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Appendix G

Debt risk premium estimate for Aurizon

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1 Executive summary

1. This report sets out CEG’s analysis of Incenta’s (2017) estimates of Aurizon’s DRP,¹ which the QCA relied upon extensively in its draft decision where the QCA applied a benchmark 10-year DRP of 2.00%.² Incenta also rejected implementing adjustments to account for the existence of a coal premium.³

1.1 Best estimate of Aurizon’s DRP

2. There are two key problems with Incenta’s dummy intercept estimates:
 - Incenta’s dummy variable model assumes that the DRP curves have the same slope across all credit ratings. However, investigation of the sample of bonds used by Incenta clearly shows that this assumption is false; and
 - The dummy variable estimates show that the difference between BBB and BBB+ DRPs is only 0.2 bp. Consequently, BBB and BBB+ bonds are, unlike A- bonds, prime candidates for pooling.
3. The first observation means that Incenta’s 2.00% estimate from its preferred dummy intercept model is be biased downwards by the smaller slope coefficient of the A- bonds, while the second observation suggests that the BBB and BBB+ bonds identified from Incenta’s search criteria should be pooled. In turn, A- bonds can either be excluded completely or be assigned slope dummies.⁴ Pooling the BBB and BBB+ bonds results in a sample of 23 bonds, which is only 2 less than Incenta’s preferred sample containing 25 bonds for the DBCT decision.⁵
4. Using the first approach of pooling BBB+ and BBB bonds, the DRP estimate for Incenta’s June 2017 averaging period is 2.45%, while the second approach that includes a dummy slope for A- bonds generates a 2.32% DRP estimate (see Table 5-3). One other variation that we have considered in this report is to exclude real estate firms from the sample, which generates a pooled BBB+/BBB estimate of 2.50% based on 20 bonds.

¹ Incenta, Aurizon Network’s WACC for the 2017 DAU, December 2017.

² Incenta, Aurizon Network’s WACC for the 2017 DAU, December 2017, p. 23.

³ Incenta, Aurizon Network’s WACC for the 2017 DAU, December 2017, pp. 98-99.

⁴ Our results suggest that the A- slope dummy is statistically significant, while the A- intercept dummy is not. It is therefore more appropriate to omit the A- intercept dummy while retaining the A- slope dummy, noting that retaining both A- dummies generates DRP estimates that are numerically equivalent to excluding A- bonds from the regression.

⁵ Incenta, Aurizon Network’s WACC for the 2017 DAU, December 2017, p. 103.

5. Our best estimate of the BBB+ DRP in June 2017 is therefore between **2.32% and 2.50%**. The lower end of this bound is based on a pooled regression of A- to BBB bonds with a dummy for slopes (not intercepts). The top end of this range is based on a pooled regression of non-financial AUD issued BBB and BBB+ bonds (excluding real estate bonds) with no dummy variables.

1.2 3rd party cross checks

6. As discussed in paragraph 2, Incenta's pooled regression results show that BBB+ and BBB estimates are neither statistically nor economically significantly different. This observation thus suggests that it is appropriate to use 3rd party BBB estimates as a proxy for the benchmark BBB+ estimate, as opposed to Incenta's approach that uses a weighted average of 3rd party BBB and A estimates.
7. We note as well that using 3rd party BBB estimates directly is consistent with PwC (2013), which referred to the Bloomberg BBB BFV curve (since replaced with the Bloomberg BBB BVAL curve) because PwC considered that the curve was accepted as referring to a BBB+ estimate by convention.
8. For the June 2017 averaging period, the mean DRP estimate from 3rd party sources [Bloomberg (2.34%), RBA (2.18%), and Reuters (2.42%)] is 2.31%.⁶ We note that all three sources are above Incenta's 2.00% estimate, while two of the three sources are within the range of our best estimate (2.32% to 2.50%).

1.3 Conclusion

9. Our best estimate of the DRP in June 2017 is within the range of **2.32% to 2.50%**. In our view, Incenta's best estimate of 2.0% is unreasonable because it is based on a methodology that, given the available data set, is unduly biased by the inclusion of A-bonds without a dummy variable that adjusts for the difference in slopes of A- and BBB/BBB+ DRP vs maturity regressions.

⁶ We use Incenta's reported Bloomberg and RBA estimates, while the Reuters estimate is obtained from our own calculations.

2 Introduction

10. CEG has been asked by Aurizon to provide an update to our previous report submitted to the QCA,⁷ in which we used data over the month of June 2016 to estimate the benchmark BBB DRP that would be applied to Aurizon for the UT5 regulatory cycle. Since the submission of that report, the QCA has published its UT5 draft decision, which drew heavily from the findings of a report by Incenta (2017).⁸
11. This report therefore provides an analysis of the QCA’s UT5 draft decision pertaining to its debt risk premium estimate, and updates our results for the June 2017 averaging period that Incenta used in its report.
12. As will be set out in the remainder of this report, we have not been able to replicate Incenta’s bond samples based on their stated search criteria. Consequently, we have also not been able to replicate Incenta’s estimates although our estimates are generally fairly close to Incenta’s. However, we consider that Incenta’s methodology contains certain shortcomings that should be addressed by the QCA.
13. For the rest of this report, we use the terms “Incenta method”, “PwC method”, and “CEG method” to refer to the methodology set out in Incenta (2017), PwC (2013), and the previous CEG report submitted to the QCA.⁹ Any references to other reports by the same authors will be explicitly stated.
14. The remainder of this report is set out as follows:
 - **Section 3** provides a summary of Incenta’s methodology;
 - **Section 4** sets out our attempt to replicate Incenta’s bond sample and econometric estimates of DRP;
 - **Section 5** provides our best estimate; and
 - **Section 6** examines cross-checks.

⁷ CEG, Debt risk premium of coal transporters: A report for Aurizon Network, September 2016.

⁸ Incenta, Aurizon Network’s WACC for the 2017 DAU, December 2017.

⁹ CEG, Debt risk premium of coal transporters: A report for Aurizon Network, September 2016.

3 Incenta's methodology

15. The two key steps in Incenta's DRP methodology are:
 - Search criteria for obtaining the bond sample (section 3.1);
 - Econometric estimation of the 10-year DRP (section 3.2); and
 - Cross checks against a broader sample or against third party estimates (section 3.3).
16. These steps are loosely based on the methodology set out in a PwC (2013) report, which Aurizon applied in its proposal.

