APPENDIX 43

Extrapolating the RBA BBB curve to a 10-year tenor

QTC

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1.1 Summary

This report outlines two methods to extrapolate the Reserve Bank of Australia's (RBA) BBB non-financial corporate (NFC) credit curve to a 10-year tenor. For the purpose of estimating the benchmark debt yield, extrapolation is necessary as the effective tenor of the bonds used by the RBA to estimate the BBB swap spread for a 10-year target tenor has always been shorter than 10 years.

Both methods use the BBB swap spreads and associated effective tenors produced by the RBA to estimate the slope of the BBB swap spread curve. The extrapolation is performed by multiplying the slope estimate by the difference between 10 years and the effective tenor of the RBA's BBB swap spread for a 10-year target tenor.

Both methods are simple to implement and only make use of publicly available data produced by the RBA.

1.2 The need for extrapolation

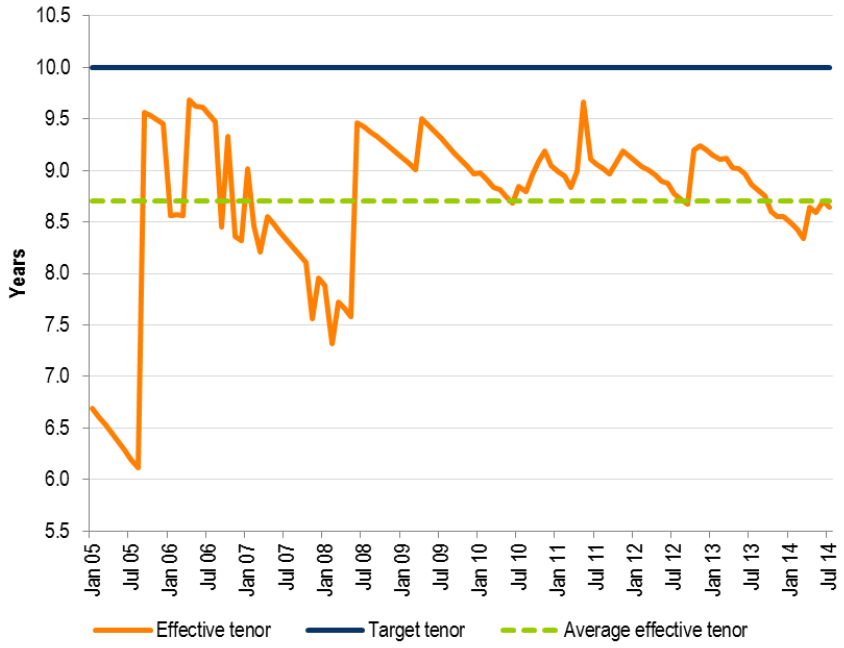
In December 2013 the RBA began publishing estimates of NFC credit spreads for broad A and BBB credit ratings and target tenors of 3, 5, 7, and 10 years. The RBA describes its estimation method as follows[1]:

> *'… 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.'*

As shown in Figure 1, the effective tenor of the bonds used by the RBA to estimate the BBB swap spread for a 10-year target tenor has always been shorter than 10 years. The average effective tenor between January 2005 to August 2014 is 8.7 years:

[1] RBA (December 2013), *New Measures of Australian Corporate Credit Spreads*, p. 23.

FIGURE 1: BBB EFFECTIVE AND TARGET TENORS



Source: RBA

As the Rate of Return Guideline specifies a benchmark debt tenor of 10 years, using the RBA's raw swap spread estimates is likely to under-estimate the benchmark debt yield[2].

1.3 Relationship between credit spreads and tenor

Before an extrapolation method can be developed it is necessary to determine the nature of the relationship between credit spreads and tenor. For this purpose the credit spread can be expressed as a swap risk premium (SRP), which is the spread to the swap yield curve, or a debt risk premium (DRP), which is the spread to the Commonwealth Government yield curve.

Since early 2012 the Australian Energy Regulator (AER) has used a 'paired bond' extrapolation method to extend the Bloomberg 7-year BBB DRP to a 10-year tenor. This method involves estimating the DRP for two bonds with different tenors that are issued by the same company[3]. The DRP difference is divided by the difference in tenors to estimate the slope of the DRP curve, which is expressed in terms of basis points per year. The slope estimate is multiplied by 3 and added to the Bloomberg 7-year DRP to estimate the 10-year DRP.

