USD, and Euros.

As we foreshadowed earlier, we suggest that the appropriateness (for the AER's purposes) of inclusion of foreign currency bonds in the sample depends on:

- the difference between the credit spreads on the AUD bonds and hedged credit spreads on similar foreign currency bonds in the sample, and

- the AER's assumptions about the benchmark debt instrument(s).

In his earlier report to the AER as a part of the rate of return guideline development, Associate Professor Martin Lally recommended that foreign currency denominated bonds be excluded from the return on debt calculations.[59] He raised several concerns in this respect, including:

- The QTC (2012) suggested that the principal US holders of USD denominated Australian bonds typically hold them until maturity and therefore these bonds are not very liquid.[60] Therefore, while primary market data on such bonds would be rare, secondary market based estimates would have low quality due to low liquidity of the market.[61]

- If foreign currency denominated bonds are being used merely to assist in estimating the DRP of a local currency bond, it may provide a poor estimate, as the DRPs from local and foreign markets may differ due to a range of factors: 'because local and foreign lender perceptions of the default risk of Australian firms may be different, premiums for the relative liquidity of the bonds may differ across markets, and the premiums for systematic risk are likely to be different'.

- If foreign currency denominated bonds are used to better reflect the actual costs of a firm's debt finance, then this would raise an issue of also including bank debt in estimation. Further, the optimal weights to be placed upon each source of debt will fluctuate over time (inversely with relative costs), and the optimal weights at the current time will be unknown. Finally, some businesses might not have access to foreign borrowing – for example, due to their limited size and/or their lack of a credit rating. Then, there is an issue of whether these businesses with limited foreign borrowing options should be treated in the same manner as the businesses that have access to foreign borrowing.

With respect to the second and third issues above raised by Associate Professor Lally, similar concerns were raised by the QTC and PwC. The QTC states:[62]

> In relation to the weighting that could be apply to international data, the maximum would be based on the proportion of debt that firms have sourced from those markets in recent issuance. For example, it may be unreasonable to conclude that where Australian firms have issued into a market several years ago (but not since), that the benchmark efficient firm would be able to issue debt during the reset period.

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[59] M. Lally, *Estimating the cost of debt of the benchmark efficient regulated energy network business*, 16 August 2013, pp. 24-27.

[60] QTC, 2012, *Submission to the AEMC*, Attachment 1, p.25.

[61] The AER could potentially use the BVAL scores of the foreign bonds to draw conclusions regarding their liquidity. However, the RBA does not use the BVAL scores as a bond selection criterion. The onus then would be on the AER to continuously monitor the composition of the foreign bond sample used in the RBA estimates.

[62] QTC, 2012, *Submission to the AEMC*, Attachment 1, p.25.

While the use of international bond issuance data may be appropriate, especially while Australian NSPs are active issuers in international markets, there is the risk that this could disadvantage NSPs if at the time of their revenue determination the opportunities to issue in international markets have been impacted by changing market conditions. In the case of bond data from any overseas market, expert financial market input should be sought regarding the current ability of Australian firms to issue into that market.

Further, on the question of using foreign debt markets data for cost of debt estimation PwC concludes in its recent report to the QCA:[63]

In our view, the application of foreign debt market data to estimate the debt risk premium for the benchmark Australian firm requires:

o Establishing the benchmark financing behaviour of the benchmark firm, i.e. discovering how much debt on average is sourced from which overseas markets;

o Establishing a clear and replicable methodology for the conversion of foreign market data to Australian dollar equivalent terms;

o The estimation of all additional transaction costs that would be incurred in sourcing debt from international markets; and

o Undertaking a comparative analysis over a reasonable period of time to assess whether the cost of debt differentials implied by a consideration of international debt market data is justified by the additional complexity and data gathering costs, and the potential for more disagreement (as foreshadowed by the Tribunal).

To assess what treatment of foreign currency bonds is more appropriate for the AER, we need to first consider whether or not a version of 'swap' covered interest parity holds for the AUD, USD and Euro-denominated bonds issued by Australian companies. This would imply that the difference between the AUD bond credit spreads and the hedged foreign currency credit spreads on comparable bonds is small (i.e., can be essentially attributed to transaction costs). If that is the case, then it would be appropriate to treat the hedged credit spreads on the USD and Euro-denominated bonds similarly to the credit spreads on the AUD-denominated bonds. This treatment would be appropriate regardless of whether the AER's benchmark debt instruments only include AUD-denominated bonds or also comparable USD and Euro-denominated bonds.

However, as Lally's report suggests, swap covered interest parity might not always hold for the bond category we are interested in. In fact, it appears that even in highly liquid markets for short-term instruments where covered interest parity is normally observed, significant deviations can occur in times of market turbulence. For example, Levich provides a diagram of deviations from covered interest parity at three-month maturity for AUD-USD currency pair showing a large spike around the time of the GFC (reproduced below in Figure).[64]

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[63] PwC, *A cost of debt estimation methodology for businesses regulated by the Queensland Competition Authority*, June 2013, p.15.

[64] R. Levich, *Evidence on financial globalization and crises: interest rate parity*, 31 August 2011, p.29. [Published in *The Evidence and Impact of Financial Globalization*, Vol. 3, pp. 417-27, edited by Gerard Caprio, Elsevier Publishing Inc., 2013; available at http://people.stern.nyu.edu/rlevich/research.html].