3.1 Bond search criteria

17. Incenta made use of two bond samples for deriving its estimates – a narrower sample based on AUD-denominated bonds with no options and an expanded sample that includes foreign bonds and bonds with options.
18. The search criteria for the two bond samples are:¹⁰
 - Active bonds maturing on 30 June 2018 or later;
 - Country of risk assessed as Australia;
 - Aggregated credit rating between A- and BBB;¹¹
 - Exclusion of inflation-linked and perpetual bonds;
 - Remaining term to maturity between 1 year and 20 years (inclusive);
 - Exclusion of bonds issued by financial entities but including real estate firms;
 - Issued in AUD with no optionality for the small sample, while the large sample further includes USD/EUR/GBP bonds and bonds with call/put/no options; and
 - Exclusion of bonds issued into the European market by Coca-Cola Amatil.
19. The above search criteria are broadly similar to those set out in PwC (2013),¹² but with some differences:

¹⁰ Incenta, Aurizon Network's WACC for the 2017 DAU, December 2017, pp. 130-134.

¹¹ Incenta formulated its own credit rating measure that aggregates the assessments of the three major credit rating agencies.

¹² PwC, A cost of debt estimation methodology for businesses regulated by the Queensland Competition Authority, June 2013.

- PwC's sample did not include a restriction on maximum maturity, possibly because the other criteria of its original bond sample did not generate bonds with long residual maturities at that time. CEG's methodology applied the same restrictions as Incenta's.
- PwC referred to bonds with "Australian issuance by an Australian entity", as opposed to Incenta referring to bonds with Australia as its country of risk.¹³ CEG's methodology restricts the sample to bonds issued by companies incorporated in Australia.¹⁴
- PwC excluded bonds where the issuing entity is a "financial entity", without mentioning its treatment of bonds issued by real estate firms. Incenta interpreted the term "financial entity" as excluding bonds issued by firms in the financial industry, without excluding bonds issued by real estate firms.¹⁵ CEG did not make a distinction between real estate firms and other types of firms in the financial industry, but presented DRP estimates with and without the financial industry bonds.
- PwC did not exclude bonds issued by Coca-Cola Amatil. Incenta excluded bonds issued by Coca-Cola Amatil in European markets. CEG excluded all bonds issued by Coca-Cola Amatil.¹⁶

3.2 Estimation method

20. PwC described three candidate econometric models (Incenta estimates in parentheses):
- Pooled regression (**1.80%**) – simple linear regression on a bond sample that includes bonds with A-, BBB+, and BBB credit ratings;
 - Single credit rating regression (**2.50%**) – simple linear regression on a bond sample that only includes BBB+ bonds; and
 - Dummy intercept regression (**2.00%**) – linear regression on a bond sample that includes bonds with A-, BBB+, and BBB credit ratings, but with separate intercepts being estimated for each credit rating.

¹³ Bloomberg uses its own proprietary methodology to identify the "country of risk" associated with each bond. The West Australian ERA uses the same criterion in its bond searches.

¹⁴ Incenta, Aurizon Network's WACC for the 2017 DAU, December 2017, p. 34.

¹⁵ Incenta applied such a distinction on the basis that real estate firms "typically receive rental streams or take on development risk", and thus differ from other financial institutions (see p. 100). This was in spite of Incenta's understanding that the West Australian ERA did not draw such a distinction either.

¹⁶ We follow Bloomberg's approach of excluding the Coca-Cola Amatil bonds from their BVAL sample. Bloomberg has not provided an explicit reason for excluding these bonds, but it is likely to be a reflection of an assessment that the Coca-Cola Amatil bonds are not representative of the broad BBB benchmark.

21. The CEG report noted that each of the three candidate econometric models has its own pros and cons, such that the choice between the three is ultimately an empirical issue to be determined by assessing the dataset. Incenta concurred with this view [emphasis added]:¹⁷

*CEG's report submitted that "it would be bad practice to apply the PwC (2013) and Incenta (2016a, and 2016b) approaches in a mechanistic way." However, Incenta has not applied the PwC (2013) approach in a mechanistic manner. **In particular, Incenta considers that it is necessary practice to examine whether all of the conditions underlying the method have been met.** These conditions are:*

- *No material bias in the bond sample – that is, the average implied credit rating of the bond sample used in the pooled regression should approximate the target credit rating;*
- *No material asymmetry in the debt risk premiums of credit rating bands – that is, the average debt risk premium differential between the bonds in the target band and in the band on either side of the target credit rating band should be approximately equal; and*
- *No material debt risk premium 'aberrations' / 'influential bonds' – that is, there should be no aberrant or 'influential' bonds whose debt risk premiums are: a) materially out of line with the debt risk premium / term relationship for that credit rating band, which becomes more important the smaller the sample size; or b) influential relative to their numbers among the bonds in the sample. The former will increase / decrease the intercept of the estimate, while the latter will influence the slope of the relationship between term and debt risk premium.*

22. The strengths and weaknesses of the three candidate models have been explored extensively in the reports by PwC, Incenta, and CEG, namely:

- Pooled regression – requires symmetry in the debt risk premium on either side of the target credit rating. That is, pooled regression should not be used if there are more A- bonds than BBB bonds or vice-versa, or if the spread between A- and BBB+ DRP is materially different from the corresponding spread between BBB+ and BBB DRP.¹⁸

¹⁷ Incenta, Aurizon Network's WACC for the 2017 DAU, December 2017, pp. 101-102.

¹⁸ Incenta states that pooled regression is a "second-best" approach in the event that a given credit rating band did not have enough bond observations to generate a reliable estimate (see p. 88). This implies that Incenta agrees that the single credit rating regression is the best approach by default in the absence of other econometric shortcomings.

- Single credit rating – certain credit rating bands have historically suffered from small sample sizes.
 - Dummy intercept – implicitly assumes that the DRPs for each credit rating band have the same slope, which is an assumption that PwC demonstrated to be empirically incorrect.¹⁹ Furthermore, PwC obtained a nonsensical result where the dummy variable model generated a lower BBB+ DRP than the corresponding BBB DRP,²⁰ while Incenta obtained a BBB+ DRP that was only 0.2 bp higher than the BBB DRP.²¹
23. Of the three candidate models, Incenta considered the dummy intercept regression to be the most appropriate. Specifically, Incenta rejected the pooled regression estimate on the basis that the sample contained relatively more bonds with A- credit ratings than each of the other two ratings, which would underestimate the DRP.
24. Incenta also rejected the single credit rating regression because it considered the sample size of six BBB+ bonds to be “too small a sample size to deliver a reliable and robust empirical estimate of the BBB+ debt risk premium”.²²

3.3 Cross-checks

25. Incenta carried out two additional forms of analyses as cross-checks of its preferred estimates:
- Re-estimating the three candidate models on an expanded sample; and
 - Obtaining third party DRP estimates from Bloomberg and the RBA.