The AER's application of this method assumes a linear relationship between the DRP and tenor. As such, the extrapolation methods outlined in this report are also based on a linear relationship between credit spreads and tenor.

1.4 Extrapolation methods

Both methods use the BBB swap spreads and associated effective tenors produced by the RBA to estimate the slope of the BBB swap spread curve[4]. The extrapolation is performed by

[2] AER (December 2013), *Better Regulation: Explanatory Statement – Rate of Return Guideline*, p. 126.
[3] Ideally, the remaining tenors of the bonds would be as close as possible to 7 and 10 years.
[4] These data are sourced from the *Aggregate Measures of Australian Corporate Bond Spreads and Yields – F3* spreadsheet from the RBA website.

multiplying the slope estimate by the difference between 10 years and the effective tenor of the RBA's swap spread for a 10-year target tenor.

1.4.1 Notation

The following notation has been used to describe each extrapolation method:

S_n = RBA BBB swap spread estimate for an *n*-year target tenor.
ET_n = Effective tenor of the RBA BBB swap spread estimate for an *n*-year target tenor.
Δ_m = Estimated slope (per year) of the BBB swap spread curve produced by method *m*.
EM_m = Extrapolation margin produced by method *m*.
ES_m = Extrapolated RBA 10-year BBB swap spread produced by method *m*.

1.4.2 Method 1

Method 1 uses the difference between the RBA's BBB swap spreads for target tenors of 7 and 10 years, and the associated effective tenors, to estimate the slope of the BBB swap spread curve spread curve. Method 1 is based on the same principles as the AER's paired bond extrapolation method.

$$\Delta_1 = (S_{10} - S_7) \,/\, (ET_{10} - ET_7)$$

1.4.3 Method 2

Method 2 uses the RBA's BBB swap spreads for target tenors of 3, 5, 7, and 10 years, and the associated effective tenors, to estimate the slope of the BBB swap spread curve. The slope is calculated using the `SLOPE(known_y's,known_x's)` function in Excel[5].

$$\Delta_2 = \texttt{SLOPE}(\{S_3\ S_5\ S_7\ S_{10}\},\{ET_3\ ET_5\ ET_7\ ET_{10}\})$$

1.4.4 Estimating the extrapolation margin

The extrapolation margin is estimated by multiplying the slope estimate by the difference between 10 years and the effective tenor of the RBA's swap spread for a 10-year target tenor:

$$EM_m = \Delta_m \times (10 - ET_{10})$$

1.4.5 Estimating the extrapolated 10-year BBB swap spread

The extrapolated 10-year BBB swap spread is estimated by adding the extrapolation margin to the RBA's BBB swap spread for a 10-year target tenor:

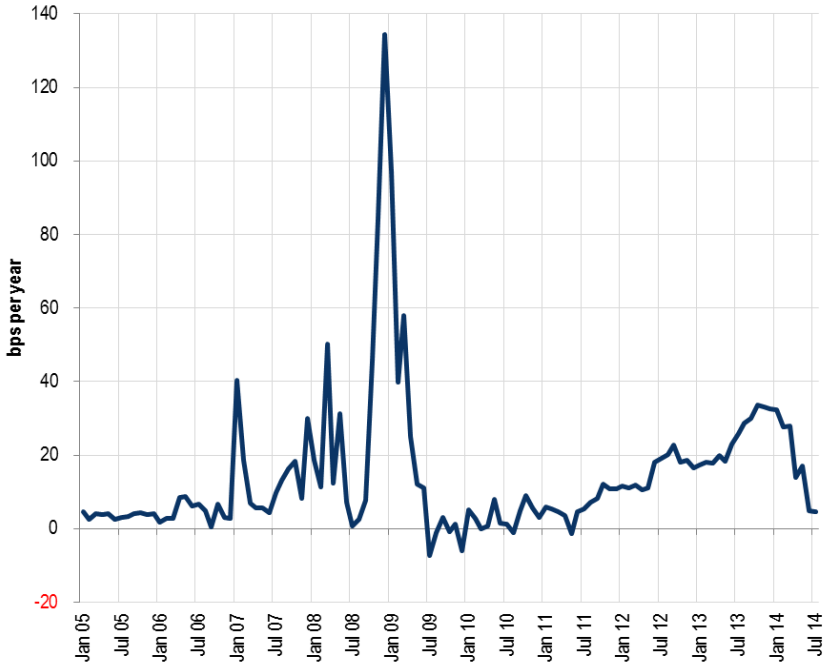
$$ES_m = S_{10} + EM_m$$

[5] The output from the SLOPE function is the estimated slope coefficient from a regression of the RBA's monthly BBB swap spreads on the associated effective debt tenors.