Deviations from Covered Interest Parity, 3-month maturity
January 1, 2000 - September 30, 2010
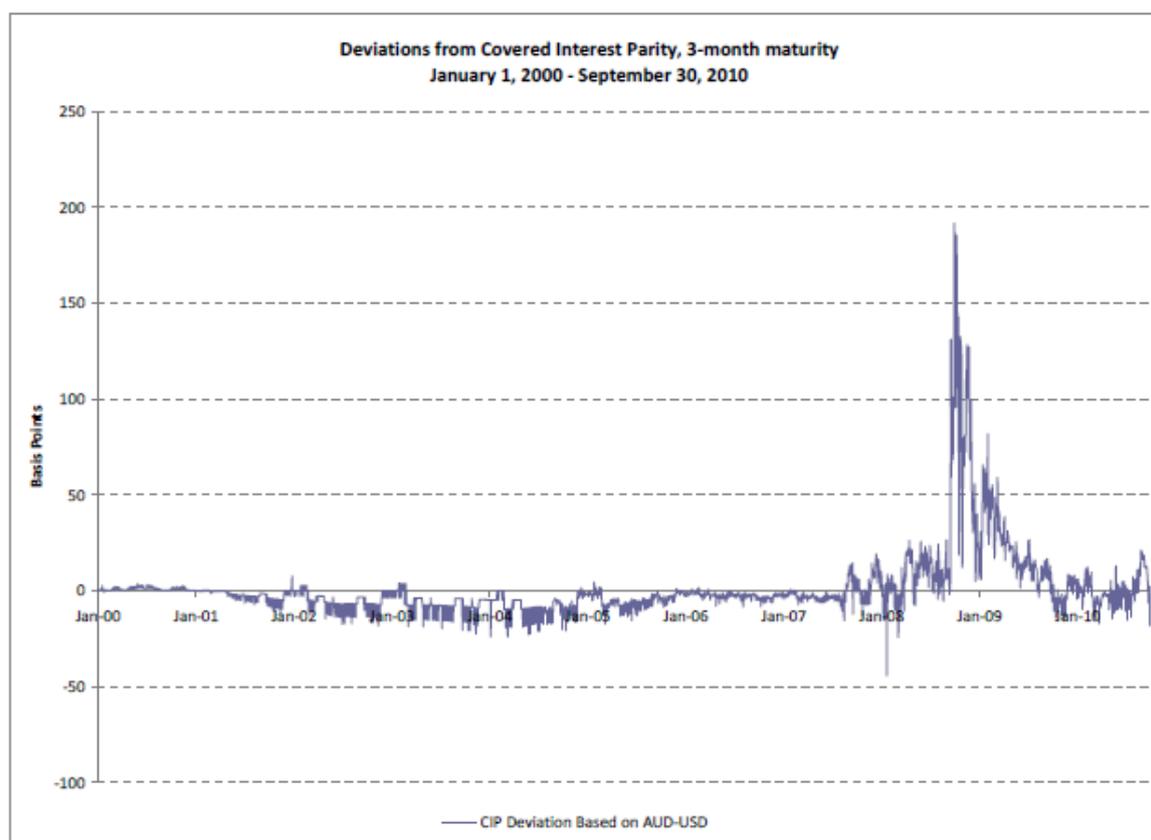
If the relevant swap covered interest parity is not observed − or is not always observed − then, the AER's assumptions about the benchmark debt instrument(s) become more important for the assessment of the two bond samples. In particular, if the AER were to use only AUD bonds as the benchmark debt instruments, then the RBA's approach would not be well suited for the AER's purposes. Further, if the AER were to use both AUD and foreign currency bonds as benchmark debt instruments, then it would need to assess whether the mix of bonds in the RBA's and Bloomberg's bond samples is a good proxy for a mix of bonds in its portfolio of benchmark debt instruments. Since Bloomberg's sample includes AUD bonds only, it is unlikely to present a good proxy for such a 'complex portfolio' of benchmark debt instruments. On the other hand, the RBA's sample is not guaranteed to present a good proxy either. This is because the RBA's bond sample contains bonds issued in the past as well as new bonds. Hence, the sample proportions of bonds in different currencies might not be reflective of the optimal proportions of a benchmark business issuing its debt today (or in the near future).

For instance, visual inspection of graphs 3 and 6 of the RBA Bulletin article (reproduced below in Figure and Figure) suggests that the RBA bond sample composition has varied significantly over time with respect to the ratio of domestic to foreign currency bonds. Given the considerations above, it is unlikely that those dynamic proportions would be reflective of the optimal allocation of debt issuance between different bonds at any point of time.

To conclude, we consider that the comparison of the two data series with respect to inclusion/exclusion of foreign currency bonds would depend on the AER's assumptions about the benchmark debt instrument(s). Hence, it is not appropriate for us to make a recommendation at this stage. We consider WACC criteria (1) and (2) to be of most relevance for the AER's decision. Specifically, the AER would need to assess whether or not the inclusion of foreign currency bonds in the estimation sample is consistent with the relevant finance principles and informed by sound

empirical analysis. Further, the AER's decision on what represents the benchmark debt instrument(s) would inform which of the two approaches (BVAL or RBA) best fits the AER's purpose.

Figure

Graph 3
Australian NFC Bonds Outstanding
Face value and credit rating at issuance

LHS: ■ USD ■ AUD ■ EUR ■ Other
* As at end November
Source: RBA

Figure

Graph 6
Number of Valid Securities by Tenor
Monthly

■ 1–2 years   ■ 2–4 years   ■ 4–6 years
■ 6–8 years   ■ 8–10 years ■ 10+ years
Sources: Bloomberg; RBA; Standard & Poor's; UBS AG, Australia Branch
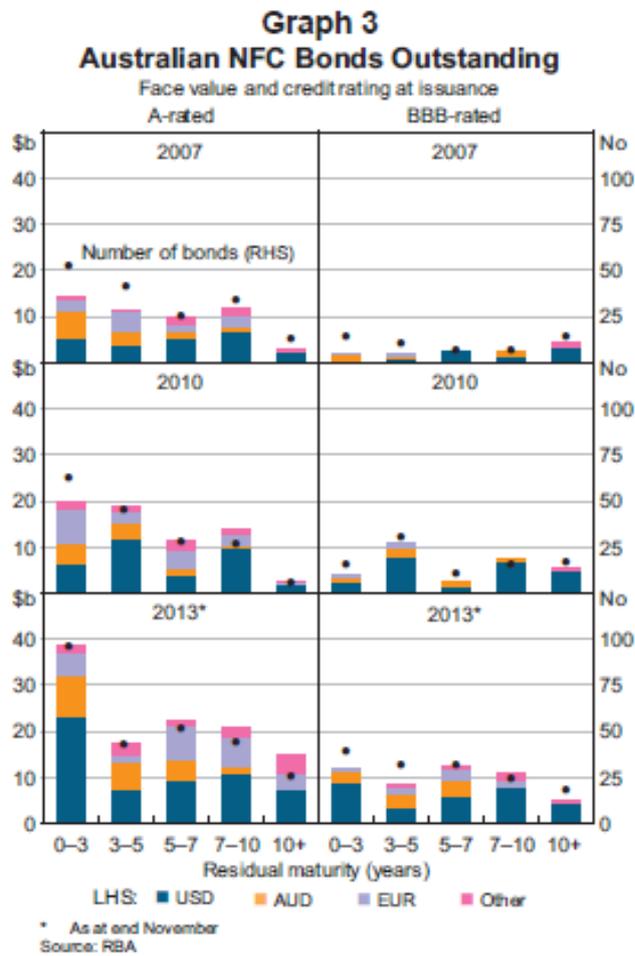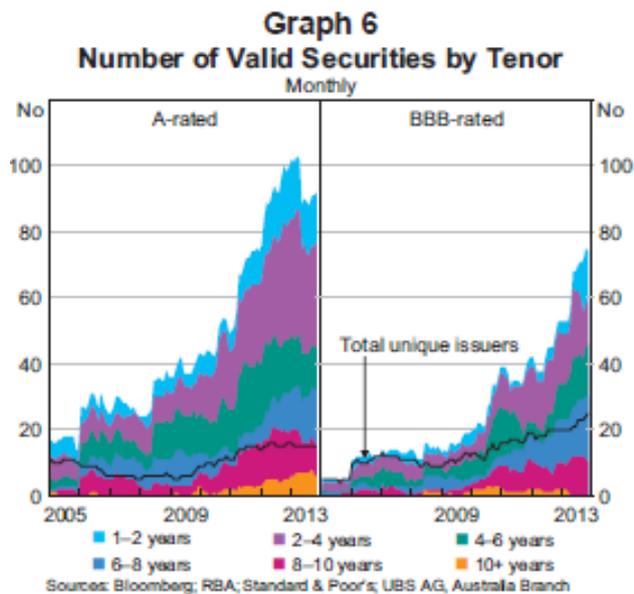
Use of bonds with embedded options