3.3.1 Expanded sample

26. Incenta's expanded sample further includes bonds with options (put and call options), as well as bonds denominated in foreign currencies (USD, Euro, and GBP). Incenta proposed the use of Bloomberg's option adjusted spreads (OAS) function to remove the impact of options on observed DRPs and the use of cross-currency swaps to adjust foreign currency DRPs into AUD DRPs.
27. Although PwC had considered bonds with options and bonds denominated in foreign currencies as part of its “complex portfolio”, it ultimately recommended not including

¹⁹ PwC, A cost of debt estimation methodology for businesses regulated by the Queensland Competition Authority, June 2013, Figure 13, p. 68.

²⁰ PwC, A cost of debt estimation methodology for businesses regulated by the Queensland Competition Authority, June 2013, Table 5.8, p. 55.

²¹ Incenta, Aurizon Network's WACC for the 2017 DAU, December 2017, Table 5.6, p. 106.

²² Incenta, Aurizon Network's WACC for the 2017 DAU, December 2017, p. 88.

such bonds due to the complexity of obtaining option-adjusted AUD equivalent yields at that time.

28. As was noted by Incenta and CEG, however, Bloomberg's OAS feature makes the task straightforward from the perspective of the end user. As long as Bloomberg's OAS feature provides reliable estimates of the impact of optionality on bond yields, the resulting yield estimates will be reliable. As far as we know there has not been a comprehensive analysis of the accuracy of the Bloomberg's OAS feature. Incenta nonetheless considered that estimates from the expanded sample could form a useful cross-check of the estimates obtained from the initial sample containing only AUD bonds with no options attached.

3.3.2 Third party estimates

29. Incenta referenced third party estimates by Bloomberg and the RBA, both of which publish yield and DRP curves for the "broad" BBB and A ratings.²³ Incenta obtained estimates from Bloomberg and the RBA by taking a weighted average of the BBB curve (2/3 weight) and the A curve (1/3 weight).
30. CEG had also referred to the Bloomberg and RBA curves as part of its analysis, but did so using the broad BBB curve estimates without making any further credit rating adjustment.
31. Incenta argued that the failure to adjust the BBB curve for a BBB+ rating target was flawed:²⁴

In short, not only are the third party estimates sometimes volatile, but in the current matter, Aurizon Network and CEG are also targeting the wrong credit rating by suggesting that the third party estimates for the broad BBB band be adopted. In 2013 the QCA tasked PwC to develop a methodology that could be applied to estimate the cost of debt for a range of potential credit rating bands, including BBB and BBB+. For Australia, none of the third party providers do this.

32. However, Incenta's argument does not appear to be consistent with the line of reasoning used by PwC, which considered the Bloomberg BBB curve – albeit the BFV curve since the BVAL curve was not available at that time – as an alternative to an econometric estimate of the benchmark BBB+ DRP:²⁵

²³ Bloomberg and RBA estimate the broad BBB curves using bond samples containing BBB+, BBB, and BBB- bonds, while the broad A curves used samples containing A+, A, and A- bonds.

²⁴ Incenta, Aurizon Network's WACC for the 2017 DAU, December 2017, p. 92.

²⁵ PwC, A cost of debt estimation methodology for businesses regulated by the Queensland Competition Authority, June 2013, p. 42.

As noted previously, the extrapolated 10 year Bloomberg BBB FVC estimate (which by convention has been accepted as the BBB+ estimate) is 325 basis points.

33. Although PwC's choice of the Bloomberg BFV curve has since been replaced with the Bloomberg BVAL curve, the reasoning set out in the above quote still applies. That is, PwC's choice was motivated by the convention at that time, which was that the Bloomberg BBB BFV curve was considered to be referring to a BBB+ estimate, and was therefore used as a 3rd party cross-check. The Bloomberg BBB BFV curve has since replaced the BBB BVAL curve, while the RBA BBB curve has also started to be used as part of regulatory decisions. Both the BVAL BBB and RBA BBB curves should therefore also be used without making credit rating adjustments.
34. We note as well that Incenta does not appear to have adjusted the RBA estimates to account the fact that the effective tenor is generally materially shorter than the 10-year target tenor.

3.4 Summary

35. Table 3-1 sets out the differences between the methods used by PwC (2013), Incenta (2017), and CEG (2016).

Table 3-1: Differences between methods

	PwC (2013)	CEG (2016)	Incenta (2017)
Data source	Bloomberg and UBS	Bloomberg	Bloomberg
Maximum bond maturity	None	20 years	20 years
Criteria for identifying Australian bonds	Australian issuance by an Australian entity	Country of incorporation	Country of risk
Bonds issued by real estate firms	Excludes "financial entities" without referring to real estate firms	Excluded	Included
Coca-Cola Amatil bonds	Included	Excluded	Excluded bonds issued in European markets
Candidate econometric models	Pooled, single rating, and dummy intercept regressions	Pooled, single rating, and dummy intercept regressions	Pooled, single rating, and dummy intercept regressions
3 rd party BBB+ estimates	Broad BBB with no adjustment for credit rating	Broad BBB with no adjustment for credit rating	Weighted average of broad BBB and broad A estimates

4 CEG replication of Incenta

4.1 Replicating Incenta's sample

36. We have applied Incenta's search criteria to Bloomberg's bond search facility (SRCH), but were unable to replicate Incenta's sample of bonds.
37. Sections 4.1.1 to 4.1.2 compare the samples that we obtained against the list of bonds set out on pages 131 to 134 of the Incenta report.

4.1.1 AUD bonds without options issued in the Australian market

38. Incenta obtained a sample of 55 bonds issued in AUD without options in the Australian market, while we obtained 53 bonds. The two missing bonds are:
 - UV8008012 Corp: AUD callable bond rated A- issued by Australia Pacific Airports Melbourne Pty Ltd (the bond did not show up in our search because it was callable); and
 - EJ4333419 Corp: AUD Bond rated BBB+ issued by Coca-Cola Amatil (we exclude all bonds issued by Coca-Cola Amatil, while Incenta only excludes CCA's bonds that were issued in foreign markets).

4.1.2 Expanded sample

39. Incenta's expanded sample contained 145 bonds, while our sample includes 153 bonds. All of the bonds in Incenta's sample are also in ours except EJ4333419 Corp – the Coca-Cola Amatil bond above and EI4595803.²⁶
40. The other 9 bonds we identified, including one bond issued by Aurizon itself, that were not in Incenta's expanded sample are shown in Table 4-1. There does not appear to be an obvious reason for these bonds to be excluded.