1.5 Estimates of the slope of the BBB swap spread curve

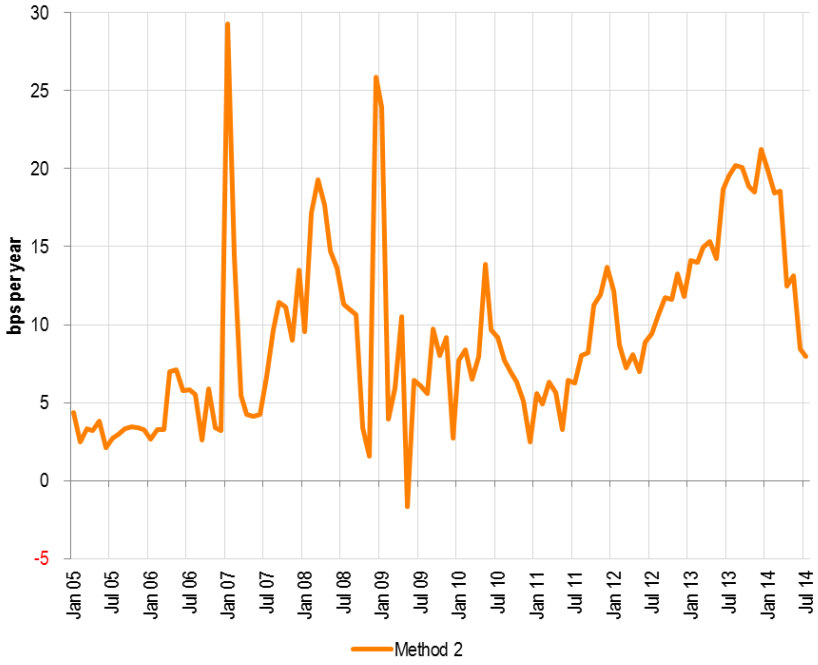
Figures 2 and 3 display the monthly estimates of the slope of the BBB swap spread curve produced by Methods 1 and 2 respectively. The average and standard deviation of the monthly slope estimates are shown in Table 1.

FIGURE 2: BBB SWAP SPREAD SLOPE ESTIMATES FOR METHOD 1



Source: RBA, QTC calculations

FIGURE 3: BBB SWAP SPREAD SLOPE ESTIMATES FOR METHOD 2



Source: RBA, QTC calculations

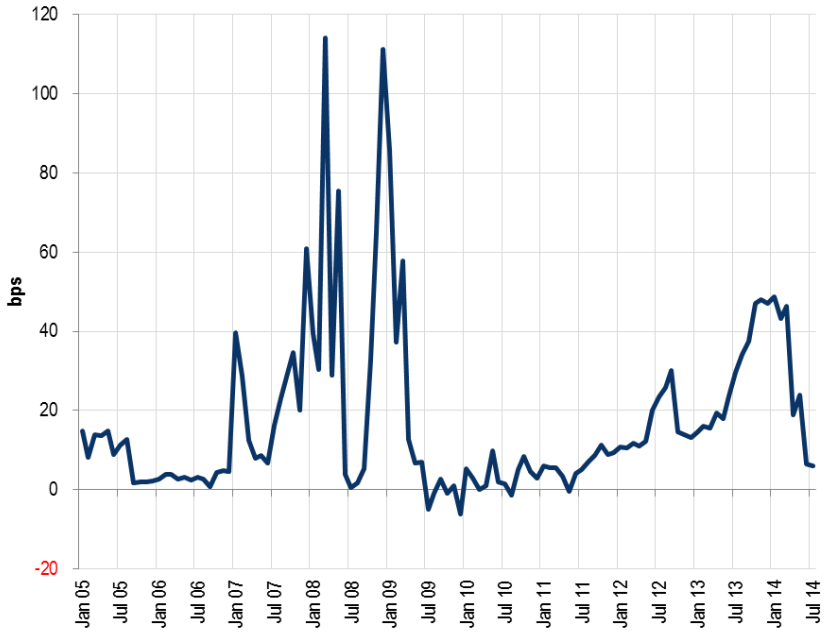
TABLE 1: BBB SWAP SPREAD SLOPE STATISTICS