Bloomberg excludes bonds with embedded structures (i.e., bonds with call and put options, convertibles and sinking funds) from its BVAL curve sample.[65]

On the other hand, the RBA sample explicitly includes bonds with embedded options, in particular, callable (including make whole callable), convertible, and puttable bonds.[66] Further, the RBA Bulletin article states that the securities with embedded options 'tend to be over-represented at longer maturities'.[67] Taking into account the RBA's econometric technique (that gives highest weight to the observations closest to the tenor for which the estimation is performed), this would suggest that the inclusion of such securities would have a more significant effect on the RBA's credit spread estimates for longer maturities.

The RBA points out that an adjustment is required to account for the optionality:[68]

> The analysis is complicated by the inclusion of bonds with embedded options, where the optionality affects the underlying value of the bond and, in turn, its yield and swap spread. This requires the use of an option adjusted spread (OAS), which measures the spread that is not attributable to the value of the option.

The RBA uses Bloomberg's OAS estimates for the bonds with options other than make whole call option. The RBA uses unadjusted spread for the latter category, since this category is currently not incorporated into Bloomberg's OAS calculations.

In a recent report to the QCA PwC removed callable bonds from its study sample with the following justification:[69]

> Call options were excluded since the observed yield needs to be adjusted to remove the effect of the option, which adds complexity and the potential for analyst-induced error.

In its 2012 report Chairmont Consulting pointed out the following problems with estimating an OAS of a (callable) bond in the context of Australian BBB corporate bond market:[70]

- the type of options embedded in the instruments are not the type of option that can be valued by a options pricing model like Black-Scholes; and

- there is no observable credit curve from the issuers that reflects "standard" (unstructured non-callable) debt to which a structured bond can be compared.

Bloomberg's YASN function draws on a comparison of bond with an embedded option and a 'standard' comparable bond without embedded options.[71] Therefore, unless a 'standard' curve is available, OAS produced by YASN function would be of poor quality:[72]

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[65] Bloomberg product sheet, *BVAL sector curves & issuer curves*, p.2.

[66] A make whole call is a provision that allows a borrower to prepay the remaining fixed rate term debt. The borrower, however, has to make an additional payment that is derived from a formula based on the net present value of the future debt payments.

[67] I. Arsov, M. Brooks, M. Kosev, *New Measures of Australian Corporate Credit Spread*, Bulletin, December Quarter 2013, p.19.

[68] I. Arsov, M. Brooks, M. Kosev, *New Measures of Australian Corporate Credit Spread*, Bulletin, December Quarter 2013, pp.18-19.

[69] PwC, *A cost of debt estimation methodology for businesses regulated by the Queensland Competition Authority*, June 2013, p.34.

[70] Chairmont Consulting, *Debt risk premium expert report*, February 2012, p.28.

YASN is meant to be used to value options by comparing a yield curve of bonds with embedded options to a yield curve of bonds without embedded options… YASN can't be used because it is supposed to be used to show an OAS of a structured security by comparing the structured security to a (non-existent) standard security or yield curve that is observable in the marketplace.

On the other hand, visual examination of Graph 5 in the Bulletin article (reproduced in Figure below) suggests that **at present** (and historically), the majority of bonds with embedded options in the RBA sample have make-whole call options only.[73] Therefore, they are treated by the RBA in the same manner as bullet bonds and no adjustment for optionality is performed. To the extent that such an approach is justified, the RBA's treatment of bonds with embedded options is unlikely to cause major concerns in terms of affecting the overall estimates. That is, of course, as long as the current trend whereby most bonds with embedded options are make whole callable bonds continues into the future.

Powers and Tsyplakov (2008) estimate empirical incremental yields associated with make whole call provisions for a set of US corporate bonds issued between 1995 and 2004 and model theoretical incremental yields.[74] The study suggests that the theoretical incremental yields for make-whole call options are small (from approximately 2 bps to 5 bps on average, depending on the underlying assumptions). The observed incremental yields for the entire sample average between 12 and 24 bps. However, the analysis further indicates that in the later years of the sample period the observed incremental yields begin to converge to model-generated values. Therefore, if this trend continues into the future – and if the study bond sample is comparable with the make whole callable bonds in the RBA sample, the RBA's treatment of these bonds would appear reasonable.

Figure

Graph 5
Number of Valid Securities by Optionality

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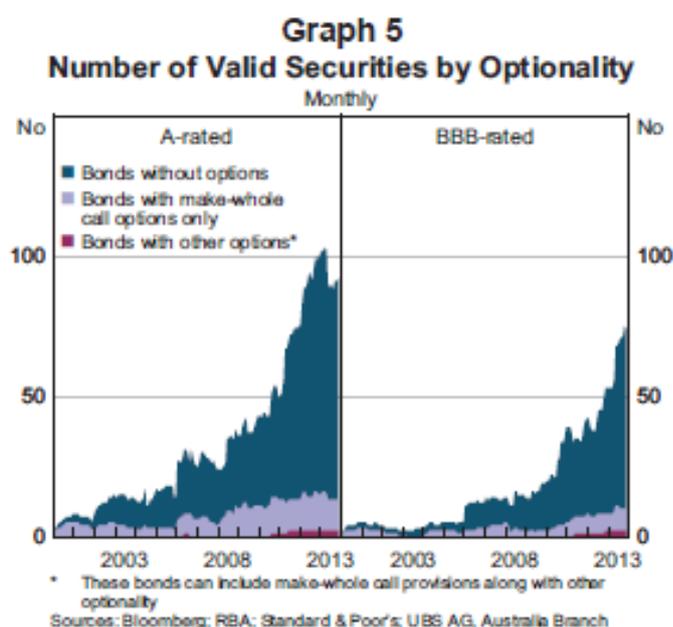
[71] Bloomberg Help provides the following description of YASN: 'YASN provides a standardized yield analysis calculator for structured notes so you can work up pricing and analyse risk. You can customize various inputs, including volatility assumptions, to calculate price, yield, fixed-equivalent yields, and risk and hedge ratios'.