²⁶ EI4595803 was issued by Goodman Funding and had a negative 20% spread estimated using Bloomberg's OAS function. We have excluded this on the basis it likely reflects a data entry problem.



Table 4-1: Bonds fulfilling Incenta's criteria without being in the sample

Ticker	Issuer	Issue date	Maturity date	Time to maturity	Industry	S&P	Moody's	Fitch	Agg. rating	C'try of risk	Currency	Maturity type	Coupon type
EK083825 Corp	VICTORIA POWER NETWORKS	27/02/2014	1/04/2019	1.79	Utilities	A-			A-	AU	AUD	CALLABLE	FLOATING
EJ568107 Corp	AUSNET SERVICES HOLDINGS	5/03/2013	6/03/2020	2.72	Utilities	A-	A3		A-	AU	AUD	AT MATURITY	FLOATING
EK958007 Corp	ENERGY PARTNERSHIP GAS	15/06/2015	15/06/2020	3.00	Renewable Energy	BBB			BBB	AU	AUD	CALLABLE	FLOATING
AN897874 Corp	GOODMAN US FIN ONE LLC	7/06/2017	15/04/2021	3.83	Real Estate	BBB+			BBB+	AU	USD	AT MATURITY	FIXED
AN897913 Corp	GOODMAN US FIN TWO LLC	7/06/2017	22/03/2022	4.76	Real Estate	BBB+			BBB+	AU	USD	AT MATURITY	FIXED
UV302700 Corp	DBNGP FINANCE CO PTY LTD	28/09/2015	28/09/2023	6.28	Utilities	BBB	NR		BBB	AU	AUD	CALLABLE	FLOATING
AN751205 Corp	AURIZON NETWORK PTY LTD	21/06/2017	21/06/2024	7.01	Transportation & Logistics	BBB+	Baa1		BBB+	AU	AUD	CALLABLE	FIXED
EK642479 Corp	SUN GROUP FINANCE	16/12/2014	16/12/2024	7.50	Industrial Other	BBB			BBB	AU	AUD	CALLABLE	FLOATING
LW794179 Corp	WSO FINANCE PTY LTD	14/07/2016	14/07/2026	9.08	Transportation & Logistics		A3	A-	A-	AU	AUD	CALLABLE	FLOATING

Source: Bloomberg, CEG analysis; Maturity and credit ratings calculated as at 16 June 2017, credit ratings recorded as at 16 June 2017 and aggregated using Incenta method

4.2 CEG estimates

41. Table 4-2 compares the Incenta estimates with CEG's DRP estimates for the 20 days ending 30 June 2017 using our own sample of bonds based on Incenta's search criteria.

Table 4-2: Replication of Incenta estimates (AUD bonds without options issued in the Australian market)

Sample	Incenta Jun 2017	CEG Jun 2017
Pooled: A- to BBB	1.80	1.85
Pooled: BBB+ to BBB	-	2.45
BBB+ only	2.50	2.49
Pooled: A- to BBB with Dummy intercepts	2.00	2.02
Pooled: A- to BBB with Dummy slopes*	-	2.32

**Regression with dummy variables for slope but not for intercept*

42. It can be seen from Table 4-2 that our estimates differ from Incenta's, but are within ± 5 bp of Incenta's estimates.

5 Best estimate

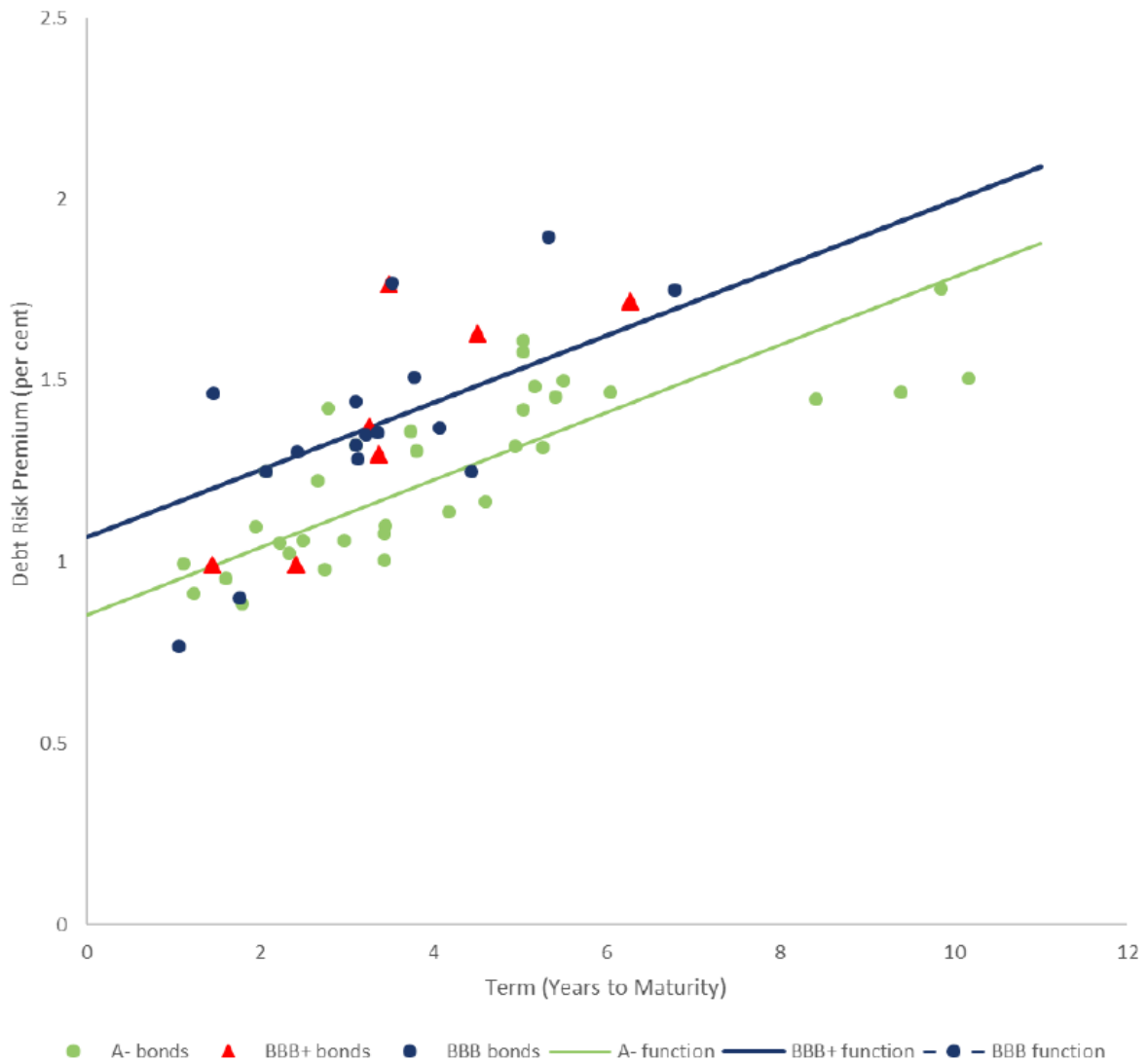
43. As stated in section 4, Incenta adopted the **2.00%** DRP estimate from the dummy variable approach. However, there are two key problems with the dummy variable estimates:
- The dummy variable model assumes that the DRP curves have the same slope across all credit ratings. However, investigation of the sample of bonds used by Incenta clearly shows that this assumption is false; and
 - The dummy variable estimates show that the difference between BBB and BBB+ DRPs is only 0.2 bp. Consequently, BBB and BBB+ bonds are, unlike A- bonds, prime candidates for pooling.