	Method 1	Method 2
Average slope per year (bps)	14.3	9.4
Standard deviation (bps)	19.4	5.9

1.6 Estimates of the BBB extrapolation margin

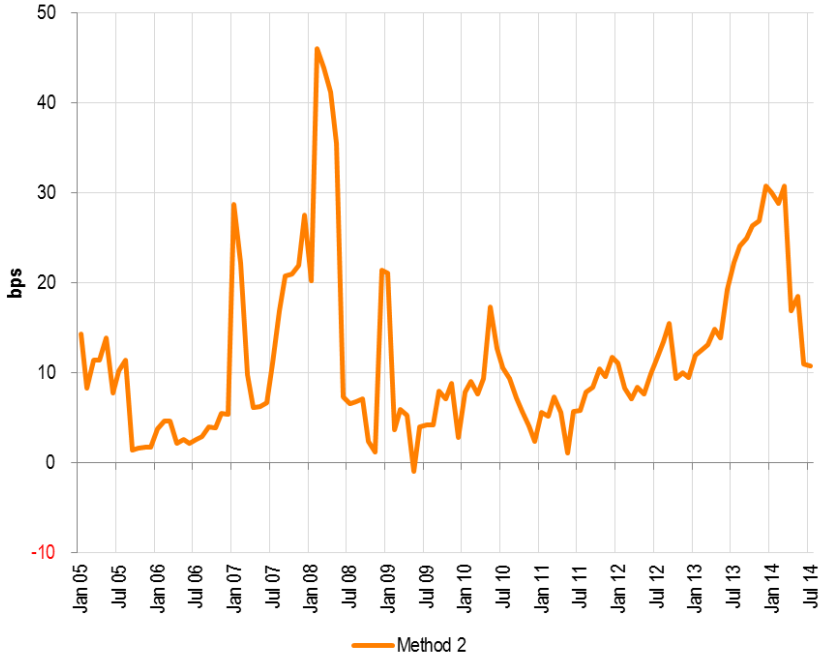
The extrapolation margins produced by Methods 1 and 2 are shown in Figures 4 and 5:

FIGURE 4: EXTRAPOLATION MARGIN FOR METHOD 1



Source: RBA, QTC calculations

FIGURE 5: EXTRAPOLATION MARGIN FOR METHOD 2



Source: RBA, QTC calculations

TABLE 2: EXTRAPOLATION MARGIN STATISTICS

	Method 1	Method 2
Average extrapolation margin (bps)	17.4	11.8
Standard deviation (bps)	21.5	9.4

1.7 Observations and conclusions

The main observations from Figures 2–5 and the data in Tables 1 and 2 are as follows:

- Method 1, which only uses the RBA's BBB swap spreads for target tenors of 7 and 10 years, and the associated effective tenors, produces larger and more volatile slope and extrapolation margin estimates.
- Method 2 makes use of all the BBB swap spread and effective tenor estimates produced by the RBA. This results in a significant reduction in the volatility of the monthly slope and extrapolation margin estimates compared to Method 1.
- Both methods have produced negative slope estimates during the test period. There are sound theoretical reasons for why the slope of the credit spread curve should be positive for investment grade credit ratings, and the theory is supported by empirical evidence[6]. As such, the negative slope estimates are likely to reflect estimation error in one or more of the RBA's BBB swap spread estimates. Regardless of the extrapolation method used, the resulting slope estimate should be constrained to be greater than or equal to zero[7].
- The average slope estimate for Method 2 of 9.4 basis points per year (refer Table 1) is broadly consistent with a range of paired bond estimates produced by the AER and PricewaterhouseCoopers (PwC)[8].

Based on these observations, QTC considers that Method 2 will produce more robust and realistic estimates of the slope of the BBB swap spread curve compared to Method 1.

In QTC's view, it is reasonable to use Method 2 to extrapolate the RBA's BBB swap spread estimate for a 10-year target tenor to a true 10-year tenor.

[6] PwC (March 2010), *Jemena Gas Networks (NSW) cost of debt report*, pp. 30–33.
[7] This approach will still produce a negative/zero extrapolation margin if the effective tenor of the RBA's BBB swap spread estimate for a 10-year target tenor is *longer* than 10 years.
[8] QTC (October 2013), *Submission to the Draft Rate of Return Guideline*, pp. 14–15.