[72] Chairmont Consulting, *Debt risk premium expert report*, February 2012, p.33.

[73] It appears that only 2-3 bonds in the 2013 sample have other types of embedded options.

[74] E. Powers, S. Tsyplakov, *What is the Cost of Financial Flexibility? Theory and Evidence for Make-Whole Call Provisions*, Financial Management, Vol. 37, No. 3 (Autumn, 2008), pp. 485-512.

In conclusion, if the AER considers the benchmark debt instrument to be a bond with no embedded features, then, other things being equal, bonds with no embedded features would be closer comparators than those with embedded features. At the same time, given the current and historical composition of the RBA bond sample, we would not expect the optionality of some bonds in the sample to have a major effect on the resulting estimates. That being said, more detailed analysis can be performed using the RBA's current and historical bond samples (subject to their availability). In addition, it is conceivable that the composition and size of the subset of bonds with embedded options used by the RBA could change over time (for example, if the proportion of bonds other than those with make whole call provisions increases). Thus, if the AER chooses to use the RBA estimates, we would advise to monitor the sample composition on an ongoing basis.

Accounting for outliers and other restrictions

In this section we consider the remaining differences in the restrictions imposed by the two data providers on the bond samples.

Firstly, while both providers refer to bonds issued by Australian entities, their definitions of the bond's country vary. The RBA uses bonds with Australia listed as country of incorporation and BVAL sample is restricted to those bonds with Australia identified country of risk. Below are the relevant definitions from Bloomberg:[75]

> **Country of Incorporation**
>
> Specifies the ISO (International Organization for Standardization) country code of where a company is incorporated…
>
> **Country of Risk**
>
> Returns the International Organization for Standardization (ISO) country code of the issuer's country of risk. Methodology consists of four factors listed in order of importance: management location, country of primary listing, country of revenue and reporting currency of the issuer. … The following methodology applies to listed/unlisted parent-subsidiary relationships:
>
> - If a subsidiary is listed, it will be assigned its own issuer country classification based on the aforementioned criteria unless the subsidiary is supported/guaranteed by the parent.
>
> - If a subsidiary is unlisted, it will be assigned the issuer country classification of its parent unless determined that there is no support/guarantee from that parent. …

While for a large proportion of bonds country of incorporation and country of risk are the same, there are some important differences between the samples. For instance, BVAL constituents do not include three BBB-rated bonds issued by Holcim Finance Australia, two of which appear to satisfy all of the RBA bond selection criteria (the third one matures within less than a year). These bonds are excluded from the BVAL sample because their country of risk is identified as Switzerland. On the other hand, the current BVAL sample (as of 6 June 2014) includes a bond issued by Powercor Pty Ltd (maturing in 2017) that lists Australia as a country of risk, but US as a country of incorporation.

Ultimately, the AER would need to consider which of the two definitions is more consistent with the AER's definition of the benchmark efficient entity.

Secondly, the two data providers use somewhat different criteria with respect to bonds' credit ratings. The RBA uses S&P credit ratings of individual bonds where available, and S&P issuer rating otherwise. If neither is available for a bond, the bond is not included in the sample. Bloomberg uses

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[75] Since both data providers use BVAL bond data as a pricing source, presumably, both restrictions are based on Bloomberg data fields.

Bloomberg composite ratings of individual bonds where available, otherwise either S&P or Moody's ratings of individual bonds are used, depending on which are available.

This difference can result in divergence between the two bond samples. For instance, bonds that are rated by Moody's but not by S&P would not be included in the RBA sample, but would be in Bloomberg's. Further, if a bond has a Bloomberg composite rating, it might be different from the bond's S&P rating. To the extent that ratings supplied by different credit rating agencies can be considered as substitutable for each other, both the RBA's and Bloomberg's criteria appear to be fit for purpose.

Thirdly, both data providers exclude several bonds from their sample. In particular, in the Bulletin article the RBA suggested that some bonds were excluded from the sample due to some form of duplication and some other special considerations (credit wrapped bond, bonds substantially downgraded after GFC, as well as observations with negative spread).[76] BVAL curve description, on the other hand, specifies that an 'outlier detection' mechanism is used, so that:[77] 'bonds that breach certain yield-to-maturity thresholds are excluded from curve construction. Outlier detection prevents instability associated with technical trading factors.'

An outlier detection and removal procedure with a similar, albeit more technical, description is used by the ECB in construction of the Euro area government bond yield curves:[78]

> Despite the …selection criteria, the yields of a few bonds may still deviate significantly from the rest. To prevent noise in the yield curve estimation, these outliers are removed from the sample. Outliers are traced separately for a number of residual maturity brackets. Bonds with yields that deviate more than two standard deviations from the average are considered as outliers and are removed from the sample. Within each of these brackets, the average yield and standard deviation are calculated. This procedure is iterated in order to reduce the sensitivity of the analysis to potentially large outliers eliminated in the first round that could have distorted the average yield level and the standard deviation.

BVAL constituents are available from the Bloomberg terminal, though only on the day of estimation. Therefore, it might be possible to establish which bonds were considered by Bloomberg analysts as outliers if one monitors the constituents sample over time.[79] Establishing which exact bonds were excluded by the RBA would rely on interpreting the information the RBA provided in the article, since a list of exceptions is not publicly provided.[80] Further, tracing excluded bonds over time (for both Bloomberg and RBA) might be resource-intensive. As the example below illustrates, it is difficult to describe an exhaustive set of bond sample selection criteria up front. Thus, whichever third party data provider the AER uses, the provider would likely exercise a degree of discretion to adjust a data sample over time. Ultimately, the AER needs to decide whether it is comfortable with the chosen data provider exercising discretion on such occasions.

Example: The BVAL bond sample of 11 April 2014 contained three MTNs issued by Coca-Cola Amatil Ltd (two of them are EMTNs, that is, they were issued into the European market in AUD). By 2 May 2014, already six Coca-Cola MTNs were BVAL constituents (five of them EMTNs; all six were issued in 2012-2013). However, 30 May 2014 the BVAL sample does not contain any bonds

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[76] I. Arsov, M. Brooks, M. Kosev, *New Measures of Australian Corporate Credit Spread*, Bulletin, December Quarter 2013, pp. 17-18.

[77] Bloomberg product sheet, *BVAL sector curves & issuer curves*, p.2.

[78] ECB, *The new euro are yield curves*, Monthly bulletin, February 2008, p.102.