5.1 DRP slopes are not constant across credit ratings

44. Figure 5-1 reproduces Figure 5.4 of Incenta's report, which shows Incenta's individual DRP estimates of the bonds in its sample. Incenta includes the BBB, BBB+ and A- regression lines in the Figure, but the BBB and BBB+ regression lines are indistinguishable due to the very small (0.2bppa) estimated premium of BBB over BBB+.

Figure 5-1: Incenta’s DRP estimates of its bond sample

Figure 5.4: Dummy variables regression estimating BBB+ debt risk premium for 20 days to 30 June, 2017



Source: Bloomberg, RBA, and Incenta analysis

Source: Incenta report, Figure 5.4

45. A visual assessment of Figure 5-1 suggests that the A-, BBB+ and BBB bonds have similar intercepts but the BBB+ and BBB bonds have very different DRP slopes than the A- bonds, which suggests that the dummy intercept approach is not appropriate for this dataset but a dummy slope approach may be. We further explore this possibility empirically in section 5.2.

5.2 Inability to distinguish between BBB and BBB+ implies these bonds should be pooled

46. Incenta’s dummy regression estimates imply that the BBB DRP is only 0.2 bp higher than the BBB+ DRP, and that this difference is not statistically significant. This can be seen in Table 5-1, where the T-statistic of the BBB intercept coefficient is only 0.02.

Table 5-1: Incenta’s DRP estimates from dummy intercept model

Table 5.6: Debt risk premium estimates using dummy variables for 20 days to 30 June, 2017

No. of bonds	Intercept	Dummy Variable Intercept Coefficient	T-statistic	Term coefficient	T-statistic	Predicted DRP at 10 years
55						
A- bond		-0.212	-2.814			1.78
BBB+ bond	1.067		13.349	0.093	7.778	2.00
BBB bond		0.002	0.019			2.00

Source: Incenta report, Table 5.6

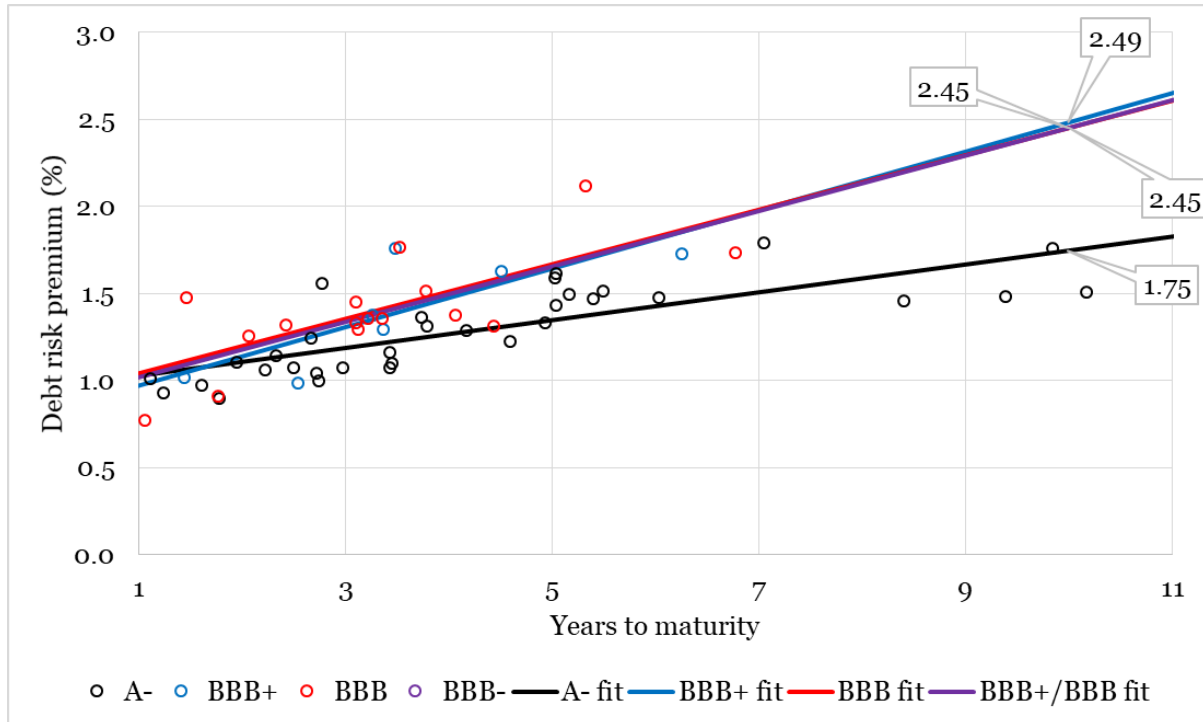
47. The conclusion of no statistical difference between BBB and BBB+ bonds suggests that the BBB and BBB+ bonds can reasonably be grouped together to arrive at an estimate of BBB+ yields. This would have the material advantage of increasing the sample size without the need to include A- bonds which clearly have a different slope to those of BBB and BBB+ bonds.
48. This is a critical finding. Incenta places most weight on the pooled dummy intercept model. However, if one accepts the results of this regression then one must, in good conscience, recommend pooling BBB and BBB+ bonds because this regression suggests that there is no statistical or economic difference between these bonds. Pooling BBB and BBB+ bonds results in a sample of 23 bonds even when the sample is restricted to AUD bonds without options. This is only 2 less than the number of bonds which Incenta used in its regression used to establish the estimate of the DBCT risk premium.²⁷

“There were sufficient BBB bonds available (25) to place reliance on a single credit rating category.”

49. The similarity between the bonds in the combined BBB and BBB+ categories, as well as the difference to the A- bonds, can be clearly seen in the Figure 5-2 below. This figure shows the regression lines for each single credit rating regression (BBB, BBB+ and A-) as well as the regression line for the pooled BBB and BBB+ regression.

²⁷ Incenta, Aurizon Network’s WACC for the 2017 DAU, December 2017, p. 103.

Figure 5-2: Pooled BBB and BBB+ regression excluding financials (but including real estate)



Source: Bloomberg; CEG analysis

50. It can be seen that the BBB and BBB+ regression lines are almost indistinguishable (consistent with Incenta’s own finding of no statistically significant difference in intercept there is also no statistically significant difference in slopes). When BBB and BBB+ bonds are pooled the resulting 10 year DRP regression line is, naturally, very similar to the BBB and BBB+ regression lines.²⁸ The pooled BBB and BBB+ 10 year DRP estimate is 2.45%. The pooled regression has a slope and intercept that is between the BBB and BBB+ slopes and intercepts. We note that including dummy variables for intercept (p-value = 0.77) or slope (p-value = 0.87) does not have an economically material effect on the BBB+ estimate and these dummy variables are not statistically significant, as can be seen in Table 5-2.
51. By contrast, the slope of the A- regression is much flatter than the slope of the other regressions, as shown in Table 5-2. This slope is statistically significantly different to that of the pooled BBB and BBB+ regression (p-value = 0.00). This clearly makes it

²⁸ We note that the single-rating BBB+ regression generates a 10-year estimate that is slightly higher than the corresponding single-rating BBB estimate, but this difference is very small and is not statistically significant. The insignificant difference between BBB and BBB+ estimates has also been observed historically, with PwC (2013) observing a positive BBB+ dummy intercept over the BBB estimate (p. 55), and Incenta (2017) finding that the BBB+ dummy intercept is only 0.2 bp above the BBB estimate (Table 5.6).

inappropriate to use A- bonds in a dummy intercept regression that assumes the same slope for all credit ratings. Doing so will bias down the estimated BBB+ slope and, as a result, bias down the 10 year BBB+ estimate.

Table 5-2: Regression results

	Coefficient	Std error	T-statistic	P-value (1-tail)*
1. BBB+ with intercept and slope dummies for BBB and A- (n = 56, df = 50); Adj R² = 0.56				
Intercept	0.80	0.19	4.27	0.00 (+)
Slope	0.17	0.05	3.42	0.00 (+)
BBB intercept dummy	0.08	0.22	0.37	0.36 (+)
A- intercept dummy	0.14	0.20	0.72	0.76 (-)
BBB slope dummy	-0.01	0.06	-1.73	0.84 (+)
A- slope dummy	-0.09	0.05	-0.20	0.04 (-)
2. BBB+ with slope dummies for BBB and A- (n = 56, df = 52); Adj R² = 0.60				
Intercept	0.92	0.05	17.04	0.00 (+)
Slope	0.14	0.02	6.29	0.00 (+)
BBB slope dummy	0.01	0.02	0.34	0.37 (+)
A- slope dummy	-0.06	0.02	-2.85	0.00 (-)
3. BBB+ with intercept and slope dummies for BBB (n = 23, df = 19); Adj R² = 0.49				
Intercept	0.80	0.23	3.54	0.00 (+)
Slope	0.17	0.06	2.83	0.01 (+)
BBB intercept dummy	0.08	0.27	0.30	0.38 (+)
BBB slope dummy	-0.01	0.07	-0.16	0.56 (+)
4. BBB+ with slope dummy for BBB (n = 23, df = 20); Adj R² = 0.55				
Intercept	0.86	0.12	7.38	0.00 (+)
Slope	0.15	0.04	4.33	0.00 (+)
BBB slope dummy	0.01	0.03	0.32	0.38 (+)
5. Pooled BBB+ & BBB with intercept and slope dummies for A- (n = 56, df = 52); Adj R² = 0.58[^]				
Intercept	0.86	0.09	9.35	0.00 (+)
Slope	0.16	0.03	6.28	0.00 (+)
A- intercept dummy	0.08	0.11	0.75	0.77 (-)
A- slope dummy	-0.08	0.03	-2.80	0.00 (-)
6. Pooled BBB+ & BBB with slope dummy for A- (n = 56, df = 53); Adj R² = 0.58[^]				
Intercept	0.92	0.05	17.07	0.00 (+)
Slope	0.14	0.02	8.45	0.00 (+)
A- slope dummy	-0.06	0.01	-4.69	0.00 (-)

Source: Bloomberg, CEG analysis; *A priori sign of the coefficient for the 1-tailed test shown in parentheses;

[^]Adj R² is 0.576 for model 5 and 0.580 for model 6; $R_{adj}^2 = 1 - \left[\frac{(1-R^2)(n-1)}{n-k-1} \right]$.

52. The process that we undertook for model selection is clearly seen in Table 5-2. First, we start with the most general model (1) that contains bonds with credit ratings from A- to BBB, and estimates intercept and slope dummies for both BBB and A- bonds (with the “intercept” and “slope” variables corresponding to the BBB+ intercept and slope). This model produces 10-year DRP estimates that are numerically equivalent to conducting separate “single-rating” regressions for each credit rating band, but the standard errors and resulting hypothesis tests are interpreted differently.
53. As opposed to testing whether each regression intercept and slope is significantly different from zero, this formulation tests whether the A- and BBB regression intercepts and slopes are significantly different (smaller for A- and larger for BBB) from the BBB+ intercept and slope respectively. The same interpretation applies to models (2) to (4) in Table 5-2, while the tests in model (5) and (6) determine whether the A- intercept and slope are significantly smaller than that of the combined pool containing BBB+ and BBB bonds.
54. We carry out 1-tail hypothesis tests at 5% significance since all of the parameters in each model have *a priori* signs.²⁹ The results for model (1) suggest that the BBB intercept and slope parameters are not significantly larger than their BBB+ counterparts, such that there is no statistical reason to include separate dummies for the BBB+ credit rating. The results also confirm the observation that the A- curve does not have an intercept that is significantly smaller than the BBB+ intercept, but the A- slope is significantly smaller than the BBB+ slope.
55. Based on the results of model (1), we remove the intercept dummies and examine the statistical significance of the A- slope, which results in model (2). The results confirm that the BBB slope is not significantly greater than the BBB+ slope, while the A- slope is significantly smaller than the BBB+ slope.
56. Models (3) and (4) further confirm that bonds with BBB+ and BBB credit ratings can be pooled, since the intercepts and slopes of the latter are not significantly different to the former.³⁰
57. Model (5) shows the regression result where bonds with BBB+ and BBB credit ratings have been pooled, while bonds with A- credit rating are assigned intercept and slope

²⁹ We expect the intercept and slope parameters of each DRP curve to have non-negative coefficients on average. (Inverted DRP curves may be possible but are fairly rare. We do not consider this possibility in our analysis, and neither do Incenta.) We also expect the intercept and slope parameters for a DRP curve with a certain credit rating to be greater than or equal to that of a DRP curve with a lower quality credit rating on average, as shown in Figure 5.13 of the PwC report.