[79] The constituents need to be recorded daily, as Bloomberg does not currently allow viewing past constituents.

[80] Upon our request, the RBA has provided us with a list of currently excluded bonds on a confidential basis.

issued by Coca-Cola Amatil. Bloomberg BVAL curve specialists provided the following explanation for removing Coca-Cola bonds from the sample in response to our inquiry:[81]

> The reason that some coca cola bonds appeared in the AUD BBB curve in April but not anymore is because of internal changes we made. We assessed the AUD BBB curve and, whilst these coca cola bonds are indeed BBB rated, they were much richer than other BBB rated AUD bonds (see attached file). As such, we decided that the A rated curve (BVSC0160 Index) is more appropriate for these bonds and better represents their yields, which is where you will be able to find them now.

The attached illustration is reproduced below (Figure).

Note that based on our understanding of the RBA's selection criteria all six Coca-Cola bonds would have been included in the RBA BBB bond sample from 14 April 2014 onwards.

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[81] E-mail correspondence with Bloomberg (3 June 2014).

Analysis of the curve-fitting methodologies

This section discusses the econometric techniques employed to estimate the yield curves, given a sample of bonds. Bloomberg does not currently provide any publicly available information on its curve-fitting methodologies, except that the estimated curve is a par yield curve and that 'the Bloomberg curve is fitted to observations by using an adaptive mix of zeroth and first order non-parametric regression and subsequently smoothed by using rational Bezier polynomials'.[82] For this reason, this section focuses on the RBA methodology that is described in the December 2013 RBA Bulletin article.[83] The section is split into subsections addressing the following questions: (1) what curve is being estimated; (2) what econometric techniques are used; (3) what adjustments are made to the input data prior to estimation.

Par yield curves versus averaging of yields to maturities or credit spreads

A yield curve is a graphical representation of the term structure of interest rates, that is, a relationship between residual maturities of a homogenous set of financial instruments and their computed interest rates.[84] This computation is made on the basis of market prices of underlying financial instruments, as well as information on the future promised payments for these financial instruments, such as bond coupon rate and redemption payment in case of fixed rate bonds.

One commonly used measure of ex ante (promised) return on a bond is yield to maturity (YTM), or redemption yield. It is the bond's internal rate of return — 'the single interest rate at which the dirty price of a bond is equal to the present value of the stream of cash flows discounted at this rate'.[85]

While YTMs are relatively straightforward to compute, their use in informing us about the underlying term structure is limited. In particular, a YTM on a zero coupon bond is simply equal to the interest rate corresponding to the remaining term to maturity on that bond. Therefore, if we have enough data on zero coupon bonds, maturing at different points in time, we can recover the underlying term structure from the YTMs of such bonds. However, in practice, such bonds are not always available and most bonds issued by Australian corporations are coupon-bearing bonds. The relationship between the interest rates and YTM of a coupon-bearing bond is more complex:[86]

> When calculating the yield to maturity of coupon-bearing bonds, all payment flows (coupons and redemptions) are discounted to current values at the same rate – i.e. the yield to maturity. Unless a constant discount rate applies to all maturities, i.e. the term structure is flat, the (zero coupon) interest rates – also referred to as spot rates – and yields to maturity of coupon bonds will differ.

In other words, YTMs on coupon-bearing bonds cannot be aggregated into a yield curve (or term structure) in a straightforward manner:[87]

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[82] The former information is available, for example, from the AUD Corporate BBB BVAL Curve page on Bloomberg terminal. The latter information is available from the description of the 'Bloomberg curve fitter' in Bloomberg CRV tool. Correspondence with Bloomberg representatives (24 June and 14 August 2014) confirms that this description also applies to BVAL sector level curves.

[83] I. Arsov, M. Brooks, M. Kosev, *New Measures of Australian Corporate Credit Spread*, Bulletin, December Quarter 2013, pp. 15-26.

[84] See, for example, ECB, *The new euro are yield curves*, Monthly bulletin, February 2008, p.97.

[85] J. James and N. Webber (2000), *Interest rate modelling* (Wiley Series in Financial Engineering), p.6. The dirty price is the price of a bond including any interest that has accrued since the issue of the most recent coupon payment.

[86] ECB, *The new euro are yield curves*, Monthly bulletin, February 2008, p.98.

[87] Stephen M. Schaefer, *The problem with redemption yields*, Financial Analysts Journal, Vol. 33, No. 4 (Jul. - Aug., 1977), p.59-60.

…since yields depend on the coupon, yields of bonds with different coupons will not generally lie along a smooth curve. Fitting a curve through points that do not and should not lie along a curve is unlikely to be a profitable exercise…

…Since we can deduce so little from a direct comparison of redemption yields, it is perhaps not surprising that more elaborate calculations based on these measures yield little further information. As we have already indicated, the redemption yield depends not only on the spot rates and term to maturity, but also on the size of the coupon. **In general, two bonds with the same maturity but different coupons will have different redemption yields. Trying to fit a smooth curve through a set of points that do not lie on the same curve is therefore pointless, and it is even more pointless to try to read omens in the deviations from the curve.** [Emphasis added.]

Fortunately, interest rates (a.k.a. 'spot' rates or zero coupon rates) can be recovered if we observe prices and promised coupon and redemption payments for a large enough bond sample. In fact, there exists a variety of financial models and econometric techniques for estimation of zero coupon yield curves. For example, the ECB and several other central banks use the Svensson model (which is an extension of the Nelson-Siegel model), the Nelson-Siegel model, or smoothing splines to estimate zero coupon yield curves.[88] The RBA uses the Merrill Lynch Exponential Spline model to estimate risk-free zero-coupon yield curves.[89] Other approaches such as non-parametric econometric methods have also been suggested.[90]

In addition to using zero-coupon yield curves, there are two other commonly used ways to represent the estimated yield curve: as an instantaneous forward yield curve and as a par yield curve. The ECB, for example, generally reports all three curves for euro area government bonds.

The par yield and forward yield curves can be easily derived from the zero coupon yield curve. The par yield curve is often favoured by market practitioners, as they typically trade coupon-bearing bonds. It represents a yield on a bond that is priced at par, that is, its current market price is equal to its face (or redemption, or par) value.[91]

The chart below (Figure) based on the analysis of Shaefer provides an illustration of this concept, as well as the earlier point made by Shaefer.[92] Shaefer illustrated that the YTM of any coupon-bearing bond always lies between the zero coupon yield curve (a.k.a. spot yield curve) and a yield curve corresponding to an annuity.[93]

On the chart, each curve represents a YTM on a fixed rate bond. The horizontal axis refers to the residual maturity of a bond and the vertical axis measures the corresponding YTM. For example, for a set of bonds with 10 years to maturity, the YTMs are as follows (Table).[94]

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[88] Bank for International Settlements, *Zero-coupon yield curve estimated by central banks: technical documentation*, BIS Papers No 25, October 2005; ECB, *The new euro are yield curves*, Monthly bulletin, February 2008, pp.95-103.