³⁰ We note that the coefficients in model (4) are numerically equivalent to their corresponding coefficients in model (1), because including separate intercept and slope parameters for a particular credit rating is equivalent to generating a separate regression line for said credit rating.

dummies.³¹ The A- intercept dummy is not statistically smaller than the pooled BBB+/BBB intercept, but the A- slope is statistically smaller than the pooled BBB+/BBB slope.

58. Finally, model (6) removes the A- intercept dummy from model (5), leaving a single A- slope dummy that continues to be statistically smaller than the slope of the pooled BBB+/BBB curve.
59. The adjusted R² of each regression also shows that removing intercept dummies while retaining slope dummies results in better model fitting, which is to be expected since the intercept dummies are not significant in any of the models shown in Table 5-2.

5.3 Best estimate of DRP from pooled regressions

60. In our view, pooling BBB and BBB+ bonds will result in a reliable estimate of the 10 year BBB+ DRP (2.45%) because BBB and BBB+ bond yields are economically and statistically indistinguishable.
61. When we perform a pooled regression of A- to BBB rated bonds with dummy variables for the slope (but not the intercept) we estimate that the BBB+ DRP is 2.32%. In our view, if A- bonds are to be pooled with BBB and BBB+ bonds it is critical that a dummy for slopes is used because it is clear from the data that the main source of difference is the slopes of the credit rating regressions (not the intercepts).

Table 5-3: Estimates of DRP that are not biased by lower A- DRP slope (AUD bonds without options issued in the Australian market)

Sample	Incenta Jun 2017	CEG Jun 2017
Pooled: BBB+ to BBB	-	2.45
BBB+ only	2.50	2.49
Pooled: A- to BBB with Dummy slopes	-	2.32

5.4 Excluding real estate firms

62. We note that Incenta interprets the PwC practice as excluding only financial companies that are not real estate companies (even though Bloomberg classifies real estate companies as financial companies). If we instead also exclude real estate financial companies then the number of bonds drops from 23 to 20 and the pooled BBB/BBB+ DRP estimate rises from 2.45% to 2.50%.

³¹ We note that the 10-year A- DRP estimate implied by model (5) is numerically equivalent to that implied by model (1), since both models include separate intercept and slope parameters for the A- credit rating.

5.5 Incenta logic supports CEG preferred estimate

63. The pooling of BBB and BBB+ bonds is a flexible response to the qualities that are observable in the data. It reflects a reasoned assessment of the trade-offs between the weaknesses of the various regression models. Specifically:
- the single BBB+ credit rating approach has too small a sample size to be reliable;
 - the differences between BBB+ and A- bonds means that inclusion of the former in a the pooled regression and intercept dummy variable approaches both suffer from material bias – reflecting both asymmetry in sample sizes across credit ratings and, in the case of the latter, the difference in DRP slopes;
 - by contrast, the similarity between BBB+ and BBB bonds makes pooling of these bonds an appropriate response to the lack of BBB+ bonds.
64. Incenta has indicated that it prefers a flexible application of the PwC approach, as opposed to doing so mechanistically [emphasis added]:³²

When one of these conditions is not met, Incenta’s approach has been to investigate ways of overcoming the potential for distorted estimates of the debt risk premium, and to obtain the most appropriate estimate based on the available data. This has at times involved the running of sensitivities with excluded bonds that looked like aberrations. An example was a set of DBCT bonds that were rated BBB+ but were actually being priced as BBB (and were subsequently re-rated to BBB and below). Consistent with the PwC (2013) approach, we have had regard to results obtained by the introduction of dummy variables, and have also applied single credit rating regression when the number of bonds has been sufficient. In addition, the QCA’s preferred approach requires that we compare our findings using the PwC (2013) approach against the third party estimates of Bloomberg and the RBA. Rather than creating risk, Incenta’s flexible application of the PwC (2013) approach has provided greater regulatory certainty by not applying the method mechanistically.

65. On one hand, Incenta has implicitly stated that the single credit rating approach is the preferred approach in the absence of issues pertaining to data quality and regression diagnostics [emphasis added]:³³

We agree with CEG that one of the assumptions behind using the “pooled regression” approach is that approximate symmetry exists in the debt risk premium on either side of the target credit rating, and that bias could result

³² Incenta, Aurizon Network’s WACC for the 2017 DAU, December 2017, p. 102.

³³ Incenta, Aurizon Network’s WACC for the 2017 DAU, December 2017, p. 88.

*if this is not the case. We draw attention to the fact that **the pooled regression approach was a second-best approach**. It was made clear in our previous report on DBCT that “**the pooled regression approach was designed to overcome the problem of there not being enough bond observations in a given credit rating band to allow a reliable estimate to be made.**”*

66. At the same time, Incenta has addressed a similar issue in a previous report for Aurizon, whereby Incenta acknowledged the trade-off between the problem of small sample size and other data issues, and argued that there was no perfect solution to it [emphasis added]:³⁴

Other criticisms of the simple weighting mechanism could be advanced. For example, the PwC weighting cross-check does not take account of whether there is an even spread of bonds in the three credit rating bands at different terms to maturity. We highlighted these characteristics in our original report, which showed that the BBB+ bond in the sample had an average term to maturity of 5.54 years, while the BBB bonds were only 4.09 years from maturity, and the A- bonds were on average only 3.68 years from maturity.

***However, unless the specific impacts on the debt risk premium of all these characteristics are known, it is not possible to devise a specific weighting mechanism that would accommodate these differences and jointly determine the ‘perfect’ estimate of the debt risk premium.** If the characteristics that determine bond yields were all known in this way, estimating the cost of debt would be straight forward. Since they are not known it is necessary to estimate the debt risk premium with less than perfect data. More data is better, because a small sample can be affected by unusual observations.*

*The problems highlighted by Aurizon Network are caused by the relatively low number of BBB+ bonds available, and the relatively high yields of a small number of these bonds. **In these circumstances we continue to favour a pooled regression with 80 or more bond debt risk premium observations determining the outcome, precisely because smaller samples are potentially significantly influenced by unusual observations.***

67. The above discussion makes clear that the ultimate trade-off of importance involves:

³⁴ Incenta, Aurizon Network 2014 DAU – response to submissions on WACC, September 2015, pp. 29-30.

- BBB+ estimates being unbiased but, with small sample sizes, high variance (i.e., high variance due to smaller samples being “potentially significantly influenced by unusual observations”);
 - Pooling with other credit ratings reducing variance (by virtue of using a larger sample size) but potentially introducing bias (e.g., if DRP slopes are not the same and/or the impact of a change in credit rating notch is not equal across all credit rating notches).
68. When this is recognised then the inclusion of each credit rating notch in a pooled regression must be assessed on its own merits. The analysis we have performed shows that adding BBB bonds to BBB+ bonds will reduce variance without any material increase in bias. However, the addition of A- bonds will strongly bias downward the 10 year DRP estimate.

5.6 Conclusion

69. Our best estimate of the BBB+ DRP in June 2017 is between 2.32% and 2.50%. The lower end of this bound is based on a pooled regression of A- to BBB bonds with a dummy for slopes (not intercepts). The top end of this range is based on a pooled regression of non-financial AUD issued BBB and BBB+ bonds (excluding real estate bonds) with no dummy variables.

6 Cross checks

6.1 Third party DRP estimates

70. It is also the case that, if one accepts Incenta’s pooled regression results, then this implies that Incenta’s method for arriving at a third party (RBA/Bloomberg) BBB+ estimate is flawed. Incenta’s method assumes that each credit rating notch has the same premium to the next highest credit rating notch. This assumption allows Incenta to arrive at a BBB+ credit rating by giving 1/3rd and 2/3rd weight to the A and BBB third party estimates respectively. However, Incenta’s pooled regression results imply that this gives too much weight to the A- credit rating because BBB+ and BBB credit ratings have, in fact, the same DRPs.
71. That is, the fact that Incenta’s dummy variable estimates suggest that BBB+ and BBB estimates are neither statistically nor economically significantly different suggests that it is appropriate to use 3rd party BBB estimates as a proxy for the benchmark BBB+ estimate. The relevant cross-checks are set out below.

Table 6-1: Third party cross-checks

Source	Jun 2017 (%)
RBA BBB	2.18*
Bloomberg BBB	2.34*
Reuters BBB	2.42**
Average	2.31

*Reported by Incenta. **Obtained by CEG

72. These cross-checks fall above Incenta’s best estimate (2.00%). By contrast, two of the three cross-checks fall within our range for the best estimate (2.32% to 2.50%).
73. We note as well that the discussion in section 3.3.2 shows that PwC (2013) opted to refer to the Bloomberg BBB BFV curve (since replaced with the Bloomberg BBB BVAL curve) since it was accepted as referring to a BBB+ estimate by convention. Since the Bloomberg BBB BFV curve has now been replaced with the BBB BVAL curve, while the RBA BBB curve has also started to be used as part of regulatory decisions, both the BVAL BBB and RBA BBB curves should thus also be used without making credit rating adjustments

6.2 Foreign currency bonds

74. If we include foreign currency bonds but retain all of our other assumptions (pooled BBB/BBB+ bonds excluding financial bonds and bonds with options) then our results are summarised below, where “Pooled: BBB+ to BBB” refers to a regression on a

sample that pools BBB+ and BBB bonds, while “Pooled Dummy slope BBB+” uses a sample containing A- to BBB bonds, but includes a slope dummy for A- bonds only.

Table 6-2: DRP estimates with and without real estate bonds

Sample	Include real estate (number of bonds)	Exclude real estate (number of bonds)
AUD bonds without options issued in the Australian market		
Pooled: BBB+ to BBB	2.45% (23)	2.50% (20)
Pooled Dummy slope BBB+*	2.32% (23)	2.37% (20)
AUD and FX bonds without options		
Pooled: BBB+ to BBB	2.15% (50)	2.18% (41)
Pooled Dummy slope BBB+	2.15% (96)	2.24% (74)
AUD and FX bonds with options		
Pooled: BBB+ to BBB	2.04% (90)	2.06% (71)
Pooled Dummy slope BBB+	2.01% (153)	2.02% (112)

75. It can be seen that including foreign currency bonds reduces the estimated DRP at 10 years by around 15 to 30 bppa (depending on the regression in question). Including bonds with options further reduces the estimate by a similar magnitude.
76. On the assumption that the benchmark is the issuance of AUD debt without options then the inclusion of foreign currency and bonds with options can only be justified to the extent that the benefits in terms of reduced variance (due to larger sample size) are outweighed by the costs in terms of increased bias (due to different yields on non AUD bonds and non-AUD bonds with options). Given that there are 23 BBB and BBB+ AUD bonds without options it is not clear that there are material advantages in terms of reduced variance from widening the sample while it is the case that there is potentially material costs in terms of increased bias.
77. In this regard we note Incenta’s report suggests that with a sample of 25 bonds the advantages of expanding the sample further, at the risk of increased bias, did not justify such an expansion:³⁵

In our analysis for DBCT we applied a single credit rating (BBB) regression to estimate the debt risk premium because:

- *The pooled regression method was likely to provide an inaccurate estimate owing to extreme asymmetry in the debt risk premium differentials around the BBB bond; and*

³⁵ Incenta, Aurizon Network’s WACC for the 2017 DAU, December 2017, p. 103.

• There were sufficient BBB bonds available (25) to place reliance on a single credit rating category.

78. Incenta's position is consistent with that of our previous report for Aurizon, in which we suggested that the ERA's methodology was one possible option if small sample size were to be an issue [emphasis added]:³⁶

Given the potential concerns with application of the PwC/Incenta method with a small sample size, we consider that some consideration should be given to the inclusion of bonds issued in foreign currencies (swapped back into AUD) and bonds issued with options (but with DRPs adjusted using ERA's methodology as cited in section 3.3.2). This involves more or less adopting the ERA/RBA approach to sample selection.

When we do this the sample size increases materially as illustrated in Figure 4-13 below, which includes callable and puttable bonds while excluding bonds issued by financial firms.

79. We once again reiterate our overall position that the PwC approach should be applied flexibly rather than mechanically (which is also consistent with Incenta's view as set out in paragraph 64):³⁷

This is because the appropriate linear regression to apply is an empirical matter and cannot be selected without knowing the DRP sample for the actual averaging period - a point noted by Incenta (2016b). A mechanistic application of any one of the variations of the linear regression approach risks giving rise to highly variable/unpredictable results that may end up being inappropriate.

³⁶ CEG, Debt risk premium of coal transporters: A report for Aurizon Network, September 2016, p. 34 at [123]-[124].

³⁷ CEG, Debt risk premium of coal transporters: A report for Aurizon Network, September 2016, p. 4 at [10].