[89] R. Finlay, D. Olivan, *Extracting Information from Financial Market Instruments*, Bulletin, March Quarter 2012, pp. 45-54.

[90] Linton O., E. Mammen, J. Nielsen and C. Tanggard (2001*), Yield Curve Estimation by Kernel Smoothing Methods*, Journal of Econometrics, 105, pp. 185–223.

[91] For a bond trading at par, its YTM is equal to its coupon.

[92] Stephen M. Shaefer, *The problem with redemption yields*, Financial Analysts Journal, Vol. 33, No. 4 (Jul. - Aug., 1977), pp.59-67.

[93] An annuity is a stream of periodic payments, usually in equal amounts, made over a specified period of time.

[94] The values in the table were derived based on an assumed shape of a spot yield curve.

Coupon	YTM (redemption yield), 10 years
Zero coupon (Spot rate)	6.6%
1% p.a., paid annually	6.5%
5% p.a., paid annually	6.4%
Par yield	6.3%
10% p.a., paid annually	6.2%
20% p.a., paid annually	6.1%
Annuity (proxies infinite coupon)	5.7%

Figure
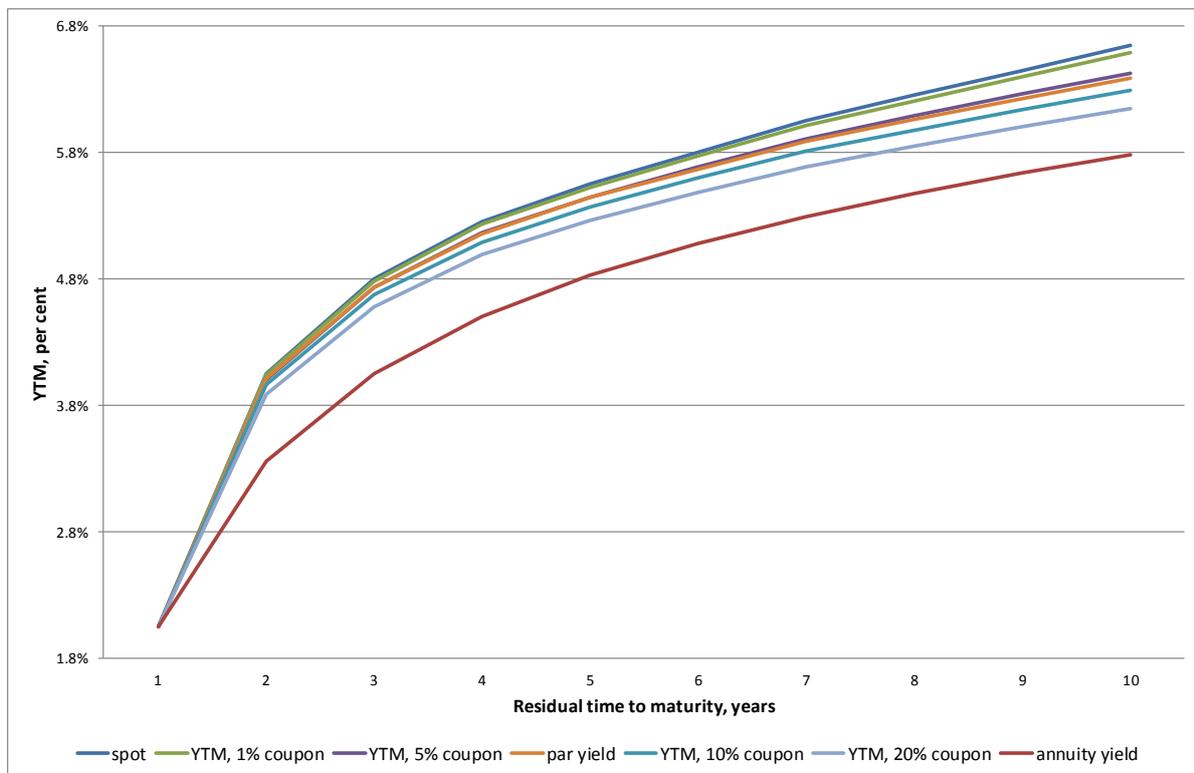
It can be seen, therefore, that bonds with different coupon rates have different YTMs. Thus, if we have a set of bond YTMs for coupon-bearing bonds with different coupons, those YTMs will not

generally lie on the same curve.[95] At the same time, we may expect there to be one zero coupon yield curve and one par yield curve.

Bloomberg describes the BVAL curves as par yield curves. At the same time, the RBA's methodology is based on computing the weighted average of the bonds' credit spreads. That is, differences between the bonds' YTMs and the corresponding swap rates. Such a method clearly does not result in an estimate of either a par yield curve or a zero coupon rate curve. Therefore, strictly speaking, the resulting estimate may only by chance accurately represent the underlying term structure. This problem would be somewhat reduced if the bonds in the RBA sample, for instance, trade at par at every estimation point. However, such a situation cannot be guaranteed, unless it is added as a bond selection criterion. For example, the BVAL bond sample for 6 June 2014 has bonds with coupon rates ranging from 4.5% to 8.25% and most of them trade at a premium.

In conclusion, in evaluating the appropriateness of the RBA's and Bloomberg's approaches for the AER's purposes, we suggest that AER needs to take into consideration WACC criteria (1) and (2). That is, it needs to form an opinion of whether the RBA methodology (and, respectively, BVAL methodology) is fit for the purpose of providing an estimate of the return on debt of the benchmark debt instrument and whether, as such, it is consistent with well accepted economic and finance principles. In our opinion:

(1) the RBA's resulting estimate does not represent a par yield curve or a zero-coupon yield curve. As such, it is not clearly consistent with well accepted finance principles.

(2) An estimated par yield curve, other things being equal, would fit the AER's purpose better than an estimate of an average yield/credit spread over a range of coupon-bearing bonds.

Use of econometric techniques

RBA methodology

The RBA provides the following summary of its econometric method:[96]

> In this article, aggregate credit spreads of A-rated and BBB-rated Australian NFCs are estimated for a given (target) tenor as the weighted average of the Australian dollar equivalent credit spreads over the swap rate. The method is applied to the cross-section of bonds in the sample that have the desired credit rating. The weights are determined by a Gaussian kernel that assigns a weight to every observation in the cross-section depending on the distance of the observation's residual maturity and the target tenor according to a Gaussian (normal) distribution centred at the target tenor… The advantage of the Gaussian kernel over other more simplistic weighting methods, such as an equally weighted average, is that it uses the entire cross-section of bonds, albeit with weights approaching zero as the distance of the bonds' residual maturity from the target tenor increases. This provides a robust method capable of producing estimates even when the number of available observations is relatively small.

In particular, the credit spread estimator for a target tenor T takes the following form:

$$S(T) = \sum_{i=1}^{N} w_i(T; \sigma) S_i$$

Where T is the target tenor, σ is the standard deviation of the Gaussian kernel, and S_i is observed spread for bond i in the sample of N bonds with the given broad credit rating. The weight for the target tenor T of applied to observation i is determined as follows:

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[95] And similarly, neither will their spreads to a swap curve.

[96] I. Arsov, M. Brooks, M. Kosev, *New Measures of Australian Corporate Credit Spread*, Bulletin, December Quarter 2013, p.20.

$$w_i = \frac{K(T_i - T; \sigma)F_i}{\sum_{j=1}^{N} K(T_j - T; \sigma)F_j}$$

In the above formula F_i is the face value of bond i and $K(T_i\text{-}T;\sigma)$ is the Gaussian kernel function defined as follows:

$$K(T_i - T; \sigma) = \frac{1}{\sqrt{2\pi}\sigma} exp\left[-\frac{(T_i - T)^2}{2\sigma^2}\right]$$

The RBA emphasises the effect parameter σ has on the smoothness of the resulting estimated curve. Other things being equal, a higher σ results in a smoother curve, because observations further away from the target tenor are given higher relative weights (hence its interpretation as a 'bandwidth' parameter). On the other hand, a lower σ results in observations closest to the target tenor getting higher relative weights. This means that the estimated curve would fit the observed data better, but might be less smooth.

The RBA states that '[t]he optimal choice of the smoothing parameter can be made objectively'.[97] The RBA further suggests a method recognising a trade-off between the goodness of fit and the smoothness of the resulting curve. However, the ultimate choice of the final parameter appears to also be based on examination of the estimated credit spreads and other considerations.

There is no agreement in the literature on the best objective criterion for the choice of the bandwidth (that is, σ in the RBA's notation).[98] In particular, Pagan and Ullah suggest that setting the bandwidth parameter based on visual inspection (or 'eye-balling', as they call it) might have its merits:[99]

> Despite all these endeavours, in some ways it is still unclear whether automatic bandwidth selection is preferable to "eye-balling." If the expectation is to be evaluated at only a limited number of points x, and x is of no more than two dimensions, there is much to be said for selecting h by graphical methods.

At the same time, choice of the bandwidth of a kernel estimator is normally related to the data sample size, i.e., as the sample size increases, the bandwidth becomes narrower.[100] We note that the RBA recognises that the optimal smoothing parameter might change over time, but keeps the bandwidth σ fixed for the entire estimation period from 2005 to 2013 'in the interests of simplicity'.[101]

There exists a variety of kernel methods of estimating conditional moments.[102] The methods vary with respect to the choice of the kernel K, the parameter determining the bandwidth of the kernel (σ in case of Gaussian kernel), as well as the particular estimation technique employed. The estimator used by the RBA is similar to the Nadaraya-Watson kernel estimator, except for the introduction of additional weighting by face value by the RBA.[103] While the effect of weighting by face value has not been

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[97] I. Arsov, M. Brooks, M. Kosev, *New Measures of Australian Corporate Credit Spread*, Bulletin, December Quarter 2013, p.21.

[98] See, for example: A. Pagan and Ullah (1999), *Nonparametric econometrics* (Cambridge University Press), pp.118-122.

[99] A. Pagan and Ullah (1999), *Nonparametric econometrics* (Cambridge University Press), p.120. In Pagan and Ullah's notation, x corresponds to the RBA's tenor T and h corresponds to the RBA's σ.

[100] A. Pagan and Ullah (1999), *Nonparametric econometrics* (Cambridge University Press), chapters 2 and 3.

[101] I. Arsov, M. Brooks, M. Kosev, *New Measures of Australian Corporate Credit Spread*, Bulletin, December Quarter 2013, p.22.

[102] A. Pagan and Ullah (1999), *Nonparametric econometrics* (Cambridge University Press), chapter 3.

[103] A. Pagan and Ullah (1999), *Nonparametric econometrics* (Cambridge University Press), p.86.

addressed analytically by the RBA, the RBA suggests that such weighting does not have a substantial effect of the resulting estimates.[104]

A potential problem for the AER with using the Nadaraya-Watson kernel estimator for samples such as the RBA's bond sample is illustrated below. The overwhelming majority of bonds in the RBA's sample have a remaining time to maturity of less than 10 years (refer to Figure) – which is the AER's tenor of interest. As is recognised by the RBA:[105]

> At the end points of the tenor range (1 and 10 years, but particularly at the 1-year tenor), the Gaussian kernel, and other similar methods, may be somewhat biased because there are no observations below and above the target tenor. Effectively, the weighted average is calculated from bonds on only one side of the estimation window. At the 10-year tenor, this is also an issue due to the sparse issuance above 10 years, but is less problematic for the A-rated bonds, for which some observations are available. However, the degree of bias depends on the true shape of the credit spread curve, with steeper curves resulting in more biased estimates.

Some kernel estimation methods — in particular, local linear regression — have better finite-sample properties than the Nadaraya-Watson estimators.[106] Pagan and Ullah suggest that:[107]

> …unlike the Nadaraya-Watson kernel estimator, … [the local linear regression estimator's] bias and variance are of the same order of magnitude in both interior and near the boundary of the support…

> It is generally the case that local linear regression estimator has smaller MSE than the kernel estimator [Nadaraya-Watson]; this turns out to be particularly true around the boundary points.

Methods that allow for a variable bandwidth also generally improve the goodness of fit of the resulting estimator.[108]

Estimation for terms to maturity close to the end of the sample

Below we provide an example of a potential problem with the RBA-style kernel estimator arising close to the boundary of the bond sample – or, even more generally, in situations where the bond sample distribution is asymmetric around a given maturity.

As of March 2014, the RBA BBB bond sample included 20 bonds with residual maturity of 1 to 4 years, 16 bonds with residual maturity of 4-6 years, 15 bonds with residual maturities of 6-8 years, and 9 bonds with residual maturities of 8-12 years.

It can easily be seen that the distribution of the bond sample across maturities is not uniform – and neither should it be expected to be uniform. All bonds that were originally issued at 8-12 years to maturity would be expected to move into the next cohort down (6-8 years to maturity) as time passes, unless they drop out of the sample (for instance, due to a default or a rating downgrade). Eventually, we can expect them to be in the 1-4 years cohort. However, only those bonds that were originally issued for a term longer than 8 years would ever make it into the 8-12 years cohort. Therefore,

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[104] I. Arsov, M. Brooks, M. Kosev, *New Measures of Australian Corporate Credit Spread*, Bulletin, December Quarter 2013, p.21.

[105] I. Arsov, M. Brooks, M. Kosev, *New Measures of Australian Corporate Credit Spread*, Bulletin, December Quarter 2013, p.20.

[106] As the name suggests, local linear regression means that a weighted linear regression analysis is performed for each tenor of interest, with weights determined based on the chosen kernel *K*.

[107] A. Pagan and Ullah (1999), *Nonparametric econometrics* (Cambridge University Press), pp.105-106.

[108] A. Pagan and Ullah (1999), *Nonparametric econometrics* (Cambridge University Press), p.94.

generally speaking, we would expect to observe more bonds in the 1-4 cohort than other cohorts. Further, we would expect the cohort of bonds with more than 8 years to maturity to be the smallest.

However, the weighting system applied to the credit spreads of individual bonds is symmetric around the tenor of interest. For example, if the tenor we are interested in is 10 years and $\sigma = 1.5$ (as in the RBA's method), the corresponding weights applying to bond credit spreads of different remaining term to maturity would be as follows.[109]

Table

Remaining term to maturity	5	6	7	8	9	10	11	12	13	14	15
$K(T_i - 10; 1.5)$	0.00	0.01	0.04	0.11	0.21	0.27	0.21	0.11	0.04	0.01	0.00

That is, the largest weight would be given to the bond observations with 10 years to maturity, and then the weights would decrease as the remaining term to maturity moves further away from 10 years.

Given an asymmetric bond distribution across remaining term to maturity and assuming that actual credit spread increases with the term to maturity (which is often the case), we might expect the resulting estimate to be biased downwards if there are more bonds in the sample with term to maturity under 10 years relative to those over 10 year to maturity.

As noted above, to some extent this bias can be addressed by adjusting the kernel window width (σ) depending on the number of observations. Further, this problem can be addressed by using a local linear regression kernel estimator. However, while the RBA is aware of this concern, it is not addressed by its current methodology. Therefore, we consider that it is unclear whether the RBA's use of econometric techniques satisfies the AER's first and second WACC criteria, that is, whether it is fit for purpose and informed by sound empirical analysis and robust data.

At the same time, there is very little information available in the public domain in relation to the econometric approach used for BVAL curve estimation. As mentioned earlier, the only non-confidential description of Bloomberg methodology we are aware of is the following:[110]

> The Bloomberg curve is fitted to observations by using an adaptive mix of zeroth and first order non-parametric regression and subsequently smoothed by using rational Bezier polynomials.

As far as we understand, 'zeroth order non-parametric regression' is likely referring to a non-parametric regression that fits a constant, such as the Nadaraya-Watson approach, while 'first order non-parametric regression' is likely referring to a local linear regression estimator. Thus, at first glance, Bloomberg appears to be using a somewhat similar approach to that of the RBA, although there would also be differences – for example, Bloomberg's approach is estimating a par yield curve, local linear regression appears to be used, and there is a separate smoothing step. However, a more detailed comparison — and in particular that related to a potential bias and goodness of fit — is not possible due to the limited amount of information available on the BVAL curve-fitting approach.

RBA's conversion of the USD and Euro credit spreads into AUD credit spreads

Given the proportion of the foreign currency bonds in the RBA sample and their importance for the credit spread estimation, especially at the longer maturities, we consider it would be important to evaluate the conversion of the foreign currency credit spreads into those in AUD performed by the

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[109] We assume for simplicity that all bonds have identical face value. As the RBA suggests that weighting by face value produces very similar results to not weighting by face value.

[110] This information is available from the description of the 'Bloomberg curve fitter' in Bloomberg CRV tool. Correspondence with Bloomberg representatives (24 June and 14 August 2014) confirms that this description also applies to BVAL sector level curves.

RBA. However, we consider that the Bulletin article does not provide sufficient detail with regards to the procedure to enable us to replicate the conversion or provide a comprehensive assessment of it.[111] It appears that the procedure relies on the approximation of the exact conversion formula based on the concept of bond duration similar to the procedure employed by PwC in its report to the QCA.[112] We note there are other potential approaches such as cross-currency spread matrix and swap manager (SWPM) function available from Bloomberg. The RBA article notes its chosen methodology is 'commonly used by market participants in practice'.[113]

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[111] The description is provided in general terms and is explained in approximately half a page of the article. Upon request, RBA staff have provided further information on its conversion methodology, however this information was provided on a confidential basis. The analysis in this report is based solely on non-confidential information.

[112] PwC, *A cost of debt estimation methodology for businesses regulated by the Queensland Competition Authority*, June 2013, pp. 105-109.

[113] I. Arsov, M. Brooks, M. Kosev, *New Measures of Australian Corporate Credit Spread*, Bulletin, December Quarter 2013, p.25.

Errata (7 Nov. 14)

Following the completion of this report "Return on debt estimation: a review of the alternative third party data series: August 2014", correspondence with the RBA has clarified certain minor matters of methodology that are not accurately reflected in the report. Those aspects are as follows:

1. The report states that the RBA bond sample includes 'both secured and unsecured senior bonds'. In fact the sample is not limited to senior bonds.

Original text	Correct text
Page 8, Table 1, column 'RBA sample'; 'Both secured and unsecured senior bonds'	'Both secured and unsecured bonds'
Page 12; 'Currently the majority of BBB rated Australian senior bonds are unsecured'	'Currently the majority of BBB rated Australian bonds in the RBA sample are unsecured'
Page 22; 'AUD BBB Corp BVAL sample only includes senior unsecured bonds, while the RBA does not specify an equivalent restriction on bond security. Currently the vast majority of Australian BBB-rated corporate bond are unsecured bonds.'	'AUD BBB Corp BVAL sample only includes senior unsecured bonds, while the RBA does not specify an equivalent restriction on bond security or seniority. Currently the vast majority of Australian BBB-rated corporate bonds in the RBA sample are unsecured bonds.'

2. Figures 1-3 present yields for various bond series. The Bloomberg series are all plotted using effective annual rates. The RBA series have not been converted to effective annual rates. The figures plot yields reported in the RBA table F3, which the RBA indicates (in e-mail correspondence on 16 October 2014) are not effective annual rates and 'can be best thought of as annual rates with semi-annual compounding'. Therefore, the RBA and Bloomberg yields in Figure 1 are not plotted on a strictly comparable basis. The qualitative conclusions of the report are not affected by this difference.